

# HOME ENERGY RATING SYSTEMS (HERS) FIELD VERIFICATION AND DIAGNOSTIC TESTING REGULATIONS

CALIFORNIA  
ENERGY  
COMMISSION

for the  
**2005 BUILDING ENERGY EFFICIENCY  
STANDARDS FOR LOW-RISE  
RESIDENTIAL BUILDINGS**

**STANDARDS/REGULATIONS**



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Arnold Schwarzenegger, *Governor*



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**Note: The following pages are excerpts from the Residential Alternative Calculation Method Approval Manual P400-03-003F.**

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# Overview



## Overview

The Building Energy Efficiency Standards for low-rise residential buildings (Sections 151(f) 7 and 151 (f) 10 for newly constructed buildings, 152 (a) 1 or 152 (a) 2 for additions, and 152 (b) 1 D and 152 (b) 1 E for alterations to existing buildings) contain requirements for field verification and diagnostic testing by a certified HERS (Home Energy Rating System) rater. Also, compliance credit is available for several other measures that require HERS rater field verification and diagnostic testing, as specified in the Residential Alternative Calculation Methods (ACM) Approval Manual. For buildings that have used a measure for compliance that requires HERS rater field verification and diagnostic testing, Section 10-103 (e) 2 requires that building departments not approve the building until the building department has received a Certificate of Field Verification and Diagnostic Testing (CF-4R) that has been signed and dated by the HERS rater. The Commission approves HERS providers, subject to the Commission's HERS regulations, which appear in the California Code of Regulations, Title 20, 1670-1675.

The purpose of this document is to put under one cover the regulations directly related to residential HERS field verification and diagnostic testing so that building officials, builders, installing contractors, energy consultants, HERS providers and raters and other people who have a role in successful compliance for measures requiring HERS field verification and diagnostic testing can easily locate the requirements. This document includes:

- Chapter 7 of the Residential ACM Manual, which provides detailed information for what measures require HERS field verification and diagnostic testing (see Table 7-1) and what procedures must be followed to complete the process,
- appendices RC, RD, RE, RF, RH and RI, which provide the protocols that builders, installing contractors and raters must use to complete field verification,
- compliance forms necessary for documenting measures that require field verification and diagnostic testing, including the CF-1R, CF-4R, and CF-6R and
- the HERS regulations, which provides the duties of HERS providers, the obligations of raters to provide true, accurate and complete reports of field verification findings (Section 1672 (d)), and rules for avoiding conflicts-of-interest between raters and builders and between raters and installing contractors (Section 1673 (i)).

Readers should recognize that the Residential Compliance Manual provides further clarification of the HERS rater field verification and diagnostic testing process as it relates to specific measures (the reader could search for "HERS" or "field verification" to find pertinent sections). The Residential Compliance Manual is on the Commission's website at:

<http://www.energy.ca.gov/2005publications/CEC-400-2005-005/CEC-400-2005-005-CMF.PDF> .



# **Home Energy Rating Systems (HERS) Required Field Verification and Diagnostic Testing**

**Note:** the following pages are excerpts from the *Residential Alternative Calculation Method Approval Manual P400-03-003F*.



## **7. Home Energy Rating Systems (HERS) Required Field Verification and Diagnostic Testing**

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### **7.1. California Home Energy Rating Systems**

Compliance credit for particular energy efficiency measures, which the Commission specifies, requires field verification and diagnostic testing of as-constructed dwelling units (as defined in Section 7.9) by a certified HERS (Home Energy Rating System) rater. The Commission approves HERS providers, subject to the Commission's HERS regulations, which appear in the California Code of Regulations, Title 20, Division 2, Chapter 4, Article 8, Sections 1670-1675. Approved HERS providers are authorized to certify HERS raters and maintain quality control over field verification and diagnostic testing ratings.

When compliance documentation indicates field verification and diagnostic testing of specific energy efficiency measures as a condition for complying with Title 24, Part 6, an approved HERS provider and certified HERS rater shall be used to conduct the field verification and diagnostic testing. HERS providers and raters shall be considered special inspectors by building departments, and shall demonstrate competence, to the satisfaction of the building official, for the visual inspections and diagnostic testing. The HERS provider and rater shall be independent entities from the builder or subcontractor installer of the energy efficiency improvements being tested and verified, and shall have no financial interest in the installation of the improvements. Third Party Quality Control Programs approved by the Commission may serve the function of HERS raters for field verification purposes as specified in Section 7.6.

The remainder of this chapter describes the:

- Measures that require field verification or testing (including references to test procedures or protocols that shall be followed by installers and HERS raters);
- Required documentation and communication steps;
- Requirements for certification by the installer that the installation complies;
- Required HERS rater verification procedures, and sampling procedures to be used if the builder chooses to do sampling;
- Requirements for Third Party Quality Control Programs that are authorized to serve the function of HERS raters;
- Requirements for sampling when field verification and diagnostic testing is required for additions and alterations; and
- Responsibilities of each of the parties involved in the field verification and diagnostic testing process.

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### **7.2. Measures Required Field Verification and Diagnostic Testing**

Table R7-1 describes the measures that require installer certification and HERS rater field verification and diagnostic testing, and identifies the protocol or test procedure in the appendices

that shall be used for completing installer and HERS rater diagnostic testing and HERS rater field verification.

*Table R7-1 – Summary of Measures Requiring Field Verification and Diagnostic Testing*

Measure Title	Description	Protocol or Test Procedure
<b>Duct Measures</b>		
Duct Sealing	Package D requires that space conditioning ducts be sealed. If sealed and tested ducts are claimed in the proposed design ACM calculation, diagnostic testing is required to verify that leakage is less than the specified criteria.	ACM Appendix RC-2005
Supply Duct Location, Surface Area and R-factor	If compliance credit is claimed for improved supply duct location, surface area and R-value, field verification is required to verify that duct system was installed according to the design, including location, size and length of ducts, duct insulation R-value and installation of buried ducts. <sup>1</sup>	ACM Appendix RC-2005
<b>Air Conditioner Measures</b>		
Improved Refrigerant Charge	Package D requires in some climate zones that split system air conditioners and heat pumps be diagnostically tested in the field to verify that they have the correct refrigerant charge (see Section 4.7.3). The Proposed Design is modeled with less efficiency if diagnostic testing and field verification is not performed.	ACM Appendix RD-2005
Installation of Thermostatic Expansion Valve (TXV)	A TXV may be installed as an alternative to refrigerant charge testing. The existence of a TXV has the same calculated benefit as refrigerant charge testing and requires field verification.	ACM Appendix RI-2005
Adequate Air Flow	Air conditioner efficiency requires adequate airflow across the evaporator coil. Compliance credit may be taken when airflow is higher than the criteria specified	ACM Appendix RE-2005
Air Handler Fan Watt Draw	If compliance credit is taken for reductions in fan power, the installed fan power shall be diagnostically tested and verified in the field.	ACM Appendix RE-2005
High Energy Efficiency Ratio (EER)	Compliance credit may be taken for increases in EER by installation of specific air conditioner or heat pump models, but only if the installation of that high EER model is field verified.	ACM Appendix RI-2005
Maximum Cooling Capacity	An additional compliance credit may be taken when the requirements for the combination of adequate air flow, duct sealing and Improved refrigerant charge are met and air conditioners are sized according to the ACM calculations. Field verification is required.	ACM Appendix RF-2005
<b>Building Envelope Measures</b>		
Building Envelope Sealing	The default building envelope specific leakage area (SLA) is specified in Section 4.5.1. Compliance credit may be taken for improved building envelope sealing, but only if lower SLA values are field verified through diagnostic testing.	ASTM E779-03
High Quality Insulation Installation	ACMs recognize Standard and improved envelope construction. Compliance credit for improved envelope construction requires field verification.	ACM Appendix RH-2005

<sup>1</sup>. Note: Compliance credit for increased duct insulation R-value (not buried ducts) may be taken without field verification if the R-value is the same throughout the building, and for supply ducts located in crawlspaces and garages where all supply registers are either in the floor or within 2 feet of the floor. These two credits may be taken subject only to building department inspection.

2. Note: The requirement for verification of a high EER does not apply to equipment rated only with an EER.

All features that require verification and/or testing shall be listed in the *Field Verification and Diagnostic Testing* section of on the *Certificate of Compliance* (CF-1R). The listing shall include “eligibility and installation criteria” for such features. Field verified and diagnostically tested features shall be described in the *Compliance Supplement*. Installers shall certify that the requirements for compliance have been met on the *Installation Certificate* (CF-6R). Field

Verification and diagnostic testing shall be performed by a HERS rater and documented on the *Certificate of Field Verification and Diagnostic Testing* (CF-4R).

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### **7.3. Summary of Documentation and Communication**

The documentation and communication process for measures that require field verification and diagnostic testing is summarized below. The subsequent sections of this chapter contain additional information.

- The documentation author shall complete the compliance documents, including the CF-1R. A CF-1R shall be prepared for each dwelling unit. For multi-family buildings a single CF-1R is typically prepared for a whole building, but separate compliance documentation shall be required for dwelling units that have measures requiring field verification and diagnostic testing.
- The documentation author shall provide a signed Certificate of Compliance (CF-1R) to the builder, which indicates that any HERS diagnostic testing and field verification measure is required for compliance. The builder shall make arrangements for the services of a certified HERS rater prior to installation of the measures, so that once the installation is complete the HERS rater has ample time to complete the field verification and diagnostic testing without delaying final approval of occupancy by the building department.
- The builder or subcontractor installs the measure(s) that require field verification and diagnostic testing. The builder or installer completes diagnostic testing and the procedures specified in Section 7.4. When the installation is complete, the builder or subcontractor completes the CF-6R (Installation Certificate), keeping it at the building site for review by the building department. A copy of the CF-6R is also provided to the HERS rater.
- The HERS rater shall complete the field verification and diagnostic testing as specified in Section 7.5, and provides signed CF-4Rs, Certificate of Field Verification and Diagnostic Testing, to the HERS provider, builder and building department. The building department shall not approve a dwelling unit for occupancy until the building department has received a CF-4R that has been signed by the certified HERS rater.

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### **7.4 Installer Requirements for Installation Certification (CF-6R)**

Installation certificates (CF-6R) are required for each and every dwelling unit. When the installation of measures that require field verification and diagnostic testing is complete, the builder or the builder's subcontractor shall complete diagnostic testing and the procedures specified in this section. When the installation is complete, the builder or the builder's subcontractor shall complete the CF-6R (Installation Certificate), and keep it at the building site for review by the building department. The builder also shall provide a copy of the Installation Certificate to the HERS rater for any measures requiring field verification and diagnostic testing.

#### **7.4.1 Measures Requiring Diagnostic Testing and Field Verification**

When compliance includes duct sealing, improved air conditioner refrigerant charge and airflow across the evaporator coil, reduced air conditioner fan power or building envelope sealing, builder employees or subcontractors shall:

- complete diagnostic testing, and

- certify on the CF-6R the diagnostic test results and that the work meets the requirements for compliance credit.

For refrigerant charge and airflow measurement when the outside temperature is below 55°F, the installer shall follow the alternate charge and airflow measurement procedure described in Appendix RD, Section RD3. Builder employees or subcontractors using these procedures shall certify on the CF-6R that they used these procedures, the diagnostic results, that the work meets the requirements for compliance credit, and that they will return to correct refrigerant charge and airflow if the HERS rater determines at a later time when the outside temperature is above 55°F that correction is necessary.

For duct sealing diagnostic testing completed at the rough-in stage of construction, builder employees or subcontractors shall:

- at rough-in, complete the fan pressurization test and certify on the CF-6R the diagnostic results,
- after installation of the interior finishing wall, complete the installer visual inspection at final construction stage (See ACM RC-2005), and
- certify on the CF-6R the diagnostic results and that the work meets the requirements for compliance credit.

#### **7.4.2 Measures Requiring Field Verification**

When compliance includes supply duct location, surface area and R-value improvements, installation of an air conditioner thermostatic expansion valve, high air conditioner EER, and high quality building envelope construction builder employees or subcontractors shall:

- record the feature on the CF-6R,
- record on the CF-6R field measurements required to field verify the measure, and
- certify on the CF-6R that the work meets the requirements for compliance credit.

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### **7.5 Verification and Sampling Procedures**

At the builder's option HERS field verification and diagnostic testing shall be completed either for each dwelling unit or for a sample of dwelling units in which the measure requiring field verification and diagnostic testing is installed. Note that if multiple measures requiring field verification and diagnostic testing are installed in dwelling units, sample testing does not have to be completed for all of the measures in the same dwelling unit. Dwelling units in the sample shall be in the same subdivision or multifamily housing development. Field verification and diagnostic testing for compliance credit for duct sealing shall use the diagnostic duct leakage from fan pressurization of ducts in Section RC3.1, ACM RC-2005. Field verification and diagnostic testing for compliance credit for refrigerant charge and airflow measurement shall use the standard charge and airflow measurement procedure specified in ACM RD-2005. Field verification and diagnostic testing shall not use the alternate charge and airflow measurement procedure. Field verification and diagnostic testing shall be scheduled and completed when the outside temperature is above 55°F.

The builder shall provide the HERS rater a copy of the CF-6R containing the installation certifications required in Section 7.4. Prior to completing field verification and diagnostic testing, the HERS rater shall first verify that the installation certifications have been completed. If the builder chooses the sampling option, the procedures described in this section shall be followed. Sampling procedures described in this section shall be included in the *Residential Manual*.

### **7.5.1 Initial Field Verification and Testing**

The HERS rater shall diagnostically test and field verify the first dwelling unit of each model. To be considered the same model, dwelling units shall be in the same subdivision or multifamily housing development and have the same energy designs and features, including the same floor area and volume, for each dwelling unit, as shown on the CF-1R. For multi-family buildings, variations in exterior surface areas caused by location of dwelling units within the building shall not cause dwelling units to be considered a different model. This initial testing allows the builder to identify and correct any potential construction flaws or practices in the build out of each model. If field verification and diagnostic testing determine that the requirements for compliance are met, the HERS rater shall provide a signed and dated *Certificate of Field Verification and Diagnostic Testing* (CF-4R) to the builder the HERS provider, and the building department.

### **7.5.2 Sample Field Verification and Testing**

After the initial testing is completed, the builder shall identify a group of up to seven dwelling units from which a sample will be selected for testing, and notify the HERS provider. If multiple measures requiring field verification and diagnostic testing are installed, each dwelling unit in the group shall have the same measures requiring field verification and diagnostic testing as the other dwelling units in the group. If some dwelling units have installed a different set of measures requiring field verification and diagnostic testing, these dwelling units shall be in a separate group.

The builder shall identify the group of dwelling units by location of County, City and either the street address or the subdivision and lot number, or the multifamily housing project name and shall identify the names and license numbers of subcontractors responsible for installations requiring diagnostic testing or field verification. The builder may remove dwelling units from the group by notifying the HERS provider. Removed dwelling units which are constructed shall either be field verified and diagnostically tested individually or shall be included in a subsequent group for sampling.

The HERS rater shall select a minimum of one dwelling unit out of the group for diagnostic testing and field verification. When several dwelling units are ready for testing at the same time, the HERS rater shall randomly select the dwelling units to be tested. The HERS rater shall diagnostically test and field verify the dwelling units selected by the HERS rater.

If field verification and diagnostic testing determines that the requirements for compliance are met, the HERS rater shall provide a signed and dated *Certificate of Field Verification and Diagnostic Testing* to the builder, the HERS provider, and the building department. The *Certificate of Field Verification and Diagnostic Testing* shall report the successful diagnostic testing results and conclusions regarding compliance for the tested dwelling unit.

The HERS rater shall also provide a signed and dated *Certificate of Field Verification and Diagnostic Testing* to the builder and the HERS provider for up to six additional dwelling units in the group. The *Certificate* shall not be provided for dwelling units in which the feature requiring field verification and diagnostic testing has not been installed, sealed or completed. Whenever the builder changes subcontractors who are responsible for the feature that is being diagnostically field verified and tested, the builder shall notify the HERS rater of any subcontractors who have changed, and terminate sampling for the identified group. All dwelling units using *HERS Required Verification* features for compliance that were installed by previous subcontractors or were subject to verification and testing under the supervision of a previous HERS provider, for which the builder does not have a completed *Certificate of Field Verification and Diagnostic Testing*, shall either be individually tested or included in a separate group for sampling. Dwelling units with installations completed by new subcontractors shall either be individually tested or shall be included in a new sampling group following a new *Initial Field Verification and Testing*.

The HERS rater shall not notify the builder when sample testing will occur prior to the completion of the work that is to be tested. After the HERS rater notifies the builder when testing will occur, the builder shall not do additional work on the features being tested.

### **7.5.3 Re-sampling, Full Testing and Corrective Action**

When a failure is encountered during sample testing, the HERS rater shall conduct re-sampling to assess whether that failure is unique or the rest of the dwelling units are likely to have similar failings. The HERS rater shall select for re-sampling one of the up to six untested dwelling units in the group.

If testing in dwelling units in the re-sample confirms that the requirements for compliance credit are met, then the dwelling unit with the failure shall not be considered an indication of failure in the other dwelling units in the group. The HERS rater shall provide a signed and dated *Certificate of Field Verification and Diagnostic Testing* to the builder, the HERS provider, and the building department for up to six additional dwelling units in the group, including the dwelling unit in the re-sample. The builder shall take corrective action for the dwelling unit with the failure, and then the HERS rater shall retest to verify compliance and issue a signed and dated *Certificate of Field Verification and Diagnostic Testing* to the builder.

If field verification and testing in the re-sample results in a second failure, the builder shall take corrective action in all unoccupied dwelling units in the group that have not been tested. In cases where corrective action would require destruction of building components, the builder may choose to reanalyze compliance and choose different measures that will achieve compliance. In this case a new Certificate of Compliance shall be completed and submitted to the HERS provider, HERS rater and building department. When a builder chooses to take corrective action, the HERS rater shall conduct field verification and diagnostic testing in each of these dwelling units to verify that problems have been corrected and that the requirements for compliance have been met, and shall report to the HERS provider, the builder, and the building department. Builders shall offer at no charge to building owners (for a definition of “building owner” and of other terms used see Section 7.9) in occupied dwelling units in the group to complete field verification and testing and corrective action if necessary. Builders shall report to the HERS provider the identifying location of any dwelling unit in which the building owner declines field verification and testing and corrective. The HERS provider shall verify that the builder has made

this offer. If a building owner in an occupied dwelling unit declines this offer, field verification, testing and corrective action will not be required for that dwelling unit and the dwelling unit will no longer be considered a part of the group. If a building owner accepts this offer, the builder shall take corrective action. The HERS rater shall then conduct field verification and diagnostic testing to verify that problems have been corrected and that the requirements for compliance have been met, and shall report to the HERS provider, builder, and the building department. The HERS provider shall file a report with the building department explaining all action taken (including field verification, testing, corrective action, offers to building owners for testing and corrective action and building owner declines of such offers) to bring into compliance dwelling units for which full testing has been required. If corrective action requires work not specifically exempted by the CMC or the CBC, the builder shall obtain a permit from the building department prior to commencement of any of the work.

If additional dwelling units in the group are completed during the time required to correct, field verify and test the previously completed dwelling units in the group, the rater shall individually field verify and diagnostically test those additional dwelling units to confirm that the requirements for compliance credit are met.

Corrections shall not be made to a sampled or re-sampled dwelling unit to avoid a failure. If corrections are made to a sampled or re-sampled dwelling unit to avoid failure, corrections, field verification and testing shall be performed on 100% of the dwelling units in the group.

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## **7.6 Third Party Quality Control Programs**

The Commission may approve Third Party Quality Control Programs that serve the function of HERS raters for field verification purposes. Third Party Quality Control Programs shall provide training to installers regarding compliance requirements for measures for which diagnostic testing and field verification is required. Third Party Quality Control Programs shall collect data from participating installers for each installation completed for compliance credit, complete data checking analysis to evaluate the validity and accuracy of the data to independently determine whether compliance has been achieved, provide direction to the installer to retest and correct problems when data checking determines that compliance has not been achieved, require resubmission of data when retesting and correction is directed, and maintain a database of all data submitted by installers in a format that is acceptable to the Commission and available to the Commission upon request. The data that is collected by the Third Party Quality Control Program shall be more detailed than the data required for showing compliance with the Standards, shall provide an independent check on the validity and accuracy of the installer's claim that compliance has been achieved, and shall not be alterable by the installer to indicate that compliance has been achieved when in fact compliance has not been achieved.

The Third Party Quality Control Program shall also obtain the services of a HERS rater to conduct independent field verifications, completing all of the responsibilities of a HERS rater as specified in this Chapter with the exception that sampling shall be completed for a group of up to thirty dwelling units with a minimum sample of one out of every thirty sequentially completed dwelling units from the group. The HERS rater shall be an independent entity from the Third Party Quality Control Program. Re-sampling, Full Testing and Corrective Action shall be completed as specified in section 7.5.3 with the exception that re-sampling shall be completed for a minimum of one out of every thirty dwelling units from the group.

The Third Party Quality Control Program shall meet all of the requirements of a HERS rater specified in the Commission's HERS Program regulations (California Code of Regulations, Title 20, Division 2, Chapter 4, Article 8, Sections 1670 -1675), including the requirement to be an independent entity from the builder and the HERS rater that provides independent field verifications, subcontractor installer as specified by section 1673(i). A Third Party Quality Control Program may have business relationships with installers participating in the Program to advocate or promote the Program and an installer's participation in the Program, and to advocate or promote products that the Third Party Quality Control Program sells to installers as part of the Program.

Prior to approval by the Commission, the Third Party Quality Control Program shall provide a detailed explanation to the Commission of 1) the data that is to be collected from the installers, 2) the data checking process that will be used to evaluate the validity and accuracy of the data, 3) the justification for why this data checking process will provide strong assurance that the installation actually complies, and 4) the format for the database that will be maintained and provided to the Commission upon request. The Third Party Quality Control Program may apply for a confidential designation of this information as specified in the Commission's Administrative Regulations (California Code of Regulations, Title 20, Division 2, Chapter 7, Article 2, Section 2505). The Third Party Quality Control Program shall also provide a detailed explanation of the training that will be provided to installers, and the procedures that it will follow to complete independent field verifications.

The Third Party Quality Control Program shall be considered for approval as part of the rating system of a HERS Provider, which is certified as specified in the Commission's HERS Program regulations, Section 1674. A Third Party Quality Control Program can be added to the rating system through the recertification of a certified HERS Provider as specified by Section 1674(d).

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### **7.7 Sampling for Additions or Alterations**

When compliance for an addition or alteration requires diagnostic testing and field verification, the building owner may choose for the testing and field verification to be completed for the dwelling unit alone or as part of a sample of dwelling units for which the same installing company has completed work that requires testing and field verification for compliance. The building owner or agent of the building owner shall complete the applicable portions of a Certificate of Compliance (CF-1R). The HERS provider shall define the group for sampling purposes as all dwelling units where the building permit applicant has chosen to have testing and field verification completed as part of a sample for the same installing company. The group shall be no larger than seven. The installing company may request a smaller group for sampling. Whenever the HERS rater for the group is changed, a new group will be established. Initial Field Verification and Testing shall be completed for the first dwelling unit in each group. Re-sampling, Full Testing and Corrective Action shall be completed if necessary as specified by section 7.5.3.

Field verification may be completed by an approved Third Party Quality Control Program as specified in section 7.6. The group for sampling purposes shall be no larger than thirty when a Third Party Quality Control Program is used. The Third Party Quality Control Program may define the group instead of the Provider. When a Third Party Quality Control Program is used, the CF-4R shall document that data checking has indicated that the dwelling unit complies. The building official may approve compliance based on the CF-4R on the condition that if sampling

indicates that re-sampling, full testing and corrective action is necessary, such work shall be completed.

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## **7.8 Summary of Responsibilities**

This section summarizes responsibilities described previously in this chapter and organizes them by the responsible party.

### **7.8.1 Builder**

The builder shall make arrangements for the services of a certified HERS rater prior to installation of the measures, so that once the installation is complete the HERS rater has ample time to complete the field verification and diagnostic testing without delaying final approval of occupancy by the building department.

Builder employees or subcontractors responsible for completing either diagnostic testing, visual inspection or verification as specified in Section 7.4 shall certify the diagnostic testing results and that the work meets the requirements for compliance credit on the CF-6R.

The builder shall provide the HERS rater with the identifying location of the group of dwelling units to be included in the sample for field verification and diagnostic testing. The builder shall provide the HERS provider a copy of the CF-6R signed by the builder employees or subcontractors certifying that diagnostic testing and installation meet the requirements for compliance credit.

The builder shall provide a *Certificate of Field Verification and Diagnostic Testing* (CF-4R) signed and dated by the HERS rater to the building official in conjunction with requests for final inspection for each dwelling unit.

When re-sampling reveals a failure, builders shall offer, at no charge to building owners in occupied dwelling units in the group, to complete field verification, testing and corrective action if necessary. Building owners may decline to have field verification and testing and corrective action completed. Builders shall report the identifying location of any dwelling unit in which the building owner declines field verification and testing and corrective action to the HERS provider. Builders shall take corrective action as required in all unoccupied dwelling units in the group and in occupied dwelling units in the group where building owners have accepted field verification, testing and corrective action.

### **7.8.2 HERS Provider and Rater**

The HERS provider shall maintain a list of the dwelling units in the group from which sampling is drawn, the dwelling units selected for sampling, the dwelling units sampled and the results of the sampling, the dwelling units selected for re-sampling, the dwelling units that have been tested and verified as a result of re-sampling, the corrective action taken, and copies of all *Certificates of Field Verification and Diagnostic Testing* for a period of five years.

The HERS rater providing the diagnostic testing and verification shall sign and date a *Certificate of Field Verification and Diagnostic Testing* certifying that he/she has verified that the requirements for compliance credit have been met. *Certificates of Field Verification and Diagnostic Testing* shall be provided for the tested dwelling unit and each of up to six other

dwelling units from the group for which compliance is verified based on the results of the sample. The HERS rater shall provide this certificate to the builder, the HERS provider, and the building department.

The HERS rater shall provide a separate *Certificate of Field Verification and Diagnostic Testing* for each dwelling unit the rater determines has met the diagnostic requirements for compliance. The HERS rater shall identify on the *Certificate of Field Verification and Diagnostic Testing* if the dwelling unit has been tested or if it was an untested dwelling unit approved as part of sample testing. The HERS rater shall not sign a *Certificate of Field Verification and Diagnostic Testing* for a dwelling unit that does not have a CF-6R signed by the installer as required in Section 7.4. If field verification and testing on a sampled dwelling unit identifies a failure to meet the requirements for compliance credit, the HERS rater shall report to the HERS provider, the builder, and the building department that re-sampling will be required.

If re-sampling identifies another failure, the HERS rater shall report to the HERS provider, the builder, and the building department that corrective action and diagnostic testing and field verification will be required for all the untested dwelling units in the group. This report shall specify the identifying location of all dwelling units that shall be fully tested and corrected. The HERS provider shall also report to the builder once diagnostic testing and field verification has shown that the failures have been corrected in all of the dwelling units except those for which the building owner has declined field verification, testing and corrective action.

When individual dwelling unit testing and verification confirms that the requirements for compliance have been met, the HERS rater shall provide a *Certificate of Field Verification and Diagnostic Testing* for each dwelling unit in the group.

The HERS provider shall file a report with the building department explaining all action taken (including field verification, testing, corrective actions, offers to building owners for testing and corrective action, and building owner declines of such offers) to bring into compliance dwelling units for which full testing has been required.

### **7.8.3 Third Party Quality Control Program**

An approved Third Party Quality Control Program shall:

- Provide training to installers regarding compliance requirements for measures for which diagnostic testing and field verification is required,
- Collect data from participating installers for each installation completed for compliance credit,
- Complete data checking analysis to evaluate the validity and accuracy of the data to independently determine whether compliance has been achieved,
- Provide direction to the installer to retest and correct problems when data checking determines that compliance has not been achieved,
- Require resubmission of data when retesting and correction is directed, and
- Maintain a database of all data submitted in a format that is acceptable to the Commission and available to the Commission upon request.

The Third Party Quality Control Program shall obtain the services of an independent HERS rater to conduct independent field verifications, completing all of the responsibilities of a HERS rater

as specified in this Chapter with the exception that sampling shall be completed for a group of up to thirty dwelling units and sampling and re-sampling shall be completed for a minimum of one out of every thirty sequentially completed dwelling units from the group.

#### **7.8.4 Building Department**

The building department at its discretion may require independent testing and field verification to be scheduled so that it can be completed in conjunction with the building department's required inspections, and/or observe the diagnostic testing and field verification performed by builder employees or subcontractors and the certified HERS rater in conjunction with the building department's required inspections to corroborate the results documented in installer certifications, and in the *Certificate of Field Verification and Diagnostic Testing*.

For dwelling units that have used a compliance alternative that requires field verification and diagnostic testing, the building department shall not approve a dwelling unit for occupancy until the building department has received a *Certificate of Field Verification and Diagnostic Testing* that has been signed and dated by the HERS rater.

If necessary to avoid delay of approval of dwelling units completed when outside temperatures are below 55°F, building departments may approve compliance credit for refrigerant charge and airflow measurement when installers have used the alternate charging and airflow measurement procedure described in ACM Appendix RD-2005, Section RD3. This approval will be on the condition that installers provide a signed agreement to the builder with a copy to the building department to return to correct refrigerant charge and airflow if the HERS rater determines at a later time when the outside temperature is above 55°F that correction is necessary.

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#### **7.9 Definitions of Terms Used In This Chapter**

The following definitions apply to the procedures described in this document.

**Building Owner** means the owner of the dwelling unit.

**Builder** means the general contractor responsible for construction.

**Building Department** means the city, county or state agency responsible for approving the plans, issuing a building permit and approving occupancy of the dwelling unit.

**Dwelling Unit** means the building for single-family residences or each dwelling unit within a multifamily building project.

**HERS Provider** means an organization that the Commission has approved to administer a home energy rating system program, certify raters and maintain quality control over field verification and diagnostic testing required for compliance with the Energy Efficiency Standards.

**HERS Rater** means a person certified by a Commission approved HERS Provider to perform the field verification and diagnostic testing required for demonstrating compliance with the standards.

**Independent Entity** means having no financial interest in, and not advocating or recommending the use of any product or service as a means of gaining increased business with, firms or persons specified in Section 1673(i) of the California Home Energy Rating System Program regulations (California Code of Regulations, Title 20, Division 2, Chapter 4, Article 8).

**Financial Interest** means an ownership interest, debt agreement, or employer/employee relationship. Financial interest does not include ownership of less than 5% of the outstanding equity securities of a publicly traded corporation.

NOTE: The definitions of "independent entity" and "financial interest," together with Section 1673(i), prohibit conflicts of interest between providers and raters, or between providers/raters and builders/subcontractors.

**Documentation Author** means the person responsible for completing the compliance documentation that demonstrates whether a building complies with the standards. Compliance documentation requirements are defined in the Residential Manual.

**Model** means a floor plan and house design that is repeated throughout a subdivision or within a multi-family building. To be considered the same model, dwelling units shall be in the same subdivision or multi-family housing development and have the same energy designs and features, including the same floor area and volume, for each dwelling unit, as shown on the CF-1R. For multi-family buildings, variations in exterior surface areas caused by location within the building shall not cause dwelling units to be considered a different model.

**Certificate of Field Verification and Diagnostic Testing (CF-4R)** means a document with information required by the Commission that is prepared by the HERS rater to certify that measures requiring field verification and diagnostic testing comply with the requirements.

**Certificate of Compliance (CF-1R)** means a document with information required by the Commission that is prepared by the Documentation Author that indicates whether the building includes measures that require field verification and diagnostic testing.

**Installation Certificate (CF-6R)** means a document with information required by the Commission that is prepared by the builder or installer verifying that the measure was installed to meet the requirements of the standards.

## **Procedures for Field Verification and Diagnostic Testing of Air Distribution Systems**

**Note:** the following pages are excerpts from the *Residential Alternative Calculation Method Approval Manual P400-03-003F*.



## ACM RESIDENTIAL MANUAL APPENDIX RC

### Appendix RC – Procedures for Field Verification and Diagnostic Testing of Air Distribution Systems

#### RC.1 Purpose and Scope

ACM RC-2005 contains procedures for measuring the air leakage in forced air distribution systems as well as procedures for verifying duct location, surface area and R-value.

ACM RC-2005 applies to air distribution systems in both new and existing low-rise residential buildings.

ACM RC-2005 provides required procedures for installers, HERS raters and others who need to perform field verification and diagnostic testing to verify the efficiency of air distribution systems. Algorithms for determining distribution system efficiency are contained in Chapter 4 of the residential ACM. Table RC-1 is a summary of the tests and criteria included in ACM RC-2005.

Table RC-1 – Summary of Diagnostic Measurements

Diagnostic	Description	Procedure
Supply Duct Location, Surface Area and R-factor	Verify that duct system was installed according to the design, including location, size and length of ducts, duct insulation R-value and installation of buried ducts.	RC4.1 Diagnostic Supply Duct Location, Surface Area and R-value
Duct Leakage	Verify that duct leakage is less than the criteria or in the case of existing ducts that all accessible leaks have been sealed	RC.4.3 Diagnostic Duct Leakage

#### RC.2 Instrumentation Specifications

The instrumentation for the air distribution diagnostic measurements shall conform to the following specifications:

##### RC2.1 Pressure Measurements

All pressure measurements shall be measured with measurement systems (i.e. sensor plus data acquisition system) having an accuracy of  $\pm 0.2$  Pa. All pressure measurements within the duct system shall be made with static pressure probes as specified by the measurement equipment manufacturer.

##### RC2.2 Duct Leakage Measurements

The measurement of air flows during duct leakage testing shall have an accuracy of  $\pm 3\%$  of measured flow using digital gauges.

**RC2.3 Calibration**

All instrumentation used for duct leakage diagnostic measurements shall be calibrated according to the manufacturer's calibration procedure to conform to the above accuracy requirement. All testers performing diagnostic tests shall obtain evidence from the manufacturer that the equipment meets the accuracy specifications. The evidence shall include equipment model, serial number, the name and signature of the person of the test laboratory verifying the accuracy, and the instrument accuracy. All diagnostic testing equipment is subject to re-calibration when the period of the manufacturer's guaranteed accuracy expires.

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**RC.3 Apparatus****RC.3.1 Duct Pressurization**

The apparatus for fan pressurization duct leakage measurements shall consist of a duct pressurization and flow measurement device meeting the specifications in Section RC2.

**RC.3.2 Duct Leakage to Outside (Existing Duct Systems)**

The apparatus for measuring duct leakage to outside shall include a fan that is capable of maintaining the pressure within the conditioned spaces in the house 25 Pa relative to the outdoors. The fan most commonly used for this purpose is known as a "blower door", and is typically installed within a temporary seal of an open doorway.

**RC.3.3 Smoke-Test of Accessible-Duct Sealing (Existing Duct Systems)**

The apparatus for determining and verifying sealing of all accessible ducts shall also include means for introducing controllable amounts of non-toxic visual smoke into the duct pressurization apparatus for identifying leaks in accessible portions of the duct system. Adequate smoke shall be used to assure that any accessible leaks will emit visibly identifiable smoke.

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**RC.4 Procedures**

This section describes procedures that may be used to verify diagnostic inputs for the calculation of improved duct efficiency.

**RC.4.1 Diagnostic Supply Duct Location, Surface Area and R-value**

The performance calculations in ACM R4 allow credit for duct systems that are designed to be in advantageous locations, with reduced supply duct surface areas and/or higher than default R-values. Compliance credit may be taken for one or more of these duct system improvements in any combination. The procedure in this section is used to verify that the duct system is installed according to the design and meets the requirements for compliance credit.

**RC.4.1.1 Duct System Design Requirements**

The design shall show the location of equipment and all supply and return registers. The size, R-value, and location of each duct segment shall be shown in the design drawing which shall be cross referenced to the Supply Duct System Details report in the CF1-R. For ducts buried in attic insulation, the portion in contact with the ceiling or deeply buried shall be shown and the design shall

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include provisions for ducts crossing each other, interacting with the structure, and changing vertical location to connect with elevated equipment or registers as required. Credit shall be allowed for buried ducts only in areas where the ceiling is level and there is at least 6 inches of space between the outer jacket of the installed duct and the roof sheathing above.

#### **RC.4.1.2 Verifying the Duct System Installation**

The location of all supply and return registers shall be verified from an inspection of the interior of the dwelling unit. The location of the equipment and the size, R-value and location of each duct segment shall be verified by observation in the spaces where they are located. Deviations from the design shall not be allowed.

#### **RC.4.1.3 Verification for Ducts Buried in Attic Insulation**

The procedure of RC4.2.2 shall be carried out prior covering the ducts with insulation. Ducts to be buried shall be insulated to R4.2 or greater. In addition ducts designed to be in contact with the ceiling shall be in continuous contact with the ceiling drywall or ceiling structure not more than 3.5 inches from the ceiling drywall. A sign must be hung near the attic access reading "Caution: Buried Ducts. Markers indicate location of buried ducts." All ducts which will be completely buried shall have vertical markers which will be visible after insulation installation at not more than every 8 feet of duct length and at the beginning and end of each duct run.

After the ceiling insulation is installed, the R-value and type of insulation listed on the Duct System Details shall be verified. Ceiling insulation shall be level and uniform, mounding at ducts is not allowed.

#### **RC.4.2 System Fan Flow**

For the purpose of establishing duct leakage criteria, the total fan flow shall be calculated using RC4.2.1, RC4.2.2 or RC4.2.3.

##### **RC.4.2.1 Default System Fan Flow**

Default system fan flow may be used only for homes where the duct system is being tested before the air conditioning and heating system is installed and the equipment specification is not known. For heating only systems the default fan flow shall be 0.5 CFM/CFA. For systems with cooling, the default fan flow shall be 400 CFM per ton of rated cooling capacity calculated by the ACM using the procedure in Appendix RE or the heating only value whichever is greater.

##### **RC.4.2.2 Nominal System Fan Flow**

For heating only systems the fan flow shall be  $21.7 \times$  Heating Capacity in thousands of Btu/hr. For systems with cooling, the fan flow shall be 400 CFM per nominal ton of rated cooling capacity at ARI conditions or the heating only value whichever is greater.

##### **RC.4.2.3 Measured System Fan Flow**

The fan flow shall be as measured according to the procedure in Appendix RE-2005.

#### **RC.4.3 Diagnostic Duct Leakage**

Diagnostic duct leakage measurement is used by installers and raters to verify that total leakage meets the criteria for any sealed duct system specified in the compliance documents. Diagnostic Duct Leakage from Fan Pressurization of Ducts (Section RC4.3.1) is the only procedure that may be used by a HERS rater to verify duct sealing in a new home. Table RC-2 shows the leakage criteria and test

procedures that may be used to demonstrate compliance. In addition to the minimum tests shown, existing duct systems may be tested to show they comply with the criteria for new duct systems.

*Table RC-2 Duct Leakage Tests*

Case	User and Application	Leakage criteria, % of total fan flow	Procedure
Sealed and tested new duct systems	Installer Testing at Final HERS Rater Testing	6%	RC4.3.1
	Installer Testing at Rough-in, Air Handling Unit Installed	6% Installer Inspection at Final	RC4.3.2.1 RC4.3.2.3
	Installer Testing at Rough-in, Air Handling Unit Not Installed	4% Installer Inspection at Final	RC4.3.2.2 RC4.3.2.3
Sealed and tested altered existing duct system	Installer Testing HERS Rater Testing	15% Total Duct Leakage	RC4.3.1
	Installer Testing HERS Rater Testing	10% Leakage to Outside	RC4.3.3.
	Installer Testing and Inspection HERS Rater Testing and Verification	60% Reduction in Leakage and Inspection and Smoke Test	RC4.3.4 RC4.3.6 and RC4.3.7
	Installer Testing and Inspection HERS Rater Testing and Verification	Fails Leakage Test but All Accessible Ducts are Sealed Inspection and Smoke Test with 100% Verification	RC4.3.5 RC4.3.6 and RC4.3.7

#### **RC.4.3.1 Diagnostic Duct Leakage from Fan Pressurization of Ducts**

The objective of this procedure is for an installer to determine or a rater to verify the total leakage of a new or altered duct system. The total duct leakage shall be determined by pressurizing both the supply and return ducts to a pressure difference of 25 Pascals. The following procedure shall be used for the fan pressurization tests:

1. Verify that the air handler, supply and return plenums and all the connectors, transition pieces, duct boots and registers are installed. The entire duct system shall be included in the total leakage test.
2. For newly installed or altered ducts, verify that cloth backed rubber adhesive duct tape has not been used and if a platform or other building cavity used to house the air distribution system has been newly installed or altered, it contains a duct or is ducted with duct board or sheet metal.
3. Seal all the supply and return registers, except for one return register or the system fan access.
4. Attach the fan flowmeter device to the duct system at the unsealed register or access door.
5. Install a static pressure probe at a supply.
6. Adjust the fan flowmeter to produce a 25 Pascal (0.1 in water) pressure difference between the supply duct and the outside or the building space with the entry door open to the outside.
7. Record the flow through the flowmeter, this is the leakage flow at 25 Pascals.
8. Divide the leakage flow by the total fan flow and convert to a percentage. If the leakage flow percentage is less than the criteria from Table RC-2 the system passes.

When the diagnostic leakage test is performed and the measured total duct leakage is less than 6% of the total fan flow, the duct leakage factor shall be 0.96 as shown in Table R4-13.

**RC.4.3.2 Diagnostic Duct Leakage at Rough-in Construction Stage**

Installers may determine duct leakage in new construction by using diagnostic measurements at the rough-in building construction stage prior to installation of the interior finishing. When using this measurement technique, the installer shall complete additional inspection (as described in section RC4.3.2.3) of duct integrity after the finishing wall has been installed. In addition, after the finishing wall is installed, spaces between the register boots and the wallboard shall be sealed. Cloth backed rubber adhesive duct tapes shall not be used to seal the space between the register boot and the wall board.

The duct leakage measurement at rough-in construction stage shall be performed using a fan pressurization device. The duct leakage shall be determined by pressurizing both the supply and return ducts to 25 Pa. The following procedure (either RC4.3.2.1 or RC4.3.2.2) shall be used:

**RC.4.3.2.1 For Ducts with the Air Handling Unit Installed and Connected:**

For total leakage:

1. Verify that supply and return plenums and all the connectors, transition pieces and duct boots have been installed. If a platform or other building cavity is used to house the air distribution system, it shall contain a duct, and all return connectors and transition parts shall be installed and sealed. The platform, duct and connectors shall be included in the total leakage test. All joints shall be inspected to ensure that no cloth backed rubber adhesive duct tape is used.
2. Seal all the supply duct boots and return boxes except for one return duct box.
3. Attach the fan flowmeter device at the unsealed duct box.
4. Insert a static pressure probe at one of the sealed supply duct boots.
5. Adjust the fan flowmeter to maintain 25 Pa (0.1 in water) between the duct system and outside or the building space with the entry door open to the outside.
6. Record the flow through the flowmeter, this is the leakage flow at 25 Pascals.
7. Divide the leakage flow by the total fan flow and convert to a percentage. If the leakage flow percentage is less than the criteria from Table RC2 the system passes..

**RC.4.3.2.2 For Ducts with Air Handling Unit Not Yet Installed:**

For total leakage:

1. Verify that all the connectors, transition pieces and duct boots have been installed. If a platform or other building cavity is used to house the air distribution system, it must contain a duct, and all return connectors and transition parts shall be installed and sealed. The platform, duct and connectors shall be included in the total leakage test.
2. Use a duct connector to connect supply and/or return duct box to the fan flowmeter. Supply and return leaks may be tested separately. If there is only one return register, the supply and return leaks shall be tested at the same time.
3. Seal all the supply duct boots and/or return boxes except for one supply or return duct box.
4. Attach the fan flowmeter device at the unsealed duct box.

5. Insert a static pressure probe at one of the sealed supply duct boots.
6. Adjust the fan flowmeter to maintain 25 Pa (0.1 in water) between the building conditioned space and the duct system.
7. Record the flow through the flowmeter, this is the leakage flow at 25 Pascals.
8. Divide the leakage flow by the total fan flow and convert to a percentage. If the leakage flow percentage is less than the criteria from Table RC-2 the system passes.

#### ***RC.4.3.2.3 Installer Visual Inspection at Final Construction Stage***

After installing the interior finishing wall and verifying that one of the above rough-in tests was completed, the following procedure shall be used:

1. Remove at least one supply and one return register, and verify that the spaces between the register boot and the interior finishing wall are properly sealed.
2. If the house rough-in duct leakage test was conducted without an air handler installed, inspect the connection points between the air handler and the supply and return plenums to verify that the connection points are properly sealed.
3. Inspect all joints to ensure that no cloth backed rubber adhesive duct tape is used.

#### ***RC.4.3.3 Duct Leakage to Outside from Fan Pressurization of Ducts***

The objective of this test for altered existing duct systems only is to provide an alternate measurement of duct leakage to outdoors. The total duct leakage to outdoors shall be determined by pressurizing the ducts and the conditioned spaces of the house to 25 Pa. The following procedure shall be used for the fan pressurization test of leakage to outside:

1. Seal all the supply and return registers except one return register or the fan access door.
2. Attach the fan flowmeter device to the duct system at the unsealed register or access door.
3. Install a static pressure probe at the supply plenum.
4. Attach a blower door to an external doorway.
5. If any ducts are located in an unconditioned basement, all doors or accesses between the conditioned space and the basement shall be closed, and at least one operable door or window (if it exists) between the basement and outside shall be opened during the test.
6. If the ducts are located in a conditioned basement, any door between the basement and the remaining conditioned space shall be opened, and any basement doors or windows to outside must be closed during the test.
7. Adjust the blower door fan to provide 25 Pa [0.1 inches of water] pressure difference between the conditioned space and outside.
8. Adjust the fan/flowmeter to maintain zero pressure ( $\pm 0.5\text{Pa}$  [ $\pm 0.002$  inches water]) between the ducts and the conditioned space, and adjust the blower door fan to maintain 25 Pa ( $\pm 0.5\text{Pa}$ ) [0.1

inch water ( $\pm 0.002$  inches water)] between the conditioned space and outside. This step may require several iterations.

9. Record the flow through the flowmeter (Q25 [Q0.1]); this is the duct leakage at 25 Pa [0.1 inch water].
10. Divide the leakage flow by the total fan flow and convert to a percentage. If the leakage flow percentage is less than the criteria from Table RC-2 the system passes.

#### **RC.4.3.4 Leakage Improvement from Fan Pressurization of Ducts**

For altered existing duct systems which do not pass the Total Leakage (RC4.3.1) or Leakage to Outside (RC4.3.3) tests, the objective of this test is to show that the original leakage is reduced through duct sealing as specified in Table RC-2. The following procedure shall be used:

1. Use the procedure in RC4.3.1 to measure the leakage before commencing duct sealing.
2. After sealing is complete use the same procedure to measure the leakage after duct sealing.
3. Subtract the sealed leakage from the original leakage and divide the remainder by the original leakage. If the leakage reduction is 60% or greater of the original leakage, the system passes.
4. Complete the Smoke Test specified in RC4.3.6
5. Complete the Visual Inspection specified in RC4.3.7.

#### **RC.4.3.5 Sealing of All Accessible Leaks**

For altered existing duct systems that do not pass any of the Total Leakage (RC4.3.1), Leakage to Outside (RC4.3.3) or Leakage Improvement (RC4.3.4) tests, the objective of this test is to show that all accessible leaks are sealed and that excessively damaged ducts have been replaced. The following procedure shall be used:

1. Complete each of the leakage tests
2. Complete the Smoke Test as specified in RC4.3.6
3. Complete the Visual Inspection as specified in RC4.3.7.
4. Install required label on the system stating that the system fails the leakage tests.

#### **RC.4.3.6 Smoke-Test of Accessible-Duct Sealing**

For altered existing ducts that fail the leakage tests, the objective of the smoke test is to confirm that all accessible leaks have been sealed. The following procedure shall be used:

1. Inject either theatrical or other non-toxic smoke into a fan pressurization device that is maintaining a duct pressure difference of 25 Pa relative to the duct surroundings, with all grilles and registers in the duct system sealed.
2. Visually inspect all accessible portions of the duct system during smoke injection.
3. The system shall pass the test if either of the following conditions are met:
  - i. No visible smoke exits the accessible portions of the duct system.; or

- ii. Smoke only emanates from the portion of the HVAC equipment containing the furnace vestibule which is gasketed and sealed by the manufacturer rather than from the ducts.

**RC.4.3.7 Visual Inspection of Accessible Duct Sealing**

For altered existing ducts that fail the leakage tests, the objective of this inspection in conjunction with the smoke test (RC4.3.6) is to confirm that all accessible leaks have been sealed and that excessively damaged ducts have been replaced. The following procedure shall be used:

1. Visually inspect to verify that the following locations have been sealed:
  - Connections to plenums and other connections to the forced air unit
  - Refrigerant line and other penetrations into the forced air unit
  - Air handler door panel (do not use permanent sealing material, metal tape is acceptable)
  - Register boots sealed to surrounding material
  - Connections between lengths of duct, as well as connections to takeoffs, wyes, tees, and splitter boxes.
2. Visually inspect to verify that portions of the duct system that are excessively damaged have been replaced. Ducts that are considered to be excessively damaged are:
  - Flex ducts with the vapor barrier split or cracked with a total linear split or crack length greater than 12 inches
  - Crushed ducts where cross-sectional area is reduced by 30% or more
  - Metal ducts with rust or corrosion resulting in leaks greater than 2 inches in any dimension
  - Ducts that have been subject to animal infestation resulting in leaks greater than 2 inches in any dimension

# **Procedures for Determining Refrigerant Charge for Split System Space Cooling Systems without Thermostatic Expansion Valves**

**Note:** the following pages are excerpts from the *Residential Alternative Calculation Method Approval Manual P400-03-003F*.



## ACM RESIDENTIAL MANUAL APPENDIX RD

# Appendix RD – Procedures for Determining Refrigerant Charge for Split System Space Cooling Systems without Thermostatic Expansion Valves

### RD.1 Purpose and Scope

The purpose of this procedure is to determine and verify that residential split system space cooling systems and heat pumps have the required refrigerant charge. The procedures only apply to ducted split system central air conditioners and ducted split system central heat pumps that do not have thermostatic expansion valves (TXVs). The procedures do not apply to packaged systems. For dwelling units with multiple split systems or heat pumps, the procedure shall be applied to each system separately.

The procedures detailed in ACM Appendix RD-2005 are intended to be used after the HVAC installer has installed and charged the air conditioner or heat pump system in accordance with the manufacturer's instructions and specifications for the specific model equipment installed. The installer shall certify to the builder, building official and HERS rater that he/she has followed the manufacturer's instructions and specifications prior to proceeding with the procedures in this appendix.

Appendix RD-2005 defines two procedures, the Standard Charge Measurement Procedure in Section RD2 and the Alternate Charge Measurement Procedure in Section RD3. The Standard procedure shall be used when the outdoor air temperature is 55°F or above and shall always be used for HERS rater verification. HVAC installers who must complete system installation when the outdoor temperature is below 55°F shall use the Alternate procedure.

The following sections document the instrumentation needed, the required instrumentation calibration, the measurement procedure, and the calculations required for each procedure. Note: Wherever thermocouples appear in this document, thermistors can be used instead with the same requirements applying to thermistors as to thermocouples.

The reference method algorithms adjust (improve) the efficiency of split system air conditioners and heat pumps when they are diagnostically tested to have the correct refrigerant charge or when field verification indicates that a TXV has been installed. Table RD-1 summarizes the algorithms that are affected by refrigerant charge testing or field verification of a TXV.

Table RD-1 – Summary of Diagnostic Measurements

Input to the Algorithms	Variables and Equation Reference	Description	Standard Design Value	Proposed Design	
				Default Value	Procedure
Cooling System Refrigerant Charge	$F_{TXV}$ (Eq. R4-40 and R4-41)	$F_{TXV}$ takes on a value of 0.96 when the system has been diagnostically tested for the correct refrigerant charge. Otherwise, $F_{TXV}$ has a value of 0.90.	Split systems are assumed to have refrigerant charge testing or a TXV, when required by Package D.	No refrigerant charge testing or TXV.	RD2 or RD3

Note that a prerequisite for diagnostically testing the refrigerant charge is to verify that there is adequate airflow over the evaporator coil. This diagnostic test is described in ACM RE-2005.

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## **RD.2 Standard Charge Measurement Procedure**

This section specifies the Standard charge measurement procedure. Under this procedure, required refrigerant charge is calculated using the *Superheat Charging Method*. The method also checks airflow across the evaporator coil to determine whether the charge test is valid using the *Temperature Split Method* or the air flow measurement methods in ACM RE-2005.

The Standard procedure detailed in this section shall be completed when the outdoor temperature is 55°F or higher after the HVAC installer has installed and charged the system in accordance with the manufacturer's specifications. If the outdoor temperature is between 55°F and 65°F the return dry bulb temperature shall be maintained above 70°F during the test. All HERS rater verifications are required to use this Standard procedure.

### **RD.2.1 Minimum Qualifications for this Procedure**

Persons carrying out this procedure shall be qualified to perform the following:

- Obtain accurate pressure/temperature readings from refrigeration manifold gauges.
- Obtain accurate temperature readings from thermometer and thermocouple set up.
- Check calibration of refrigerant gauges using a known reference pressure and thermometer/thermocouple set up using a known reference temperature.
- Determine best location for temperature measurements in ducting system and on refrigerant line set.
- Calculate the measured superheat and temperature split.
- Determine the correct level of superheat and temperature split required, based on the conditions present at the time of the test.
- Determine if measured values are reasonable.

### **RD.2.2 Instrumentation Specifications**

Instrumentation for the procedures described in this section shall conform to the following specifications:

#### **RD.2.2.1 Digital Thermometer**

Digital thermometer shall have thermocouple compatibility (type K and J) and Celsius or Fahrenheit readout with:

- Accuracy:  $\pm(0.1\% \text{ of reading} + 1.3^\circ \text{ F})$ .
- Resolution: 0.2° F.

**RD.2.2.2 Thermocouples**

Measurements require five (5) heavy duty beaded low-mass wire thermocouples and one (1) cotton wick for measuring wet-bulb temperatures.

**RD.2.2.3 Refrigerant Manifold Gauge Set**

A standard multiport refrigerant manifold gauge with an accuracy of plus or minus 3% shall be used.

**RD.2.3 Calibration**

The accuracy of instrumentation shall be maintained using the following procedures. A sticker with the calibration check date shall be affixed to each instrument calibrated.

**RD2.3.1 Thermometer/Thermocouple Field Calibration Procedure**

Thermometers/thermocouples shall be calibrated monthly to ensure that they are reading accurate temperatures. The following procedure shall be used to check thermometer/thermocouple calibration:

1. Fill an insulated cup (foam) with crushed ice. The ice shall completely fill the cup. Add water to fill the cup.
2. Insert two thermocouples into the center of the ice bath and attach them to the digital thermometer.
3. Let the temperatures stabilize. The temperatures shall be 32°F (+/- 1°F). If the temperature is off by more than 1°F make corrections according to the manufacturer's instructions. Any thermocouples that are off by more than 3°F shall be replaced.
4. Switch the thermocouples and ensure that the temperatures read on T1 and T2 are still within +/- 1°F of 32°F.
5. Affix sticker with calibration check date onto thermocouple.
6. Repeat the process for all thermocouples.

**RD.2.3.2 Refrigerant Gauge Field Check Procedure**

Refrigerant gauges shall be checked monthly to ensure that the gauges are reading the correct pressures and corresponding temperatures. The following procedure shall be used to check gauge calibration:

1. Place a refrigerant cylinder in a stable environment and let it sit for 4 hours minimum to stabilize to the ambient conditions.
2. Attach a thermocouple to the refrigerant cylinder using duct tape so that there is good contact between the cylinder and the thermocouple.
3. Insulate the thermocouple connection to the cylinder (closed cell pipe insulation can be taped over the end of the thermocouple to provide the insulation).
4. Zero the low side compound gauge with all ports open to atmospheric pressure (no hoses attached).

5. Re-install the hose and attach the low side gauge to the refrigerant cylinder.
6. Read the temperature of the thermocouple.
7. Using a pressure/temperature chart for the refrigerant, look up the pressure that corresponds to the temperature measured.
8. If gauge does not read the correct pressure corresponding to the temperature, the gauge is out of calibration and needs to be replaced or returned to the manufacturer for calibration.
9. Repeat the process in steps 4 through 8 for the high side gauge.
10. Affix sticker with calibration check date onto refrigerant gauge.

#### **RD.2.4 Charge Measurement**

The following procedure shall be used to obtain measurements necessary to adjust required refrigerant charge as described in the following sections:

1. If the condenser air entering temperature is less than 65°F, establish a return air dry bulb temperature sufficiently high that the return air dry bulb temperature will be not less than 70°F prior to the measurements at the end of the 15 minute period in step 2.
2. Turn the cooling system on and let it run for 15 minutes to stabilize temperatures and pressures before taking any measurements. While the system is stabilizing, proceed with setting up the temperature measurements.
3. Connect the refrigerant gauge manifold to the suction line service valve.
4. Attach a thermocouple to the suction line near the suction line service valve. Be sure the sensor is in direct contact with the line and is well insulated from air temperature.
5. Attach a thermocouple to measure the condenser (entering) air dry-bulb temperature. The sensor shall be placed so that it records the average condenser air entering temperature and is shaded from direct sun.
6. Be sure that all cabinet panels that affect airflow are in place before making measurements. The thermocouple sensors shall remain attached to the system until the final charge is determined.
7. Place wet-bulb thermocouple in water to ensure it is saturated when needed. **Do not get the dry-bulb thermocouples wet.**
8. Insert the dry-bulb thermocouple in the supply plenum at the center of the airflow.
9. At 12 minutes, insert a dry-bulb thermocouple and a wet-bulb thermocouple into the return plenum at the center of the airflow.
10. At 15 minutes when the return plenum temperatures have stabilized, using the thermocouples already in place, measure and record the return (evaporator entering) air dry-bulb temperature ( $T_{\text{return, db}}$ ) and the return (evaporator entering) air wet-bulb temperature ( $T_{\text{return, wb}}$ ).
11. Using the dry-bulb thermocouple already in place, measure and record the supply (evaporator leaving) air dry-bulb temperature ( $T_{\text{supply, db}}$ ).
12. Using the refrigerant gauge already attached, measure and record the evaporator saturation temperature ( $T_{\text{evaporator, sat}}$ ) from the low side gauge.

13. Using the dry-bulb thermocouple already in place, measure and record the suction line temperature ( $T_{\text{suction, db}}$ ).
14. Using the dry-bulb thermocouple already in place, measure and record the condenser (entering) air dry-bulb temperature ( $T_{\text{condenser, db}}$ ).

The above measurements shall be used to adjust refrigerant charge and airflow as described in following sections.

### RD.2.5 Refrigerant Charge Calculations

The Superheat Charging Method is used only for non-TXV systems equipped with fixed metering devices. These include capillary tubes and piston-type metering devices. The following steps describe the calculations to determine if the system meets the required refrigerant charge using the measurements described in Section RD2.4. If a system fails, then remedial actions must be taken. If the refrigerant charge is changed and the airflow has been previously tested and shown to pass, then the airflow shall be re-tested. Be sure to complete Steps 1 and 2 of Section RD2.4 before re-testing the airflow. Both the airflow and charge must be re-tested until they both sequentially pass.

1. Calculate Actual Superheat as the suction line temperature minus the evaporator saturation temperature.

$$\text{Actual Superheat} = T_{\text{suction, db}} - T_{\text{evaporator, sat}}$$

2. Determine the Target Superheat using Table RD2 using the return air wet-bulb temperature ( $T_{\text{return, wb}}$ ) and condenser air dry-bulb temperature ( $T_{\text{condenser, db}}$ ).
3. If a dash mark is read from Table RD-2, the target superheat is less than 5°F, then the system **does not pass** the required refrigerant charge criteria, usually because outdoor conditions are too hot and dry. One of the following adjustments is needed until a target superheat value can be obtained from Table RD-2 by either 1) turning on the space heating system and/or opening the windows to warm up indoor temperature; or 2) retest at another time when conditions are different. After adjustments, repeat the measurement procedure as often as necessary to establish the target superheat. Allow system to stabilize for 15 minutes before completing the measurement procedure again.
4. Calculate the difference between actual superheat and target superheat (Actual Superheat - Target Superheat)
5. If the difference is between minus 5 and plus 5°F, then the system **passes** the required refrigerant charge criteria.
6. If the difference is greater than plus 5°F, then the system **does not pass** the required refrigerant charge criteria and the installer shall add refrigerant. After the refrigerant has been added, turn the system on and allow it to stabilize for 15 minutes before completing the measurement procedure again. Adjust refrigerant charge and repeat the measurement procedure as many times as necessary to pass the test.
7. If the difference is between -5 and -100°F, then the system **does not pass** the required refrigerant charge criteria, the installer shall remove refrigerant. After the refrigerant has been removed, turn

the system on and allow it to stabilize for 15 minutes before completing the measurement procedure again. Adjust refrigerant charge and repeat the measurement as many times as necessary to pass the test.

### RD.2.6 Airflow Verification

In order to have a valid charge test, the air flow shall be verified by either passing the temperature split test or by one of the three measurements in ACM Appendix RE-2005 with a measured airflow in excess of 0.033 cfm/Btu capacity rated at DOE A test conditions (400 cfm/12000 Btu) (dry coil). The temperature split test method is designed to provide an efficient check to see if airflow is above the required minimum for a valid refrigerant charge test. The following steps describe the calculations using the measurement procedure described in Section RD2.4. If a system fails, then remedial actions must be taken. If the airflow is changed and the refrigerant charge has previously been tested and shown to pass, then the refrigerant charge shall be re-tested. Be sure to complete Steps 1 and 2 of Section RD2.4 before re-testing the refrigerant charge. Both the airflow and charge must be re-tested until they both sequentially pass.

1. Calculate the Actual Temperature Split as the return air dry-bulb temperature minus the supply air dry-bulb temperature. Actual Temperature Split =  $T_{\text{return, db}} - T_{\text{supply, db}}$
2. Determine the Target Temperature Split from Table RD-3 using the return air wet-bulb temperature ( $T_{\text{return, wb}}$ ) and return air dry-bulb temperature ( $T_{\text{return, db}}$ ).
3. If a dash mark is read from Table RD-3, then there probably was an error in the measurements because the conditions in this part of the table would be extremely unusual. If this happens, re-measure the temperatures. If re-measurement results in a dash mark, complete one of the alternate airflow measurements in Section RE4.1.
4. Calculate the difference between target and actual temperature split (Actual Temperature Split - Target Temperature Split). If the difference is within plus 3°F and minus 3°F, then the system **passes** the adequate airflow criteria.
5. If the difference is greater than plus 3°F, then the system **does not pass** the adequate airflow criteria and the airflow shall be increased by the installer. Increasing airflow can be accomplished by eliminating restrictions in the duct system, increasing blower speed, cleaning filters, or opening registers. After corrective measures are taken, repeat measurement procedure as often as necessary to establish adequate airflow range. Allow system to stabilize for 15 minutes before repeating measurement procedure.
6. If the difference is between minus 3°F and minus 100°F, then the measurement procedure shall be repeated making sure that temperatures are measured at the center of the airflow.
7. If the re-measured difference is between plus 3°F and minus 3°F the system **passes** the adequate airflow criteria. If the re-measured difference is between minus 3°F and minus 100°F, the system passes, but it is likely that the capacity is low on this system (it is possible, but unlikely, that airflow is higher than average).

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**RD.3 Alternate Charge Measurement Procedure**

This section specifies the Alternate charge measurement procedure. Under this procedure, the required refrigerant charge is calculated using the *Weigh-In Charging Method*.

HVAC installers who must complete system installation verification when the outdoor temperature is below 55°F shall use this Alternate procedure in conjunction with installing and charging the system in accordance with the manufacturer's specifications. HERS Raters shall not use this procedure to verify compliance.

Split system air conditioners come from the factory already charged with the standard charge indicated on the name plate. The manufacturer supplies the charge proper for the application based on their standard liquid line length. It is the responsibility of the HVAC installer to ensure that the charge is correct for each air conditioner and to adjust the charge based on liquid line length different from the manufacturer's standard.

**RD.3.1 Minimum Qualifications for this Procedure**

HVAC installation technicians shall be qualified to perform the following:

1. Transfer and recovery of refrigerant (including a valid Environmental Protection Agency (EPA) certification for transition and recovery of refrigerant).
2. Accurately weigh the amount of refrigerant added or removed using an electronic scale.
3. Calculate the refrigerant charge adjustment needed to compensate for non-standard lineset lengths/diameters based on the actual lineset length/diameter and the manufacturer's specifications for adjusting refrigerant charge for non-standard lineset lengths/diameters.

**RD.3.2 Instrumentation Specifications**

The digital scale used to weigh in refrigerant must have a range of .5 oz to at least 1200 oz (75 lb.). The scale's accuracy must be  $\pm 0.25$  oz.

**RD.3.3 Weigh-In Method**

The following procedure shall be used by the HVAC installer to charge the system with the correct refrigerant charge.

1. Obtain manufacturer's standard liquid line length and charge adjustment for alternate liquid line lengths.
2. Measure and record the actual liquid line length ( $L_{\text{actual}}$ ).
3. Record the manufacturer's standard liquid line length ( $L_{\text{standard}}$ ).
4. Calculate the difference between actual and standard liquid line lengths ( $L_{\text{actual}} - L_{\text{standard}}$ ).
5. Record the manufacturer's adjustment for liquid line length difference per foot ( $A_{\text{length}}$ ).
6. Calculate the amount of refrigerant to add or remove and document the calculations on the CF-6R.
7. Weigh in or remove the correct amount of refrigerant



Table RD-2: Target Superheat (Suction Line Temperature - Evaporator Saturation Temperature) (continued)

		Return Air Wet-Bulb Temperature (°F)																										
		(T <sub>return, wb</sub> )																										
Condenser Air Dry-Bulb Temperature (°F)		50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.1	8.1	10.3	12.2	14.1	15.9	17.8	19.7	21.5	23.4	25.2	27.1	28.9	30.8
92	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.4	7.5	9.8	11.7	13.5	15.4	17.3	19.2	21.1	22.9	24.8	26.7	28.5	30.4
93	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.8	9.2	11.1	13.0	14.9	16.8	18.7	20.6	22.5	24.4	26.3	28.2	30.1
94	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.2	8.7	10.6	12.5	14.4	16.3	18.2	20.2	22.1	24.0	25.9	27.8	29.7
95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.6	8.1	10.0	12.0	13.9	15.8	17.8	19.7	21.6	23.6	25.5	27.4	29.4
96	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.5	9.5	11.4	13.4	15.3	17.3	19.2	21.2	23.2	25.1	27.1	29.0	
97	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.0	8.9	10.9	12.9	14.9	16.8	18.8	20.8	22.7	24.7	26.7	28.7	
98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.4	8.4	10.4	12.4	14.4	16.4	18.3	20.3	22.3	24.3	26.3	28.3	
99	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.8	7.9	9.9	11.9	13.9	15.9	17.9	19.9	21.9	24.0	26.0	28.0	
100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.3	7.3	9.3	11.4	13.4	15.4	17.5	19.5	21.5	23.6	25.6	27.7	
101	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.8	8.8	10.9	12.9	15.0	17.0	19.1	21.1	23.2	25.3	27.3	
102	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.2	8.3	10.4	12.4	14.5	16.6	18.6	20.7	22.8	24.9	27.0	
103	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.7	7.8	9.9	11.9	14.0	16.1	18.2	20.3	22.4	24.5	26.7	
104	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.2	7.2	9.3	11.5	13.6	15.7	17.8	19.9	22.1	24.2	26.3	
105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.7	8.8	11.0	13.1	15.2	17.4	19.5	21.7	23.8	26.0	
106	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.3	10.5	12.6	14.8	17.0	19.1	21.3	23.5	25.7			
107	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.9	10.0	12.2	14.4	16.6	18.7	21.0	23.2	25.4			
108	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.4	9.5	11.7	13.9	16.1	18.4	20.6	22.8	25.1			
109	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.9	9.1	11.3	13.5	15.7	18.0	20.2	22.5	24.7			
110	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.4	8.6	10.8	13.1	15.3	17.6	19.9	22.1	24.4			
111	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.9	8.1	10.4	12.6	14.9	17.2	19.5	21.8	24.1			
112	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.4	7.6	9.9	12.2	14.5	16.8	19.1	21.5	23.8			
113	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.2	9.5	11.8	14.1	16.4	18.8	21.1	23.5			
114	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.7	9.0	11.4	13.7	16.1	18.4	20.8	23.2			
115	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.2	8.6	10.9	13.3	15.7	18.1	20.5	22.9			

Table RD-3: Target Temperature Split (Return Dry-Bulb – Supply Dry-Bulb)

		Return Air Wet-Bulb (°F) (T <sub>return,wb</sub> )																										
Return Air Dry-Bulb (°F) (T <sub>return,db</sub> )		50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
70	20.9	20.7	20.6	20.6	20.4	20.1	19.9	19.5	19.1	18.7	18.2	17.7	17.2	16.5	15.9	15.2	14.4	13.7	12.8	11.9	11.0	10.0	9.0	7.9	6.8	5.7	4.5	3.2
71	21.4	21.3	21.1	20.9	20.7	20.4	20.1	19.7	19.3	18.8	18.3	17.7	17.1	16.4	15.7	15.0	14.2	13.4	12.5	11.5	10.6	9.5	8.5	7.4	6.2	5.0	3.8	
72	21.9	21.8	21.7	21.5	21.2	20.9	20.6	20.2	19.8	19.3	18.8	18.2	17.6	17.0	16.3	15.5	14.7	13.9	13.0	12.1	11.1	10.1	9.0	7.9	6.8	5.6	4.3	
73	22.5	22.4	22.2	22.0	21.8	21.5	21.2	20.8	20.3	19.9	19.4	18.8	18.2	17.5	16.8	16.1	15.3	14.4	13.6	12.6	11.7	10.6	9.6	8.5	7.3	6.1	4.8	
74	23.0	22.9	22.8	22.6	22.3	22.0	21.7	21.3	20.9	20.4	19.9	19.3	18.7	18.1	17.4	16.6	15.8	15.0	14.1	13.2	12.2	11.2	10.1	9.0	7.8	6.6	5.4	
75	23.6	23.5	23.3	23.1	22.9	22.6	22.2	21.9	21.4	21.0	20.4	19.9	19.3	18.6	17.9	17.2	16.4	15.5	14.7	13.7	12.7	11.7	10.7	9.5	8.4	7.2	5.9	
76	24.1	24.0	23.9	23.7	23.4	23.1	22.8	22.4	22.0	21.5	21.0	20.4	19.8	19.2	18.5	17.7	16.9	16.1	15.2	14.3	13.3	12.3	11.2	10.1	8.9	7.7	6.5	
77	-	24.6	24.4	24.2	24.0	23.7	23.3	22.9	22.5	22.0	21.5	21.0	20.4	19.7	19.0	18.3	17.5	16.6	15.7	14.8	13.8	12.8	11.7	10.6	9.5	8.3	7.0	
78	-	-	-	24.7	24.5	24.2	23.9	23.5	23.1	22.6	22.1	21.5	20.9	20.2	19.5	18.8	18.0	17.2	16.3	15.4	14.4	13.4	12.3	11.2	10.0	8.8	7.6	
79	-	-	-	-	24.8	24.4	24.0	23.6	23.1	22.6	22.1	21.4	20.8	20.1	19.3	18.5	17.7	16.8	15.9	14.9	13.9	12.8	11.7	10.6	9.4	8.1	6.9	
80	-	-	-	-	-	25.0	24.6	24.2	23.7	23.2	22.6	22.0	21.3	20.6	19.9	19.1	18.3	17.4	16.4	15.5	14.4	13.4	12.3	11.1	9.9	8.7	7.5	
81	-	-	-	-	-	-	25.1	24.7	24.2	23.7	23.1	22.5	21.9	21.2	20.4	19.6	18.8	17.9	17.0	16.0	15.0	13.9	12.8	11.7	10.4	9.2	8.0	
82	-	-	-	-	-	-	-	25.2	24.8	24.2	23.7	23.1	22.4	21.7	21.0	20.2	19.3	18.5	17.5	16.6	15.5	14.5	13.4	12.2	11.0	9.7	8.5	
83	-	-	-	-	-	-	-	-	25.3	24.8	24.2	23.6	23.0	22.3	21.5	20.7	19.9	19.0	18.1	17.1	16.1	15.0	13.9	12.7	11.5	10.3	9.1	
84	-	-	-	-	-	-	-	-	-	25.9	25.3	24.8	24.2	23.5	22.8	22.1	21.3	20.4	19.5	18.6	17.6	16.6	15.6	14.4	13.3	12.1	10.8	

## **Field Verification and Diagnostic Testing of Forced Air System Fan Flow and Air Handler Fan Watt Draw**

**Note:** the following pages are excerpts from the *Residential Alternative Calculation Method Approval Manual P400-03-003F*.



## ACM RESIDENTIAL MANUAL APPENDIX RE

### Appendix RE – Field Verification and Diagnostic Testing of Forced Air System Fan Flow and Air Handler Fan Watt Draw

#### RE.1 Purpose and Scope

ACM RE-2005 contains procedures for verifying adequate airflow in split system and packaged air conditioning systems serving low-rise residential buildings. The procedure is also used to verify reduced fan watts achieved through improved air distribution design, including more efficient motors and air distribution systems with fewer obstructions. The refrigerant charge test described in ACM RE requires as a prerequisite that adequate airflow be verified. In addition, the reference method algorithms offer a credit for low fan power which can be obtained through diagnostic measurements. Table RE-1 summarizes the diagnostic measurement procedures in ACM Appendix RE-2005 and shows their relationship to the equipment efficiency algorithms in ACM Chapter 4.

Table RE-1 – Summary of Diagnostic Measurements

Input to the Algorithms	Variables and Equation Reference	Description	Standard Design Value	Proposed Design	
				Default Value	Procedure
Fan Power Ratio	FanW/Btu (Eq. R4-48)	The ratio of fan power in Watts to the cooling capacity in Btu/h.	0.051 W/Btu.	0.051 W/Btu.	Section RE4.3
Fan Flow over Evaporator	$F_{air}$ (Eq. R4-39 and R4.40)	The term $F_{air}$ depends on the measured airflow over the evaporator coil. A value of 0.925 is used as a default, but a value of 1.000 can be used if	$F_{air} = 1.000$ when refrigerant charge testing or TXV is required by Package D.	$F_{air} = 0.925$	Section RE4.1
Refrigerant Charge Prerequisite	n. a.	An airflow of at least 350 cfm/ton must be maintained over a wet coil or 400 cfm/ton over a dry coil before a valid refrigerant charge test may be performed	n. a.	n. a.	Section RE4.1

#### RE.2 Instrumentation Specifications

The instrumentation for the diagnostic measurements shall conform to the following specifications:

##### RE.2.1 Pressure Measurements

All pressure measurements shall be measured with measurement systems (i.e., sensor plus data acquisition system) having an accuracy of  $\pm 0.2$  Pa. All pressure measurements within the duct system shall be made with static pressure probes.

**RE.2.2 Fan Flow Measurements**

All measurements of distribution fan flows shall be made with measurement systems (i.e., sensor plus data acquisition system) having an accuracy of  $\pm 7\%$  reading or  $\pm 5$  cfm whichever is greater.

**RE.2.3 Watt Measurements**

All measurements of air handler watt draws shall be made with true power measurement systems (i.e., sensor plus data acquisition system) having an accuracy of  $\pm 2\%$  reading or  $\pm 10$  watts whichever is greater.

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**RE.3 Apparatus****RE.3.1 System Fan Flows**

HVAC system fan flow shall be measured using one of the following methods.

**RE.3.1.1 Plenum Pressure Matching Measurement**

The apparatus for measuring the system fan flow shall consist of a duct pressurization and flow measurement device (subsequently referred to as a fan flowmeter) meeting the specifications in RE2.2, a static pressure transducer meeting the specifications in Section RE2.1, and an air barrier between the return duct system and the air handler inlet. The measuring device shall be attached at the air handler blower compartment door. All registers shall be in their normal operating condition. The static pressure probe shall be fixed to the supply plenum so that it is not moved during this test.

**RE.3.1.2 Flow Capture Hood Measurement**

A flow capture hood meeting the specifications in Section RE2.2 may be used to verify the fan flow at the return register(s). All registers shall be in their normal operating position. Measurement(s) shall be taken at the return grill(s).

**RE.3.1.3 Flow Grid Measurement**

The apparatus for measuring the system fan flow shall consist of a flow measurement device (subsequently referred to as a fan flow grid) meeting the specifications in RE2.2 and a static pressure transducer meeting the specifications in Section RE2.1. The measuring device shall be attached at a point where all the fan airflow shall flow through the flow grid. All registers shall be in their normal operating condition. The static pressure probe shall be fixed to the supply plenum so that it is not moved during this test.

**RE.3.2 Air Handler Watts**

The air handler watt draw shall be measured using one of the following methods.

**RE.3.2.1 Portable Watt Meter Measurement**

The apparatus for measuring the air handler watt draw shall consist of a watt meter meeting the specifications in RE2.3. The measuring device shall be attached to measure the air handler fan watt draw. All registers shall be in their normal operating condition.

**RE.3.2.2 Utility Revenue Meter Measurement**

The apparatus for measuring the air handler watt draw shall consist of the utility revenue meter meeting the specifications in RE2.3 and a stopwatch measuring in seconds. All registers shall be in their normal operating condition.

**RE.4 Procedure**

To determine and verify airflow credit a diagnostic fan flow measurement shall demonstrate air flow greater than the criteria and installation of the duct system must be designed to meet the criteria in RE4.2.

To determine and verify airflow and fan watt draw credit, in addition to verifying air flow, the air handler fan watt draw measurement shall show fan watts less than that claimed in ACM calculations and shown in CF-1R.

**RE.4.1 Diagnostic Fan Flow**

Table RE-2 – Airflow Criteria

Note: All airflows are for the fan set at the speed used for air conditioning.

Test and Condition	Cooling air flow (Wet Coil)	Test Flow if Dry Coil
Airflow needed for compliance credit	400 cfm/ton	450 cfm/ton

The system passes the fan flow test if the fan flow measured using one of the following methods is greater than the criteria in Table RE2. The Wet Coil criteria shall be used if the air conditioner is operating and conditions are such that the coil is wet. Otherwise the Dry coil criteria shall be used

**RE.4.1.1 Diagnostic Fan Flow Using Flow Capture Hood**

The fan flow measurement shall be performed using the following procedures; all registers shall be fully open, and the air filter shall be installed. Turn on the system fan at the maximum speed used in the installation (usually the cooling speed when air conditioning is present) and measure the fan flow at the return grille(s) with a calibrated flow capture hood to determine the total system return fan flow. The system fan flow (Qah, cfm) shall be the sum of the measured return flows.

**RE.4.1.2 Diagnostic Fan Flow Using Plenum Pressure Matching**

The fan flow measurement shall be performed using the following procedures:

1. If the fan flowmeter is to be connected to the air handler outside the conditioned space, then the door or access panel between the conditioned space and the air handler location shall be opened.
2. With the system fan on at the maximum speed used in the installation (usually the cooling speed when air conditioning is present), measure the pressure difference (in pascal) between the supply plenum and the conditioned space (Psp). Psp is the target pressure to be maintained during the fan flow tests. If there is no access to the supply plenum, then place the pressure probe in the nearest supply duct. Adjust the probe to achieve the highest pressure and then firmly attach the probe (e.g., with duct tape) to ensure that it does not move during the fan flow test.
3. Block the return duct from the plenum upstream of the air handler fan and the fan flowmeter. Filters are often located in an ideal location for this blockage.
3. Attach the fan flowmeter device to the duct system at the air handler. For many air handlers, there will be a removable section that allows access to the fan that is suitable for this purpose.

4. Turn on the system fan and the fan flow meter, adjust the fan flowmeter until the pressure between supply plenum and conditioned space matches Psp.
5. Record the flow through the flowmeter (Qah, cfm) - this is the diagnostic fan flow. In some systems, typical system fan and fan flowmeter combinations may not be able to produce enough flow to reach Psp. In this case record the maximum flow (Qmax, cfm) and pressure (Pmax) between the supply plenum and the conditioned space. The following equation shall be used to correct measured system flow and pressure (Qmax and Pmax) to operating condition at operating pressure (Psp).

Equation RE-1

$$\text{Air Handler Flow } Q_{ah} = Q_{max} \times (P_{sp}/P_{max})^{.5}$$

#### **RE.4.1.3 Diagnostic Fan Flow Using Flow Grid Measurement**

The fan flow measurement shall be performed using the following procedures:

1. With the system fan on at the maximum speed used in the installation (usually the cooling speed when air conditioning is present measure the pressure difference (in pascal) between the supply plenum and the conditioned space (Psp). If there is no access to the supply plenum, then place the pressure probe in the nearest supply duct. Adjust the probe to achieve the highest pressure and then firmly attach the probe (e.g., with duct tape) to ensure that it does not move during the fan flow test.
2. The flow grid shall be attached at a point where all the fan air flows through the flow grid.
3. Re-measure the system operating pressure with the flow grid in place.
4. Measure the air flow through the flow grid (Qgrid) and the test pressure (Ptest).
5. The following equation for air handler flow shall be used to correct flow through the flow grid and pressure (Qgrid and Ptest) to operating condition at operating pressure (Psp).

Equation RE-2

$$Q_{ah} = Q_{max} \times (P_{sp}/P_{test})^{.5}$$

#### **RE.4.2 Duct Design**

The duct system installation shall be verified to be consistent with the design meeting the following requirements. The duct system shall be designed to meet the airflow rate with the available external static pressure from the air handler at that airflow. The duct design shall have calculations showing the duct system will operate at equal to or greater than 0.0375 cfm/Btu rated capacity at ARI test conditions (450 cfm/12000 Btu) in cooling speed (dry coil) or, if heating only, equal to or greater than 16.8 cfm per 1000 Btu/hr furnace output. The design shall be based on the available external static pressure from the air handler, the pressure drop of external devices, the equivalent length of the runs, as well as the size, type and configuration of the ducts. The duct layout shall be included on the plans and the duct design shall be reported on the CF-6R and posted on-site.

#### **RE.4.3 Diagnostic Air Handler Watt Draw**

The system passes the Watt Draw test if the air handler watt draw is less than or equal to the value claimed in compliance calculations and reported by the ACM on the CF-1R. The diagnostic air handler watt draw shall be measured using one of the following methods:

**RE.4.3.1 Diagnostic Air Handler Watt Draw Using Portable Watt Meter**

The air handler watt draw measurement shall be performed using the following procedures; all registers shall be fully open, and the air filter shall be installed. Turn on the system fan at the maximum speed used in the installation (usually the cooling speed when air conditioning is present) and measure the fan watt draw ( $W_{fan}$ ).

**RE.4.3.2 Diagnostic Air Handler Watt Draw Using Utility Revenue Meter**

The air handler watt draw measurement shall be performed using the following procedures; all registers shall be fully open, and the air filter shall be installed. Turn on the system fan at the maximum speed used in the installation (usually the cooling speed when air conditioning is present) and turn off every circuit breaker except the one exclusively serving the air handler. Record the Kh factor on the revenue meter, count the number of full revolutions of the meter wheel over a period exceeding 90 seconds. Record the number of revolutions (Nrev) and time period (trev, seconds). Compute the air handler watt draw ( $W_{fan}$ ) using the following formula:

Equation RE-3

$$\text{Air Handler Fan Watt Draw } W_{fan} = (K_h \times N_{rev} \times 3600) / t_{rev}$$

Return all circuit breakers to their original positions.



## **HVAC Sizing**

**Note:** the following pages are excerpts from the *Residential Alternative Calculation Method Approval Manual P400-03-003F*.



# ACM RESIDENTIAL MANUAL APPENDIX RF

## Appendix RF – HVAC Sizing

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### **RF.1 Purpose and Scope**

ACM RF-2005 is a procedure for calculating the cooling load in low-rise residential buildings (Section RF2) and for determining the maximum cooling capacity for credit in ACM calculations (Section RF3). Section RF4 has a procedure for determining compliance for oversized equipment by showing that the peak power is equal to or less than equipment that minimally meet the requirements of this section.

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### **RF.2 Procedure for Calculating Design Cooling Capacity**

The following rules apply when calculating the design cooling:

#### **RF.2.1 Methodology**

The methodologies, computer programs, inputs, and assumptions approved by the commission shall be used.

#### **RF.2.2 Cooling Loads**

Except as specified in this section, calculations will be done in accordance with the method described in Chapter 28, Residential Cooling and Heating Load Calculations, 2001 ASHRAE Fundamentals Handbook. Interpolation shall be used with tables in Chapter 28. The methods in Chapter 29 may not be used under this procedure.

#### **RF.2.3 Indoor Design Conditions**

The indoor cooling design temperature shall be 75°F. An indoor design temperature swing of 3°F shall be used.

#### **RF.2.4 Outdoor Design Conditions**

Outdoor design conditions shall be selected from the 1.0 Percent Cooling Dry Bulb and Mean Coincident Wet Bulb values in Joint Appendix II REF.

#### **RF.2.5 Block Loads**

The design cooling capacity used for calculating the maximum allowable cooling capacity is based on the block (peak) load either for

1. The whole building; or
  2. For each zone within a building that is served by its own cooling system; or
  3. For each dwelling unit within a building that is served by its own cooling system.
- Room-by-room loads are not allowed for calculating the design cooling capacity.

**RF.2.6 Table Selection**

Tables 2 (cooling load temperature differences) and 4 (glass load factors) shall be used for:

1. Buildings with more than one dwelling unit using whole building block loads; or
2. Buildings or zones with either east or west exposed walls but not both east and west exposed walls.

Otherwise, Tables 1 (cooling load temperature differences) and 3 (glass load factors) shall be used.

Note: The table numbers refer to the ASHRAE Fundamentals 2001.

**RF.2.7 U-factors**

U-factors for all opaque surfaces and fenestration products shall be consistent with the methods described in Section 4.2 and Section 4.3 of the Residential ACM Manual. The effects of radiant barriers or cool roofs shall be included if these features are in the proposed building.

**RF.2.8 Solar Heat Gain Coefficients**

Solar heat gain coefficients (SHGC) shall be equal to the SHGC<sub>closed</sub> values described in Section 4.3.4 of the Residential ACM Manual.

**RF.2.9 Glass Load Factors**

Glass load factors (GLFs) shall be calculated using the equation in the footnotes of Tables 3 and 4 in Chapter 28 using the columns for “Regular Double Glass” and the rows for “Draperies, Venetian blinds, etc”. The table values used in the equation shall be  $U_t = 0.55$  and  $SC_t = 0.45$ . The shading coefficient for the alternate value shall be  $SC_a = SHGC \times 0.87$  where the SHGC value is described above. The GLF values shall also be adjusted for latitude as described in the footnotes.

Note: The table numbers refer to the ASHRAE Fundamentals 2001.

**RF.2.10 Infiltration**

The air flow (CFM) due to infiltration and mechanical ventilation shall be calculated with the effective leakage area method as documented in Section 4.5.1 of the Residential ACM Manual using the outdoor design temperature minus the indoor design temperature as the temperature difference and a 7.5 mph wind speed.

**RF.2.11 Internal Gain**

Occupancy shall be assumed to be two persons for the first bedroom and one person for each additional bedroom per dwelling unit. Each person shall be assigned a sensible heat gain of 230 Btu/hr. Appliance loads shall be 1200 Btu/hr for multifamily buildings with common floors and ceilings. Otherwise the appliance load is 1600 Btu/hr.

**RF.2.12 Cooling Duct Efficiency**

The cooling duct efficiency shall be calculated using the seasonal approach as documented in ACM Section 4.8.8.

**RF.2.13 Latent Factor.**

The latent factor shall be 1.0.

**RF.2.14 Total Cooling Load**

The total cooling load is calculated in accordance with Table 9 of Chapter 28 of the ASHRAE Handbook, Fundamentals Volume, 2001, using the values specified in this section.

**RF.2.15 Design Cooling Load**

The design cooling load is equal to the total cooling load divided by the cooling duct efficiency.

**RF.2.16 Design Cooling Capacity**

The design cooling capacity calculation adjusts the sensible design cooling load to estimate the rated cooling capacity needed as follows:

Equation RF-

$$\text{Design Cooling Capacity (Btu/hr)} = \text{Design Cooling Load (Btu/hr)} \times (0.8192 + 0.0038 \times \text{Outdoor Cooling Design Temperature (}^\circ\text{F)})$$

**RF.3 Procedure for Calculating Maximum Cooling Capacity for ACM Credit**

The following rules apply when calculating the maximum cooling capacity for ACM credit:

**RF.3.1 Design Cooling Capacity**

The design cooling capacity shall be calculated in accordance with the procedure described in RF2.

**RF.3.2 Maximum Cooling Capacity for ACM Credit**

For buildings with a single cooling system or for buildings where the design cooling capacity has been calculated separately for each cooling system, the maximum cooling capacity for ACM credit for each cooling system shall be:

*Table RF-1 – Maximum Cooling Capacity for ACM Credit*

Design Cooling Capacity (Btu/hr)	Maximum Cooling Capacity for ACM Credit (Btu/hr)
< 48000	Design Cooling Capacity + 6000
48000 - 60000	Design Cooling Capacity + 12000
>60000	Design Cooling Capacity + 30000

For buildings with more than one cooling system where the design cooling capacity has been calculated for the entire building, the maximum cooling capacity for ACM credit for the entire building shall be:

Equation RF-1

$$\begin{aligned} \text{Maximum Cooling Capacity for ACM Credit (Btu/hr)} = \\ \text{Design Cooling Capacity (Btu/hr)} + (6000 \text{ (Btu/hr)} \times \text{Number of Cooling Systems}) \end{aligned}$$

**RF.3.3 Multiple Orientations**

For buildings demonstrating compliance using the multiple orientation alternative of Section 151(c), the maximum cooling capacity for ACM credit is the highest, considering north, northeast, east,

southeast, south, southwest, west and northwest orientations. For buildings with more than one cooling system, the orientation used for determining the maximum cooling capacity for ACM credit shall be permitted to be different for each zone.

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#### **RF.4 Procedure for Determining Electrical Input Exception for Maximum Cooling Capacity for ACM Credit**

The installed cooling capacity shall be permitted to exceed the maximum cooling capacity for ACM credit if the electrical input of the oversized cooling system is less than or equal to the electrical input of a standard cooling system using the following rules:

##### **RF.4.1 Design Cooling Capacity**

The design cooling capacity shall be calculated for the Proposed Design in accordance with the procedure described in RF2.

##### **RF.4.2 Standard Total Electrical Input**

The standard electrical input is calculated as follows:

$$\begin{array}{l} \text{Equation RF-2} \qquad \qquad \text{Standard Total Electrical Input (W) =} \\ \qquad \qquad \qquad \qquad \qquad 0.1048 \text{ (W/Btu/hr) x Design Cooling Capacity (Btu/hr)} \end{array}$$

##### **RF.4.3 Proposed Electrical Input**

The proposed electrical input (W) for the installed cooling system is calculated as follows:

$$\begin{array}{l} \text{Equation RF-3} \qquad \qquad \text{Proposed Compressor Electrical Input (W) =} \\ \qquad \qquad \qquad \qquad \text{Electrical Input (W) - (.0122 * Design Cooling Capacity (Btu/hr))} \end{array}$$

Where “Electrical Input” is as published in the Directories of Certified Appliances maintained by the California Energy Commission in accordance with the requirements of the Appliance Standards. The proposed electrical input (W) for the installed cooling system is published as the “Electrical Input” in the Directories of Certified Appliances maintained by the California Energy Commission in accordance with the requirements of the Appliance Standards.

##### **RF.4.4 Proposed Fan Power**

The proposed fan power (W) of the installed cooling system is equal to either:

1. 0.017 (W/Btu/hr) x Design Cooling Capacity (Btu/hr); or
2. The measured fan power (W) where the measured fan power is determined at an airflow equal to or greater than the adequate airflow criteria using the procedure described in ACM RE-2005 of the *Residential ACM Manual*.

##### **RF.4.5 Proposed Total Electrical Input**

The proposed electrical input is equal to:

Equation RF-4

$$\begin{aligned} \text{Proposed Total Electrical Input (W)} &= \\ \text{Proposed Electrical Input (W)} &+ \text{Proposed Fan Power (W)} \end{aligned}$$

For buildings with more than one cooling system, the proposed total electrical power shall be the sum of the values for each system. If the proposed total electrical input is less than or equal to the standard total electrical input, then the installed cooling capacity may exceed the allowable cooling capacity for ACM credit.



## **High Quality Insulation Installation Procedures**

**Note:** the following pages are excerpts from the *Residential Alternative Calculation Method Approval Manual P400-03-003F*.



## ACM RESIDENTIAL MANUAL APPENDIX RH

# Appendix RH – High Quality Insulation Installation Procedures

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### **RH.1 Purpose and Scope**

ACM RH-2005 is a procedure for verifying the quality of insulation installation in low-rise residential buildings. A compliance credit is offered when this procedure is followed by the insulation installer and a qualified HERS rater. The procedure and credit applies to wood framed construction with wall stud cavities, ceilings, and roof assemblies insulated with mineral fiber or cellulose insulation in low-rise residential buildings.

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### **RH.2 Terminology**

- Air Barrier** An air barrier is needed in all thermal envelope assemblies to prevent air movement. Insulation, other than foam, is not designed to stop air movement. For insulation installed horizontally, such as in an attic, the insulation must be in substantial contact with the assembly air barrier (usually the ceiling drywall) on one side for it to perform at its rated R-value. A wall or ceiling covering that has multiple leakage sites (such as 1 x 6 tongue and groove board ceilings) can not serve as an air barrier.
- Air-tight** Thermal envelope assemblies (such as wall assemblies) shall be built to minimize air movement. Air movement can move unwanted heat and moisture through or into the assembly. For these procedures air-tight shall be defined as an assembly or air barrier with all openings greater than 1/8 inch caulked, or sealed with expansive or minimally expansive foam.
- Excessive Compression** Batt insulation may be compressed up to 50% at obstructions such as plumbing vents and in non-standard cavities, but compression of more than 50% in any dimension is excessive and shall not be allowed. Where obstructions would cause the insulation to be compressed greater than 50% insulation shall be cut to fit around the obstruction.
- Delaminated** Batts are often split or delaminated to fit around an obstruction. For example when an electrical wire runs through a wall cavity the insulation must still fill the area both in front of the wire and the area behind the wire. This is typically accomplished by delaminating the batt from one end and placing one side of the batt behind the wire and the other in front of the wire. The location of the delamination must coincide with the location of the obstruction. For example if the wire is one third of the distance from the front of the cavity the batt should be delaminated so that two thirds of the batt goes behind the wire and one third in front of the wire.
- Draft Stops** Draft stops are installed to prevent air movement between wall cavities, other interstitial cavities - and the attic. They are typically constructed of dimensional lumber blocking, drywall or plywood. Draft stops become part of the attic air barrier and shall be air-tight. Fire blocks constructed of porous insulation materials cannot serve as draft stops since they are not air-tight.
- Friction Fit** Friction fit batts are commonly used. Friction fit batts have enough side-to-side frictional force to hold the batt in place without any other means of attachment.

Gaps	A gap is an uninsulated area at the edge of or between batts. Gaps in insulation are avoidable and are not permitted.
Hard Covers	Hard covers shall be installed above areas where there is a drop ceiling. For example a home with 10 ft ceilings may have an entry closet with a ceiling lowered to 8 ft. A hard cover (usually a piece of plywood) is installed at the 10 ft. level above the entry closet. Hard covers become part of the ceiling air barrier and shall be air-tight.
Inset Stapling	In windy areas installers often staple the flanges of faced batts to the sides of the stud in order to assure that the insulation remains in place until covered with drywall, particularly on the wall between the house and the garage where there isn't any exterior sheathing to help keep the insulation in place. The void created by the flange inset shall not extend more than two inches from the stud on each side.
Net Free-Area	The net free-area of a vent cover is equal to the total vent opening less the interference to air flow caused by the screen or louver. Screened or louvered vent opening covers are typically marked by the manufacturer with the "net free-area." For example a 22.5 in. by 3.5 in. eave vent screen with a total area of 78.75 square inches may have a net free-area of only 45 square inches.
Voids	When batt insulation is pushed too far into a wall stud cavity a void is created between the front of the batt and the drywall. Batt shall be fully lofted and fill the cavity front-to-back. Small voids less than $\frac{3}{4}$ in. deep on the front or back of a batt shall be allowed as long as the total void area is not over 10% of the batt surface area. This definition shall not preclude the practice of inset stapling as long as the void created by the flange inset meets the specification in the definition of inset stapling. Improper spraying or blowing of insulation in ceilings and wall cavities can result in areas with insufficient insulation not meeting the specified installed density and R-value. Wall and cathedral ceiling cavity areas where cellulose insulation has fallen away shall be filled with insulation. Depressions in netting or material supporting blown insulation in walls and cathedral ceilings shall be filled with insulation.

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### ***RH.3 Raised Floors and Floors Over Garages***

- Batt shall be correctly sized to fit snugly at the sides and ends, but not be so large as to buckle.
- Batt shall be cut to fit properly without gaps. Insulation shall not be doubled-over or compressed.
- Insulation shall be in contact with an air barrier - usually the subfloor.
- On floors that are over garages, or where there is an air space between the insulation and the subfloor, the rim joist shall be insulated.
- Batt shall be cut to butt-fit around wiring and plumbing, or be split (delaminated) so that one layer can fit behind the wiring or plumbing, and one layer fit in front.
- If the insulation is faced, the facing shall be placed toward the living space and be in contact with the underside of the floor sheathing. Continuous support shall be provided to keep the facing in contact with the floor sheathing. Filling the entire cavity with insulation and providing support with netting at the bottom of the framing is one acceptable method.
- Insulation shall be properly supported to avoid gaps, voids, and compression.

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**RH.4 Wall Insulation****RH.4.1. Batt Installation**

- Wall stud cavities shall be caulked or foamed to provide a substantially air-tight envelope to the outdoors, attic, garage and crawl space. Special attention shall be paid to plumbing and wiring penetrations through the top plates, electrical boxes that penetrate the sheathing, and the sheathing seal to the bottom plate.
- Installation shall uniformly fill the cavity side-to-side, top-to-bottom, and front-to-back.
- The batt shall be friction fitted into the cavity unless another support method is used
- Batt insulation shall be installed to fill the cavity and be in contact with the sheathing on the back and the wallboard on the front - no gaps or voids.
- Batts with flanges that are inset stapled to the side of the stud must be flush with the face of the cavity (or protrude beyond) except for the portion that is less than two inches from the edge of the stud.
- Non-standard-width cavities shall be filled with batt insulation snugly fitted into the space without excessive compression.
- Batt insulation shall be cut to butt-fit around wiring and plumbing, or be split (delaminated) so that one layer can fit behind the wiring or plumbing, and one layer fit in front.

**RH.4.2 Narrow-Framed Cavities**

- Non-standard width cavities shall be filled by batt insulation cut to snugly fit into the space.
- Narrow spaces (two inches or less) at windows, between studs at the building's corners, and at the intersections of partition walls shall be filled with batt insulation snugly fitted into the space (without excessive compression), loose fill insulation, or expansive or minimally expansive foam.

**RH.4.3 Special Situations****RH.4.3.1 Installations Prior to Exterior Sheathing or Lath**

- Hard to access wall stud cavities such as; corner channels, wall intersections, and behind tub/shower enclosures shall be insulated to the proper R-value. This may have to be done prior to the installation of the exterior sheathing or the stucco lath.

**RH.4.3.2 Obstructions**

- Insulation shall be cut to fit around wiring and plumbing without compression.
- Insulation shall be placed between the sheathing and the rear of electrical boxes and phone boxes.
- In cold climates, where water pipes may freeze (Climate Zones 14 and 16) pipes shall have at least two-thirds of the insulation between the water pipe and the outside. If the pipe is near the outside, as much insulation as possible shall be placed between the pipe and the outside (without excessive compression), and no insulation shall be placed between the pipe and the inside.

**RH.4.3.3 Rim Joists**

- All rim-joists shall be insulated to the same R-Value as the adjacent walls.
- The insulation shall be installed without gaps or excessive compression.

**RH.4.3.4 Kneewalls and Skylight Shafts**

- All kneewalls and skylight shafts shall be insulated to a minimum of R-19.
- The insulation shall be installed without gaps and with minimal compression.
- For steel-framed kneewalls and skylight shafts, external surfaces of steel studs shall be covered with batts or rigid foam unless otherwise specified on the CF-1R using correct U-factors from Joint Appendix IV, Table IV-11 (or U-factors approved by the CEC Executive Director).
- The house side of the insulation shall be in contact with the drywall or other wall finish.
- The insulation shall be supported so that it will not fall down by either fitting to the framing, stapling in place with minimal compression, or using other support such as netting.

**RH.4.3.5 HVAC/Plumbing Closet**

- Walls of interior closets for HVAC and/or water heating equipment, that require combustion air venting, shall be insulated to the same R-value as the exterior walls.

**RH.4.3.6 Loose Fill Wall Insulation**

- Wall stud cavities shall be caulked or foamed to provide a substantially air-tight envelope to the outdoors, attic, garage and crawl space. Special attention shall be paid to plumbing and wiring penetrations through the top plates, electrical boxes that penetrate the sheathing, and the sheathing seal to the bottom plate.
- Installation shall uniformly fill the cavity side-to-side, top-to-bottom, and front-to-back.
- Loose fill insulation shall be installed to fill the cavity and be in contact with the sheathing on the back and the wallboard on the front - no gaps or voids.
- Loose fill wall insulation shall be installed to fit around wiring, plumbing, and other obstructions.
- The installer shall certify on forms CF-6R and IC-1 that the manufacturer's minimum weight-per-square-foot requirement has been met.

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**RH.5 Ceiling and Roof Insulation****RH.5.1 Batt Insulation****RH.5.1.1 General Requirements**

- Batts shall be correctly sized to fit snugly at the sides and ends.
- Batts shall be installed so that they will be in contact with the air barrier.
- Where necessary, batts shall be cut to fit properly - there shall be no gaps, nor shall the insulation be doubled-over or compressed.

- When batts are cut to fit a non-standard cavity, they shall be snugly fitted to fill the cavity without excessive compression.
- Batt shall be cut to butt-fit around wiring and plumbing, or be split (delaminated) so that one layer can fit behind the wiring or plumbing, and one layer fit in front.
- For batts that are taller than the trusses, full-width batts shall be used so that they expand to touch each other over the trusses.
- Hard covers or draft stops shall be placed over all drop ceiling areas and interior wall cavities to keep insulation in place and stop air movement. If hard covers or draft stops are missing or incomplete, they shall be completed before insulation is installed.
- Required eave ventilation shall not be obstructed - the net free-ventilation area of the eave vent shall be maintained.
- Eave vent baffles shall be installed to prevent air movement under or into the batt.
- Insulation shall cover all recessed lighting fixtures. If the fixtures are not rated for insulation contact (IC) and air tight, the fixtures shall either be replaced or eliminated.
- All recessed light fixtures that penetrate the ceiling shall be IC and air tight (AT) rated and shall be sealed with a gasket or caulk between the housing and the ceiling.

### **RH.5.1.2 Special Situations**

#### **RH.5.1.2.1 Rafter Ceilings**

- An air space shall be maintained between the insulation and roof sheathing if required by California Building Code section 1505.3.
- Facings and insulation shall be kept away from combustion appliance flues in accordance with flue manufacturers' installation instructions or labels on the flue.

#### **RH.5.1.2.2 HVAC Platform**

- Appropriate batt insulation shall be placed below any plywood platform or cat-walks for HVAC equipment installation and access
- Batt shall be installed so that they will be in contact with the air barrier.

#### **RH.5.1.2.3 Attic Access**

- Permanently attach rigid foam or a batt of insulation to the access door using adhesive or mechanical fastener.

### **RH.5.2. Loose-Fill Ceiling Insulation**

#### **RH.5.2.1 General Requirements**

- Baffles shall be placed at eaves or soffit vents to keep insulation from blocking eave ventilation. The required net free-ventilation shall be maintained.
- Eave vent baffles shall be installed to prevent air movement under or into the loose-fill insulation
- Hard covers or draft stops shall be placed over all drop ceiling areas and interior wall cavities to keep insulation in place and stop air movement. If hard covers or draft stops are missing or

incomplete, they shall be completed before insulation is completed or the entire drop area shall be filled with loose-fill insulation level with the rest of the attic.

- Attic rulers appropriate to the material installed shall be evenly distributed throughout the attic to verify depth: one ruler for every 250 square feet and clearly readable from the attic access. The rulers shall be scaled to read inches of insulation and the R-value installed.
- Insulation shall be applied underneath and on both sides of obstructions such as cross-bracing and wiring.
- Insulation shall be applied all the way to the outer edge of the wall top plate.
- Insulation shall cover recessed lighting fixtures. If the fixtures are not rated for insulation contact (IC) and air tight, the fixtures shall either be replaced or eliminated.
- All recessed light fixtures that penetrate the ceiling shall be IC and air tight (AT) rated and shall be sealed with a gasket or caulk between the housing and the ceiling.
- Insulation shall be kept away from combustion appliance flues in accordance with flue manufacturer's installation instructions or labels on the flue.
- Insulation shall be blown to a uniform thickness throughout the attic with all areas meeting or exceeding the insulation manufacturer's minimum requirements for depth and weight-per-square-foot.
- The installer shall certify on forms CF-6R and IC-1 that the manufacturer's minimum weight-per-square-foot requirement has been met.
- The HERS rater shall verify that the manufacturer's minimum weight-per-square-foot requirement has been met for attics insulated with loose-fill mineral-fiber insulation. Verification shall be determined using the methods of the Insulation Contractor's Association of America (ICAA) Technical Bulletin #17 except that only one sample shall be taken in the area that appears to have the least amount of insulation. The rater shall record the weight-per-square-foot of the sample on the CF-4R.
- The HERS rater shall verify that the manufacturer's minimum insulation thickness has been installed. For cellulose insulation this verification shall take into account the time that has elapsed since the insulation was installed. At the time of installation, the insulation shall be greater than or equal to the manufacturer's minimum initial insulation thickness. If the HERS rater does not verify the insulation thickness at the time of installation, and if the insulation has been in place less than seven days, the insulation thickness shall be greater than the manufacturer's minimum required thickness at the time of installation less 1/2 inch to account for settling. If the insulation has been in place for seven days or longer, the insulation thickness shall be greater than or equal to the manufacturer's minimum required settled thickness.

#### **RH.5.2.2 Special Situations**

##### *RH.5.2.2.1 Kneewalls and Skylight Shafts:*

- Kneewalls and skylight shafts shall be insulated to a minimum of R-19. If loose fill insulation is used it shall be properly supported with netting or other support material.

##### *RH.5.2.2.2 HVAC Platform*

- Pressure-fill the areas under any plywood platform or walks for HVAC equipment installation and access or verify that appropriate batt insulation has been installed.

#### ***RH.5.2.2.3 Attic Access***

- Permanently attach rigid foam or a batt of insulation to the access door using adhesive or mechanical fastener.

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### ***RH.6 Materials***

- Materials shall comply with Uniform Building Code (including, but not limited to, 1997 UBC Section 707) and installed to meet all applicable fire codes.
- Materials shall meet California Quality Standards for Insulating Material, Title 24, Chapter 4, Article 3, listed in the California Department of Consumer Affairs Consumer Guide and Directory of Certified Insulating Materials.
- Materials shall comply with flame spread rating and smoke density requirements of Sections 2602 and 707 of the Title 24, Part 2: all installations with exposed facings must use fire retardant facings which have been tested and certified not to exceed a flame spread of 25 and a smoke development rating of 450. Insulation facings that do not touch a ceiling, wall, or floor surface, and faced batts on the undersides of roofs with an air space between the ceiling and facing are considered exposed applications.
- Materials shall be installed according to manufacturer specifications and instructions.

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### ***RH.7 Equipment***

- Scales - The scales used to weigh density samples shall be accurate to within +/- 0.03 pounds. Scales shall be calibrated in accordance with manufacture's instructions.

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### ***RH.8 R-Value and U-Value Specifications***

See CF-1R for minimum R-value requirements; for non-standard assemblies, also see applicable form 3R.

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### ***RH.9 Certificates***

An Insulation Certificate (IC-1) signed by the insulation installer shall be provided that states that the installation is consistent with the plans and specifications for which the building permit was issued. The certificate shall also state the installing company name, insulation manufacturer's name and material identification, the installed R-value, and, in applications of loose-fill insulation, the minimum installed weight-per-square-foot (or the minimum weight per cubic foot) consistent with the manufacturer's labeled installed-design-density for the desired R-Value, and the number of inches required to achieve the desired R-Value. The insulation installer shall also complete a form CF-6R and attach a bag label or a manufacturer's coverage chart for every insulation material used.

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### ***RH.10 Certificate Availability***

The Insulation Certificate (IC-1) and Installation Certificate (CF-6R, with insulation material bag labels or coverage charts attached), signed by the insulation installer, shall be available on the

building site for each of the HERS rater's verification inspections. Note: The HERS rater cannot verify compliance credit without these completed forms.

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**CF-6R & CF-4R Insulation Installation Quality Certificate**

Site Address \_\_\_\_\_ Permit \_\_\_\_\_

- Installation meets all applicable requirements as specified in the Insulation Installation Procedures  
(CF-6R only)
- Insulation certificate, (IC-1) signed by the installer stating: insulation manufacturer's name, material identification, installed R-values, and for loose-fill insulation: minimum weight per square foot and minimum inches
- Installation Certificate, (CF-6R) signed by the installer certifying that the installation meets all applicable requirements as specified in the Insulation Installation Procedures  
(CF-4R only)

**1. FLOOR**

- All floor joist cavity insulation installed to uniformly fit the cavity side-to-side and end-to-end
- Insulation in contact with the subfloor or rim joists insulated
- Insulation properly supported to avoid gaps, voids, and compression

**2. WALLS**

- Wall stud cavities caulked or foamed to provide an air tight envelope
- Wall stud cavity insulation uniformly fills the cavity side-to-side, top-to-bottom, and front-to-back
- No gaps
- No voids over 3/4" deep or more than 10% of the batt surface area.
- Hard to access wall stud cavities such as; corner channels, wall intersections, and behind tub/shower enclosures insulated to proper R-Value
- Small spaces filled
- Rim-joists insulated
- Loose fill wall insulation meets or exceeds manufacturer's minimum weight-per-square-foot requirement. (CF-6R only)

**3. ROOF/CEILING PREPARATION**

- All draft stops in place to form a continuous ceiling and wall air barrier
- All drops covered with hard covers
- All draft stops and hard covers caulked or foamed to provide an air tight envelope
- All recessed light fixtures IC and air tight (AT) rated and sealed with a gasket or caulk between the housing and the ceiling
- Floor cavities on multiple-story buildings have air tight draft stops to all adjoining attics
- Eave vents prepared for blown insulation - maintain net free-ventilation area

- Kneewalls insulated or prepared for blown insulation
- Area under equipment platforms and cat-walks insulated or accessible for blown insulation
- Attic rulers installed

#### 4. ROOF/CEILING BATTS

- No gaps
- No voids over ¼ in. deep or more than 10% of the batt surface area.
- Insulation in contact with the air-barrier
- Recessed light fixtures covered
- Net free-ventilation area maintained at eave vents

#### 5. ROOF/CEILING LOOSE-FILL

- Insulation uniformly covers the entire ceiling (or roof) area from the outside of all exterior walls.
- Baffles installed at eaves vents or soffit vents - maintain net free-ventilation area of eave vent
- Attic access insulated
- Recessed light fixtures covered
- Insulation at proper depth – insulation rulers visible and indicating proper depth and R-value
- Loose-fill insulation meets or exceeds manufacturer's minimum weight and thickness requirements for the target R-value. Target R-value \_\_\_\_\_ Manufacturer's minimum required weight for the target R-value \_\_\_\_\_ (pounds-per-square-foot). Manufacturer's minimum required thickness at time of installation \_\_\_\_\_ Manufacturer's minimum required settled thickness \_\_\_\_\_ Note: In order to receive compliance credit the HERS rater shall verify that the manufacturer's minimum weight and thickness has been achieved for the target R-value. (CF-6R only)
- Loose-fill mineral fiber insulation meets or exceeds manufacturer's minimum weight and thickness requirement for the target R-value. Target R-value \_\_\_\_\_ Manufacturer's minimum required weight for the target R-value \_\_\_\_\_ (pounds-per-square foot). Sample weight \_\_\_\_\_ (pounds per square foot). (CF-4R only)
- Manufacturer's minimum required thickness at time of installation \_\_\_\_\_ (inches) Manufacturer's minimum required settled thickness \_\_\_\_\_ (inches). Number of days since loose-fill insulation was installed \_\_\_\_\_ (days). At the time of installation, the insulation shall be greater than or equal to the manufacturer's minimum initial insulation thickness. If the HERS rater does not verify the insulation at the time of installation, and if the loose-fill insulation has been in place less than seven days the thickness shall be greater than the manufacturer's minimum required thickness at the time of installation less 1/2 inch to account for settling. If the insulation has been in place for seven days or longer the insulation thickness shall be greater than or equal to the manufacturer's minimum required settled thickness. Minimum thickness measured \_\_\_\_\_ (inches). (CF-4R only)

#### DECLARATION

I hereby certify that the installation meets all applicable requirements as specified in the Insulation Installation Procedures.

\_\_\_\_\_

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Item #s	Signature, Date	Title, Company Name
_____	_____	_____
Item #s	Signature, Date	Title, Company Name
_____	_____	_____
Item #s	Signature, Date	Title, Company Name
_____	_____	_____

# **Procedures for Verifying the Presence of a Thermostatic Expansion Valve or High Energy Efficiency Ratio Equipment**

**Note:** the following pages are excerpts from the *Residential Alternative Calculation Method Approval Manual P400-03-003F*.



## ACM RESIDENTIAL MANUAL APPENDIX RI

### Appendix RI – Procedures for Verifying the Presence of a Thermostatic Expansion Valve or High Energy Efficiency Ratio Equipment

#### RI.1 Purpose and Scope

The purpose of these procedures is to verify that residential space cooling systems and heat pumps have the required components to achieve the energy efficiency claimed in the compliance documents. The procedures only apply when a TXV is specified for split system equipment or an EER higher than the default is claimed. For dwelling units with multiple systems, the procedures shall be applied to each system separately.

The installer shall certify to the builder, building official and HERS rater that he/she has installed all the correct components.

The reference method algorithms adjust (improve) the efficiency of air conditioners and heat pumps when field verification indicates the specified components are installed. Table RI 1 summarizes the algorithms that are affected.

Table RI-1 – SUMMARY OF FIELD VERIFICATION

Field Verification Check	Variables and Equation Reference	Description	Standard Design Value	Proposed Design	
				Default Value	Procedure
Presence of a TXV	$F_{TXV}$ (Eq. R4-39 and R4-40)	$F_{TXV}$ takes on a value of 0.96 when the system has a verified TXV or has been diagnostically tested for the correct refrigerant charge. Otherwise, $F_{TXV}$ has a value of 0.90.	Split systems are assumed to have refrigerant charge testing or a TXV, when required by Package D.	No TXV or refrigerant charge testing.	Section RI.2
Presence of a matched High Efficiency Compressor Unit, Evaporator Coil, Refrigerant Metering Device, and (where specified) Air Handling Unit and/or Time Delay Relay.	EER	The EER is the Energy Efficiency Ratio at 95 F outdoors specified according to ARI procedures for the matched combination	Systems are assumed to have the default EER based on SEER, see ACM Equation R4-41	Default EER	Sections RI.3 and RI.4

#### RI.2 TXV Verification Procedure

The procedure shall consist of visual verification that the TXV is installed on the system.

#### RI.3 Time Delay Relay Verification Procedure

When a high EER system specification includes a time delay relay, the installation of the time delay relay shall be verified.

The procedure shall be:

- 1) Turn the thermostat down until the compressor and indoor fan are both running.
- 2) Turn the thermostat up so the compressor stops running.
- 3) Verify that the indoor fan continues to run for at least 30 seconds.

---

#### ***RI.4 Matched Equipment Procedure***

When installation of specific matched equipment is necessary to achieve a high EER, installation of the specific equipment shall be verified.

The procedure shall consist of visual verification of installation of the following equipment and confirmation that the installed equipment matches the equipment required to achieve the high EER rating:

- 1) The specified labeled make and model number of the outdoor unit.
- 2) The specified labeled make and model number of the inside coil.
- 3) The specified labeled make and model of the furnace or air handler when a specific furnace or air handler is necessary to achieve the high EER rating,
- 4) The specified metering device when a specific refrigerant metering device (such as a TXV or an EXV) is necessary to achieve the high efficiency rating.

# **HERS COMPLIANCE FORMS**

- CF-1R – Compliance Form
- CF-4R – HERS Rater Compliance Form
- CF-6R – Installer Compliance Form



<b>CERTIFICATE OF COMPLIANCE: RESIDENTIAL</b>		<b>(Page 1 of 4)</b>	<b>CF-1R</b>
Project Title	Date	Building Permit #	
Project Address			
		Plan Check / Date	
Documentation Author	Telephone	Field Check / Date	
Compliance Method (Prescriptive)	Climate Zone		
		Enforcement Agency Use Only	

Alternative Component Package Method: (check one) \_\_\_\_\_ C \_\_\_\_\_ D \_\_\_\_\_ D (Alternative)  
 • Package C and Package D choices require HERS rater field verification and/or diagnostic testing (see CF-1R page 3)  
 For Package D Alternative see Appendix B Table 151-C Footnotes 7-14

### GENERAL INFORMATION

Total Conditioned Floor Area (CFA) \_\_\_\_\_ ft<sup>2</sup>

Average Ceiling Height: \_\_\_\_\_ ft

Maximum Allowed West Facing Fenestration Products Per Table 151-B or 151-C ---- (5% X CFA) \_\_\_\_\_ ft<sup>2</sup>

Maximum Allowed Total Fenestration Products Per Table 151-B or 151-C ----(20% X CFA) \_\_\_\_\_ ft<sup>2</sup>

Building Type: (check one or more) \_\_\_\_\_ Single Family \_\_\_\_\_ Multifamily \_\_\_\_\_ Addition \_\_\_\_\_ Alteration  
 (If adding fenestration fill out WS-4R, Fenestration Maximum Allowed Area Worksheet and see Section 8.3.2 for Additions and 8.3.3 for Alterations.)

Number of Stories: \_\_\_\_\_ Number of Dwelling Units: \_\_\_\_\_

Floor Construction Type: \_\_\_\_\_ Slab/Raised Floor (circle one or both)

Front Orientation: \_\_\_\_\_ North / South / East / West / All Orientations (input front orientation in degrees from True North and circle one).

**RADIANT BARRIER** (required in climate zones 2, 4, 8-15)

### OPAQUE SURFACES INCLUDING OPAQUE DOORS

Component Type (Wall, Roof, Floor, Slab Edge, Doors)	Frame Type (Wood or Metal)	Cavity Insulation R-Value	Continuous Insulation R-Value	Assembly U-factor (for wood, metal frame and mass assemblies) <sup>1</sup>	Joint Appendix IV Reference	Roof Radiant Barrier Installed Yes or No	Location Comments (attic, garage, typical, etc.)

1) See Joint Appendix IV in Section IV.2, IV.3 and IV.4, which is the basis for the U-factor criterion. U-factors can not exceed prescriptive value to show equivalence to R-values.

**CERTIFICATE OF COMPLIANCE: RESIDENTIAL (Page 2 of 4) CF-1R**

<i>Project Title</i>	<i>Date</i>
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**FENESTRATION PRODUCTS – U-FACTOR AND SHGC**

✓  FENESTRATION MAXIMUM ALLOWED AREA WORKSHEET WS-4R –must be included for New Construction, Additions and Alterations.

Fenestration #/Type/Pos. (Front, Left, Rear, Right, Skylight)	Orientation, N, S, E, W <sup>1</sup>	Area (ft <sup>2</sup> )	U-factor <sup>2</sup>	U-factor Source <sup>3</sup>	SHGC <sup>4</sup>	SHGC Source <sup>5</sup>	Exterior Shading/Overhangs <sup>6,7</sup> ✓ box if WS-3R is included
							<input type="checkbox"/>
							<input type="checkbox"/>
							<input type="checkbox"/>
							<input type="checkbox"/>
							<input type="checkbox"/>
							<input type="checkbox"/>
							<input type="checkbox"/>

- 1) Skylights are now included in West-facing fenestration area if the skylights are tilted to the west or tilted in any direction when the pitch is less than 1:12. See §151(f)3C and in Section 3.2.3 of the Residential Manual
- 2) Enter values in this column are either NFRC Rated value or from Standards default Table 116A.
- 3) Indicate source either from NFRC or Table 116A,
- 4) Enter values in this column from NFRC or from Standards Default Table 116B or adjusted SHGC from WS-3R.
- 5) Indicate source either from NFRC or Table 116B.
- 6) Shading Devices are defined in Table 3-3 in the Residential Manual and see WS-3R to calculate Exterior Shading devices.
- 7) See Section 3.2.4 in the Residential Manual.

**HVAC SYSTEMS**

Heating Equipment Type and Capacity (furnace, heat pump, boiler, etc.)	Minimum Efficiency (AFUE or HSPF)	Distribution Type and Location (ducts, attic, etc.)	Duct or Piping R-Value	Thermostat Type	Configuration (split or package)

Cooling Equipment Type and Capacity (A/C, heat pump, evap. cooling)	Minimum Efficiency (SEER or EER)	Duct Location (attic, etc.)	Duct R-Value	Thermostat Type	Configuration (split or package)

**CERTIFICATE OF COMPLIANCE: RESIDENTIAL (Page 3 of 4) CF-1R**

<i>Project Title</i> _____	<i>Date</i> _____
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**SEALED DUCTS and TXVs (or Alternative Measures)**

A signed CF-4R Form must be provided to the building department for each home for which the following. are required.

✓	
<input type="checkbox"/>	Sealed Ducts (all climate zones) (Installer testing and certification and HERS rater field verification required.)
<input type="checkbox"/>	TXVs, readily accessible (climate zones 2 and 8-15 only) (Installer testing and certification and HERS Rater field verification required.)
<input type="checkbox"/>	Refrigerant Charge (climate zones 2 and 8-15 only) (Installer testing and certification and HERS Rater field verification required.)

**OR**

<input type="checkbox"/>	Alternative to Sealed Ducts and Refrigerant Charge /TXVs (See Package D Alternative Package Features for Project Climate Zone in the RM Appendix B Table 151-C, Footnotes 7-14.
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**OR**

<input type="checkbox"/>	For additions and alterations, duct systems that are not documented to have been previously sealed as confirmed through field verification and diagnostic testing in accordance with procedures in the Residential ACM Manual and duct systems with more than 40 linear feet in unconditioned spaces shall meet the requirements of Section 150(m) and duct insulation requirements of Package D.
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**WATER HEATING SYSTEMS**

✓	
<input type="checkbox"/>	Check box if system meets criteria of a “Standard” system. Standard system is one gas-fired water heater per dwelling unit. If the water heater is a storage type, 50 gallons is the maximum capacity and recirculation system is not allowed.
<input type="checkbox"/>	Check box when using Preapproved Alternative Water Heating table, Table 5-4 in Chapter 5 in the Residential Manual. No water heating calculations are required, and the system complies automatically.
<input type="checkbox"/>	Check box if system does not meet criteria of “Standard” system, and does not comply with the Preapproved Alternative Water Heating table. In this case, the Performance Method must be used and must be included in the submittal.
<input type="checkbox"/>	Check box to verify that a time control is required for a recirculating system pump for a system serving multiple units

**Systems serving single dwelling units**

Water Heater Type/Fuel Type	Distribution Type	Number in System	Rated Input <sup>1</sup> (kW or Btu/hr)	Tank Capacity (gallons)	Energy Factor <sup>1</sup> or Thermal Efficiency	Standby <sup>1</sup> Loss (%)	Tank External Insulation R-Value

**System serving multiple dwelling units**

Water Heater Type	Distribution Type	Number in System	Rated Input <sup>1</sup> (kW or Btu/hr)	Tank Capacity (gallons)	Energy Factor <sup>1</sup> or Thermal Efficiency	Standby <sup>1</sup> Loss (%)	Tank External Insulation R-Value

1) For small gas storage water heaters (rated inputs of less than or equal to 75,000 Btu/hr), electric resistance, and heat pump water heaters, list Energy Factor. For large gas storage water heaters (rated input of greater than 75,000 Btu/hr), list Rated Input, Recovery Efficiency, Thermal Efficiency and Standby Loss. For instantaneous gas water heaters, list Rated Input and Thermal Efficiencies.

**Pipe Insulation** (kitchen lines  $\geq 3/4$  inches) All hot water pipes from the heating source to the kitchen fixtures that are  $3/4$  inches or greater in diameter shall be thermally insulated as specified by Section 150 (j) 2 A or 150 (j) 2 B.

**CERTIFICATE OF COMPLIANCE: RESIDENTIAL (Page 4 of 4) CF-1R**

<i>Project Title</i>	<i>Date</i>

**SPECIAL FEATURES NOT REQUIRING HERS VERIFICATION** (add extra sheets if necessary)

Indicate which special features are part of this project. The list below only represents special features relevant to the prescriptive method.

<input checked="" type="checkbox"/>	<b>Feature</b>	<b>Required Forms (if applicable)</b>	<b>Description</b>
<input type="checkbox"/>	Metal Framed Walls	CF-1R	
<input type="checkbox"/>	Radiant Barriers	CF-1R	
<input type="checkbox"/>	Exterior Shades	WS-4R	
<input type="checkbox"/>	Cool Roof	N/A; Attach CRRC Label to Forms.	
<input type="checkbox"/>	Dedicated Hydronic Heating System	Performance Calculation Required; Attach Run to Forms.	
<input type="checkbox"/>	Combined Hydronic System	Performance Calculation Required; Attach Run to Forms.	
<input type="checkbox"/>	Gas Cooling	Performance Calculation Required.	
<input type="checkbox"/>	Buried Ducts	N/A; Indicate on building plans.	
<input type="checkbox"/>	Kitchen Pipe Insulation	See Section 5.6.2 Distribution Systems in Residential Manual.	
<input type="checkbox"/>	Multiple Water Heaters Per Dwelling Unit	See Table 5-13 or use Performance Calculation and attach Run to Forms.	
<input type="checkbox"/>	Central Water Heating System Serving Multiple Dwellings	Performance Calculation and attach Run to Forms.	
<input type="checkbox"/>	Non-NAECA Large Water Heater	CF-1R	
<input type="checkbox"/>	Indirect Water Heater	See Table 5-13 or use Performance Calculation and attach Run to Forms	
<input type="checkbox"/>	Instantaneous Gas Water Heater	See Table 5-13 or use Performance Calculation and attach Run to Forms	
<input type="checkbox"/>	Solar Water Heating System	See Table 5-13 or use Performance Calculation and attach Run to Forms	
<input type="checkbox"/>	Wood Stove Boiler	Performance Calculation and attach Run to Forms	

**SPECIAL FEATURES REQUIRING HERS RATER VERIFICATION**

(add extra sheets if necessary) Indicate to the HERS Rater which credits are part of this project and need verification.

<input checked="" type="checkbox"/>	<b>Feature</b>	<b>Required Forms (if applicable)</b>	<b>Description</b>
<input type="checkbox"/>	Duct Sealing	CF-6R part 4 of 12	
<input type="checkbox"/>	Refrigerant Charge	CF-6R part 5 of 12	
<input type="checkbox"/>	Thermostatic Expansion Valve	CF-6R part 6 of 12	

**CERTIFICATE OF FIELD VERIFICATION & DIAGNOSTIC TESTING (Page 1 of 8) CF-4R**

Project Address		Builder Name
Builder Contact	Telephone	Plan Number
HERS Rater	Telephone	Sample Group Number
Compliance Method (Prescriptive)		Climate Zone
Certifying Signature	Date	Sample House Number
Firm		HERS Provider
Street Address:		City/State/Zip:

**Copies to: BUILDER, HERS PROVIDER AND BUILDING DEPARTMENT**

**HERS RATER COMPLIANCE STATEMENT**

The house was:   Tested   Approved as part of sample testing, but was not tested

As the HERS rater providing diagnostic testing and field verification, I certify that the house identified on this form complies with the diagnostic tested compliance requirements as checked  on this form. The HERS rater must check and verify that the new distribution system is fully ducted and correct tape is used before a CF-4R may be released on every tested building. The HERS rater must not release the CF-4R until a properly completed and signed CF-6R has been received for the sample and tested buildings.

- The installer has provided a copy of CF-6R (Installation Certificate).
- New Distribution system is fully ducted (i.e., does not use building cavities as plenums or platform returns in lieu of ducts).
- New systems where cloth backed, rubber adhesive duct tape is installed, mastic and draw bands are used in combination with cloth backed, rubber adhesive duct tape to seal leaks at duct connections.

**MINIMUM REQUIREMENTS FOR DUCT LEAKAGE REDUCTION COMPLIANCE CREDIT**

*Procedures for field verification and diagnostic testing of air distribution systems are available in RACM, Appendix RC4.3.*

**Duct Diagnostic Leakage Testing Results**

<b>NEW CONSTRUCTION:</b>			
	Duct Pressurization Test Results (CFM @ 25 Pa)	Measured Values	
1	Enter Tested Leakage Flow in CFM:		
2	Fan Flow: Calculated (Nominal: <input checked="" type="checkbox"/> Cooling <input checked="" type="checkbox"/> Heating) or <input checked="" type="checkbox"/> Measured Enter Total Fan Flow in CFM:		<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>
3	Pass if Leakage Percentage ≤ 6% [ 100 x [ _____(Line # 1) / _____(Line # 2)]]		<input type="checkbox"/> Pass <input type="checkbox"/> Fail
<b>ALTERATIONS: Duct System and/or HVAC Equipment Change-Out</b>			
4	Enter Tested Leakage Flow in CFM from CF-6R: <b>Pre-Test</b> of Existing Duct System Prior to Duct System Alteration and/or Equipment Change-Out.		
5	Enter Tested Leakage Flow in CFM: <b>Final Test</b> of New Duct System or Altered Duct System for Duct System Alteration and/or Equipment Change-Out.		
6	Enter Reduction in Leakage for Altered Duct System [ _____(Line # 4) Minus _____(Line # 5)] (Only if Applicable)		
7	Enter Tested Leakage Flow in CFM to Outside (Only if Applicable)		<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>
8	Entire New Duct System - Pass if Leakage Percentage ≤ 6% [100 x [ _____(Line # 5) / _____(Line # 2)]]		<input type="checkbox"/> Pass <input type="checkbox"/> Fail
<b>TEST OR VERIFICATION STANDARDS: For Altered Duct System and/or HVAC Equipment Change-Out</b>			<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>
<b>Use one of the following four Test or Verification Standards for compliance:</b>			
9	Pass if Leakage Percentage ≤ 15% [100 x [ _____(Line # 5) / _____(Line # 2)]]		<input type="checkbox"/> Pass <input type="checkbox"/> Fail
10	Pass if Leakage to Outside Percentage ≤ 10% [100 x [ _____(Line # 7) / _____(Line # 2)]]		<input type="checkbox"/> Pass <input type="checkbox"/> Fail
11	Pass if Leakage Reduction Percentage ≥ 60% [100 x [ _____(Line # 6) / _____(Line # 4)]] and Verification by Smoke Test and Visual Inspection		<input type="checkbox"/> Pass <input type="checkbox"/> Fail
12	Pass if Sealing of all Accessible Leaks and Verification by Smoke Test and Visual Inspection		<input type="checkbox"/> Pass <input type="checkbox"/> Fail
<b>Pass if One of Lines # 9 through # 12 pass</b>			<input type="checkbox"/> Pass <input type="checkbox"/> Fail

**CERTIFICATE OF FIELD VERIFICATION & DIAGNOSTIC TESTING (Page 2 of 8) CF-4R**

Project Address	Builders Name
-----------------	---------------

**Copies to: BUILDER, HERS PROVIDER AND BUILDING DEPARTMENT**

**✓  DIAGNOSTIC SUPPLY DUCT LOCATION, SURFACE AREA AND R-VALUE**

*Procedures for field verification and diagnostic testing for this group compliance credits are available in RACM, Appendix RC, RE & RH.*

**✓  LESS THAN 12 LINEAL FEET OF SUPPLY DUCT OUTSIDE OF CONDITIONED SPACE COMPLIANCE CREDIT**

✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Less than 12 lineal feet of supply duct outside of conditioned space.	Yes to this compliance credit is a pass	✓	<input type="checkbox"/> Pass	✓	<input type="checkbox"/> Fail
---	------------------------------	-----------------------------	---	---	---	-------------------------------	---	-------------------------------

**✓  SUPPLY DUCTS LOCATED IN CONDITIONED SPACE COMPLIANCE CREDIT**

✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Ducts are located within the conditioned volume of building.	Yes to this compliance credit is a pass	✓	<input type="checkbox"/> Pass	✓	<input type="checkbox"/> Fail
---	------------------------------	-----------------------------	--	---	---	-------------------------------	---	-------------------------------

**Duct System Design verification is required for a compliance credit for the following:**

1. Supply duct surface area reduction
2. Buried supply ducts on the ceiling
3. Deeply buried supply ducts

**✓  DUCT SYSTEM DESIGN VERIFICATION**

✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Adequate airflow verified					
✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	The duct system design plan meets the requirements specified in RACM, Appendix RE, Section RE.4.2					
✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	The duct system design plan exists on building plans					
✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Duct sizes, duct system layout and locations of supply & return registers match the duct system design plan					
				Yes to all is a pass	✓	<input type="checkbox"/> Pass	✓	<input type="checkbox"/> Fail

**✓  SUPPLY DUCTS SURFACE AREA REDUCTION COMPLIANCE CREDIT**

Attic	Crawl Space	Basement	Covered	Deeply Covered	Other	Duct Diameter	R-4.2 Surface Area	R-6.0 Surface Area	R-8.0 Surface Area		
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>						
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>						
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>						
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>						
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>						
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>						
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>						
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>						
Total Surface Area for Each R-Value =											
✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Duct Surface Area matches Performance's CF-1R?					✓	<input type="checkbox"/> Pass	✓	<input type="checkbox"/> Fail
							Yes to all is a pass	✓	<input type="checkbox"/> Pass	✓	<input type="checkbox"/> Fail

**✓  BURIED DUCTS ON THE CEILING COMPLIANCE CREDIT**

✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Buried Ducts on the Ceiling					
✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Verified High Insulation Installation Quality			✓		
				Yes to duct system design, supply duct surface area reduction and this compliance credit is a pass	✓	<input type="checkbox"/> Pass	✓	<input type="checkbox"/> Fail

**✓  DEEPLY BURIED DUCTS COMPLIANCE CREDIT**

✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<i>Deeply Buried Ducts</i>					
✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Verified High Insulation Installation Quality			✓		
				Yes to duct system design, supply duct surface area reduction and this compliance credit is a pass	✓	<input type="checkbox"/> Pass	✓	<input type="checkbox"/> Fail

**CERTIFICATE OF FIELD VERIFICATION & DIAGNOSTIC TESTING (Page 3 of 8) CF-4R**

Project Address		Builder Name
Builder Contact	Telephone	Plan Number
HERS Rater	Telephone	Sample Group Number
Compliance Method (Prescriptive)		Climate Zone
Certifying Signature	Date	Sample House Number
Firm		HERS Provider
Street Address:		City/State/Zip:

**Copies to: BUILDER, HERS PROVIDER AND BUILDING DEPARTMENT**

**HERS RATER COMPLIANCE STATEMENT**

The house was:   Tested        Approved as part of sample testing, but was not tested

As the HERS rater providing diagnostic testing and field verification, I certify that the house identified on this form complies with the diagnostic tested compliance requirements as checked on this form.

The installer has provided a copy of CF-6R (Installation Certificate).

**THERMOSTATIC EXPANSION VALVE (TXV)**

*Procedures for field verification of thermostatic expansion valves are available in RACM, Appendix RI.*

				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Access is provided for inspection. The procedure shall consist of visual verification that the TXV is installed on the system and installation of the specific equipment shall be verified.	<input type="checkbox"/>	<input type="checkbox"/>
			Yes is a pass	Pass	Fail

**REFRIGERANT CHARGE MEASUREMENT**

Verification for Required Refrigerant Charge for Split System Space Cooling Systems without Thermostatic Expansion Valves

Outdoor Unit Serial #		
Location		
Outdoor Unit Make		
Outdoor Unit Model		
Cooling Capacity		Btu/hr
Date of Verification		
Date of Refrigerant Gauge Calibration		(must be checked monthly)
Date of Thermocouple Calibration		(must be checked monthly)

Standard Charge Measurement (outdoor air dry-bulb 55 °F and above):

Note: The system should be installed and charged in accordance with the manufacturer's specifications and installer verification shall be documented on CF-6R before starting this procedure. If outdoor air dry-bulb is below 55 °F rater shall use the Alternative Charge Measure Procedure

Procedures for Determining Refrigerant Charge using the Standard Method are available in RACM, Appendix RD2.

<input checked="" type="checkbox"/> <input type="checkbox"/> Yes <input type="checkbox"/> No	A copy of CF-6R (Installation Certificate) has been provided with refrigerant charge measurement documented.
--	--

**CERTIFICATE OF FIELD VERIFICATION & DIAGNOSTIC TESTING (Page 4 of 8) CF-4R**

Project Address	Builders Name
-----------------	---------------

**Copies to: BUILDER, HERS PROVIDER AND BUILDING DEPARTMENT**

Measured Temperatures

Supply (evaporator leaving) air dry-bulb temperature (Tsupply, db)		°F
Return (evaporator entering) air dry-bulb temperature (Treturn, db)		°F
Return (evaporator entering) air wet-bulb temperature (Treturn, wb)		°F
Evaporator saturation temperature (Tevaporator, sat)		°F
Suction line temperature (Tsuction, db)		°F
Condenser (entering) air dry-bulb temperature (Tcondenser, db)		°F

Superheat Charge Method Calculations for Refrigerant Charge

Actual Superheat = Tsuction, db – Tevaporator, sat		°F
Target Superheat (from Table RD-2)		°F
Actual Superheat – Target Superheat (System passes if between -5 and +5°F)		°F

Temperature Split Method Calculations for Adequate Airflow

*Split Method Calculation is not necessary if Adequate Airflow credit is taken*

Actual Temperature Split = T return, db Tsupply, db		°F
Target Temperature Split (from Table RD3)		°F
Actual Temperature Split Target Temperature Split (System passes if between -3°F and +3°F or, upon remeasurement, if between -3°F and -100°F)		°F

Standard Charge Measurement Summary:

System shall pass both refrigerant charge and adequate airflow calculation criteria from the same measurements. If corrective actions were taken, both criteria must be remeasured and recalculated

<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	System Passes
-------------------------------------	------------------------------	-----------------------------	---------------

Alternative Charge Measurement (outdoor air dry-bulb below 55 °F)

Note: The system should be installed and charged in accordance with the manufacturer’s specifications and installer verification shall be documented on CF-6R before starting this procedure. If outdoor air dry-bulb is 55 °F or above, rater shall use the Standard Charge Measure Procedure:

*Procedures for Determining Refrigerant Charge using the Alternative Method are available in RACM, Appendix RD3.*

<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	A copy of CF-6R (Installation Certificate) has been provided with refrigerant charge measurement documented.
-------------------------------------	------------------------------	-----------------------------	--

Weigh-In Charging Method for Refrigerant Charge

Actual liquid line length:		ft
Manufacturer’s Standard liquid line length:		ft
Difference (Actual – Standard):		ft

Manufacturer’s correction (ounces per foot) _____ x difference in length = _____ ounces (“+ “ = add ounces) (“-“ = remove ounces)
--

Alternative Charge Measurement Summary:

System shall pass both refrigerant charge and adequate airflow calculation criteria from the same measurements. If corrective actions were taken, both criteria must be remeasured and recalculated.

<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	System Passes
-------------------------------------	------------------------------	-----------------------------	---------------

**CERTIFICATE OF FIELD VERIFICATION & DIAGNOSTIC TESTING (Page 5 of 8) CF-4R**

Project Address		Builder Name
Builder Contact	Telephone	Plan Number
HERS Rater	Telephone	Sample Group Number
Certifying Signature	Date	Sample House Number
Firm	HERS Provider	
Street Address:	City/State/Zip:	

**Copies to: BUILDER, HERS PROVIDER AND BUILDING DEPARTMENT**

**HERS RATER COMPLIANCE STATEMENT**

The house was:  Tested  Approved as part of sample testing, but was not tested

As the HERS rater providing diagnostic testing and field verification, I certify that the house identified on this form complies with the diagnostic tested compliance requirements as checked on this form.

The installer has provided a copy of CF-6R (Installation Certificate).

**ADEQUATE AIRFLOW VERIFICATION**

*Procedures for field verification and diagnostic testing of adequate airflow are available in RACM, Appendix RE4.1.*

Method For Airflow Measurement				
<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Duct design exists on plans	
<input type="checkbox"/>	RE4.1.1		Diagnostic Fan Flow Using Flow Capture Hood	
<input type="checkbox"/>	RE4.1.2		Diagnostic Fan Flow Using Plenum Pressure Matching	
<input type="checkbox"/>	RE4.1.3		Diagnostic Fan Flow Using Flow Grid Measurement	
			<b>Measured Airflow:</b>	
			<b>Rated Tons:</b>	
				Total CFM
				cfm/ton
<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Measured airflow is greater than the criteria in Table RE-2	<input type="checkbox"/>
			Yes is a pass	<input type="checkbox"/>
				Pass
				Fail

**MAXIMUM COOLING CAPACITY**

*Procedures for determining maximum cooling load capacity are available in RACM, Appendix RF3.*

1	<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Adequate airflow verified (see adequate airflow credit)	
2	<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Refrigerant charge or TXV	
3	<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Duct leakage reduction credit verified	
4	<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Cooling capacities of installed systems are ≤ to maximum cooling capacity indicated on the Performance's CF-1R and RF-3.	
5	<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	If the cooling capacities of installed systems are > than maximum cooling capacity in the CF-1R, then the electrical input for the installed systems must be ≤ to electrical input in the CF-1R.	
Yes to 1, 2, and 3; and Yes to either 4 or 5 is a pass					
					<input checked="" type="checkbox"/>
					<input checked="" type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>
					Pass
					Fail

**HIGH EER AIR CONDITIONER**

*Procedures for verification are available in RACM, Appendix RI.*

1	<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	EER values of installed systems match the CF-1R	
2	<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	For split system, indoor coil is matched to outdoor coil	
3	<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Time Delay Relay Verified (If Required)	
Yes to 1 and 2; and 3 (If Required) is a pass					
					<input checked="" type="checkbox"/>
					<input checked="" type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>
					Pass
					Fail

**CERTIFICATE OF FIELD VERIFICATION & DIAGNOSTIC TESTING (Page 6 of 8) CF-4R**

Project Address		Builder Name
Builder Contact	Telephone	Plan Number
HERS Rater	Telephone	Sample Group Number
Certifying Signature	Date	Sample House Number
Firm	HERS Provider	
Street Address:	City/State/Zip:	

**Copies to: BUILDER, HERS PROVIDER AND BUILDING DEPARTMENT**

**HERS RATER COMPLIANCE STATEMENT**

The house was:   Tested   Approved as part of sample testing, but was not tested

As the HERS rater providing diagnostic testing and field verification, I certify that the house identified on this form complies with the diagnostic tested compliance requirements as checked on this form.

The installer has provided a copy of CF-6R (Installation Certificate).

**FAN WATT DRAW**

*Procedures for measuring the air handler watt draw are available in RACM, Appendix RE3.2.*

<input checked="" type="checkbox"/> <b>Method For Fan Watt Draw Measurement</b>				
<input type="checkbox"/>	RE3.2.1	Portable Watt Meter Measurement		
<input type="checkbox"/>	RE3.2.2	Utility Revenue Meter Measurement		
Measured Fan watt Draw:		(enter watts here)		Watts
Measured Fan Flow (Enter total cfm from airflow verification)				cfm
Enter results of Watts/cfm:				Watts/cfm
			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	Calculated fan watt/cfm is equal to or lower than the fan watt/cfm draw documented in CF-1R	<input type="checkbox"/>	<input type="checkbox"/>
		Yes is a pass	Pass	Fail

**HERS RATER COMPLIANCE STATEMENT**

The house was:   Tested   Approved as part of sample testing, but was not tested

As the HERS rater providing diagnostic testing and field verification, I certify that the house identified on this form complies with the diagnostic tested compliance requirements as checked on this form.

The installer has provided a copy of CF-6R (Installation Certificate).

**MINIMUM REQUIREMENTS FOR INFILTRATION REDUCTION COMPLIANCE CREDIT**

*Procedures for field verification and diagnostic testing of infiltration reduction are available in RACM Section 3.5.*

**Diagnostic Testing Results**

	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Building Envelope Leakage (CFM @ 50 Pa) as measured by Rater:	
1.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Is measured envelope leakage less than or equal to the required level from CF-1R?	
2.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Is Mechanical Ventilation shown as required on the CF-1R?	
2a.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	If Mechanical Ventilation is required on the CF-1R (Yes in line 2), has it been installed?	
2b.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Check this box yes if mechanical ventilation is required (Yes in line 2) and ventilation fan watts are no greater than shown on CF-1R.	
3.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Check this box yes if measured building infiltration (CFM @ 50 Pa) is greater than the CFM @ 50 values shown for an SLA of 1.5 on CF-1R (If this box is checked no, mechanical ventilation is required.)	
4.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Check this box yes if measured building infiltration (CFM @ 50 Pa) is less than the CFM @ 50 values shown for an SLA of 1.5 on CF-1R, mechanical ventilation is installed and house pressure is greater than minus 5 Pascal with all exhaust fans operating.	
Pass if: a) Yes in line 1 and line 3, or b) Yes in line 1 and line2, 2a, and 2b, or c)Yes in line 1 and line 4, Otherwise Fail.				<input type="checkbox"/> Pass <input type="checkbox"/> Fail

CERTIFICATE OF FIELD VERIFICATION & DIAGNOSTIC TESTING (Page 7 of 8) CF-4R		
Project Address		Builder Name
Builder Contact	Telephone	Plan Number
HERS Rater	Telephone	Sample Group Number
Certifying Signature	Date	Sample House Number
Firm		HERS Provider
Street Address:		City/State/Zip:

Copies to: BUILDER, HERS PROVIDER AND BUILDING DEPARTMENT

**HERS RATER COMPLIANCE STATEMENT**

The house was:   Tested   Approved as part of sample testing, but was not tested

As the HERS rater providing diagnostic testing and field verification, I certify that the house identified on this form complies with all applicable requirements of the “High Quality Installation of Insulation” protocols as specified in the Residential ACM, Appendix RH and as checked on this form. Note that to PASS and receive compliance credit, NONE of the BOXES below may be checked “No” and the first three boxes also must be checked. Check “NA” only if the item is not part of the design of the building (i.e., single story buildings do not have rim joists or there may be no recessed can lights installed, etc.).

**REQUIREMENTS FOR “HIGH QUALITY INSTALLATION OF INSULATION” COMPLIANCE CREDIT**

- The building is wood frame construction with wall stud cavities, ceilings, and roof assemblies insulated with mineral fiber or cellulose insulation in low-rise residential buildings.
- Description of insulation, (CF-6R, formerly IC-1) signed by the installer stating: insulation manufacturer’s name, material identification, installed R-values, and for loose-fill insulation: minimum weight per square foot and minimum inches.
- Installation Certificate, (CF-6R) signed by the installer certifying that the installation meets all applicable requirements as specified in the High Quality Insulation Installation Procedures (ACM, Appendix RH).

**FLOOR**

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	All floor joist cavity insulation installed to uniformly fit the cavity side-to-side and end-to-end
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Insulation in contact with the subfloor or rim joists insulated
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Insulation properly supported to avoid gaps, voids, and compression
Yes	No	NA	
<input checked="" type="checkbox"/> <b>WALLS</b>			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Wall stud cavity insulation uniformly fills the cavity side-to-side, top-to-bottom, and front-to-back
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	No gaps
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	No voids over 3/4” deep or more than 10% of the batt surface area.
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Hard to access wall stud cavities such as; corner channels, wall intersections, and behind tub/shower enclosures insulated to proper R-Value
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Small spaces filled
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Rim-joists insulated
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Wall stud cavities caulked or foamed to provide an air tight envelope
Yes	No	NA	

**CERTIFICATE OF FIELD VERIFICATION & DIAGNOSTIC TESTING (Page 8 of 8) CF-4R**

Project Address

Builders Name

**✓ ROOF/CEILING PREPARATION**

<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	All draft stops in place to form a continuous ceiling and wall air barrier
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	All drops covered with hard covers
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	All draft stops and hard covers caulked or foamed to provide an air tight envelope
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	All recessed light fixtures IC and air tight (AT) rated and sealed with a gasket or caulk between the housing and the ceiling
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	Floor cavities on multiple-story buildings have air tight draft stops to all adjoining attics
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	Eave vents prepared for blown insulation - maintain net free-ventilation area
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	Knee walls insulated or prepared for blown insulation
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	Area under equipment platforms and cat-walks insulated or accessible for blown insulation
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	Attic rulers installed

**✓ ROOF/CEILING BATTS**

<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	No gaps
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	No voids over 3/4 in. deep or more than 10% of the batt surface area
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	Insulation in contact with the air-barrier
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	Recessed light fixtures covered
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	Net free-ventilation area maintained at eave vents

**✓ ROOF/CEILING LOOSE-FILL**

<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	Insulation uniformly covers the entire ceiling (or roof) area from the outside of all exterior walls
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	Baffles installed at eaves vents or soffit vents - maintain net free-ventilation area of eave vent
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	Attic access insulated
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	Recessed light fixtures covered
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	Insulation at proper depth – insulation rulers visible and indicating proper depth and R-value
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	Loose-fill mineral fiber insulation meets or exceeds manufacturer's minimum weight and thickness requirement for the target R-value. Target R-value _____ Manufacturer's minimum required weight for the target R-value _____ (pounds-per-square foot). Sample weight _____ (pounds per square foot).
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA	Manufacturer's minimum required thickness at time of installation _____ (inches) Manufacturer's minimum required settled thickness _____ (inches). Number of days since loose-fill insulation was installed _____ (days). At the time of installation, the insulation shall be greater than or equal to the manufacturer's minimum initial insulation thickness. If the HERS rater does not verify the insulation at the time of installation, and if the loose-fill insulation has been in place less than seven days the thickness shall be greater than the manufacturer's minimum required thickness at the time of installation less 1/2 inch to account for settling. If the insulation has been in place for seven days or longer the insulation thickness shall be greater than or equal to the manufacturer's minimum required settled thickness. Minimum thickness measured (inches).

**INSTALLATION CERTIFICATE**

Site Address

Permit Number

An installation certificate is required to be posted at the building site or made available for all appropriate inspections. (The information provided on this form is required) After completion of final inspection, a copy must be provided to the building department (upon request) and the building owner at occupancy, per Section 10-103(a).

**WATER HEATING SYSTEMS:**

Heater Type	CEC Certified Mfr Name & Model Number	Distribution Type (Std, Point-of-Use, etc)	If Recirculation, Control Type	# of Identical Systems	Rated Input (kW or Btu/hr) <sup>1</sup>	Tank Volume (gallons)	Efficiency (EF, RE) <sup>2</sup>	Standby Loss (%) <sup>2</sup>	External Insulation R-value <sup>2</sup>

- For **small gas storage** (rated input of less than or equal to 75,000 Btu/hr), **electric resistance** and **heat pump water heaters**, list Energy Factor (EF). For **large gas storage water heaters** (rated input of greater than 75,000 Btu/hr), list Recovery (RE), Thermal Efficiency, Standby Loss and Rated Input. For **instantaneous gas water heaters**, list Thermal Efficiency and Rated Input.
- R-12 external insulation is mandatory for storage water heaters with an energy factor of less than 0.58.

**Kitchen Piping:**

If indicated on the CF-1R, all hot water piping  $\geq 3/4$  inches in diameter that runs from the hot water source to the kitchen fixtures is insulated.

**Faucets & Shower Heads:**

All faucets and showerheads installed are certified to the Energy Commission, pursuant to Title 24, Part 6, Section 111.

**Central Water Heating in Buildings with Multiple Dwelling Units** (required for prescriptive)

- All hot water piping in main circulating loop is insulated to requirements of §150(j)
  - Central hot water systems serving six or fewer dwelling units which have (1) less than 25' of distribution piping outdoors; (2) zero distribution piping underground; (3) no recirculation pump; and (4) insulation on distribution piping that meets the requirements of Section 150(j)
  - Central hot water systems serving more than 6 dwelling units - presence of either a time control or a time/temperature control
- I, the undersigned, verify that equipment listed above my signature is: 1) the actual equipment installed; 2) equivalent to or more efficient than that specified in the certificate of compliance (Form CF-1R) submitted for compliance with the *Energy Efficiency Standards* for residential buildings; and 3) equipment that meets or exceeds the appropriate requirements for manufactured devices (from the *Appliance Efficiency Regulations* or Part 6), where applicable.

Installing Subcontractor (Co. Name) OR General Contractor (Co. Name) OR Owner	
Signature:	Date:

**Copies to: BUILDING DEPARTMENT, HERS RATER (IF APPLICABLE) BUILDING OWNER AT OCCUPANCY**

**INSTALLATION CERTIFICATE**

Site Address

Permit Number

An installation certificate is required to be posted at the building site or made available for all appropriate inspections. (The information provided on this form is required) After completion of final inspection, a copy must be provided to the building department (upon request) and the building owner at occupancy, per Section 10-103(a).

**FENESTRATION/GLAZING:**

Item	Manufacturer/Brand Name (GROUP LIKE PRODUCTS)	Product U-factor <sup>1</sup> (≤ CF-1R value) <sup>2</sup>	Product SHGC <sup>1</sup> (≤CF-1R value) <sup>2</sup>	# of Panes	Total Quantity of Like Product (Optional)	Area Square Feet	Exterior Shading Device or Overhang	Comments/Location/ Special Features
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								
11.								
12.								
13.								
14.								
15.								

<sup>1)</sup> Use values from a fenestration product’s NFRC label. For fenestration products without an NFRC label, use the default values from Section 116 of the Energy Efficiency Standards.

<sup>2)</sup> Installed U-factor must be less than or equal to values from CF-1R. Installed SHGC must be less than or equal to values from CF-1R, or a shading device (exterior or overhang) is installed as specified on the CF-1R. Alternatively, installed weighted average U-factors for the total fenestration area are less than or equal to values from CF-1R. If using default table SHGC values from §116 identify whether tinted or not.

I, the undersigned, verify that the fenestration/glazing listed above my signature: 1) is the actual fenestration product installed; 2) is equivalent to or has a lower U-factor and lower SHGC than that specified in the certificate of compliance (Form CF-1R) submitted for compliance with the *Energy Efficiency Standards* for residential buildings; and 3) the product meets or exceeds the appropriate requirements for manufactured devices (from Part 6), where applicable.

Item #s (if applicable)	Signature	Date	Installing Subcontractor (Co. Name) OR General Contractor (Co. Name) OR Owner OR Window Distributor
Item #s (if applicable)	Signature	Date	Installing Subcontractor (Co. Name) OR General Contractor (Co. Name) OR Owner OR Window Distributor
Item #s (if applicable)	Signature	Date	Installing Subcontractor (Co. Name) OR General Contractor (Co. Name) OR Owner OR Window Distributor

**Copies to: Building Department , HERS Rater (if applicable) Building Owner at Occupancy**

**INSTALLATION CERTIFICATE****(Page 3 of 12) CF-6R**

Site Address

Permit Number

An installation certificate is required to be posted at the building site or made available for all appropriate inspections. (The information provided on this form is required) After completion of final inspection, a copy must be provided to the building department (upon request) and the building owner at occupancy, per Section 10-103(a).

**HVAC SYSTEMS:*****Heating Equipment***

Equip Type (pkg. heat pump)	CEC Certified Mfr. Name and Model Number	# of Identical Systems	Efficiency (AFUE, etc.) <sup>1</sup> (≥CF-1R value)	Duct Location (attic, etc.)	Duct or Piping R-value	Heating Load (Btu/hr)	Heating Capacity (Btu/hr)

***Cooling Equipment***

Equip Type (pkg. heat pump)	CEC Certified Mfr. Name and Model Number	# of Identical Systems	Efficiency (SEER or EER) <sup>1</sup> (≥CF-1R value)	Duct Location (attic, etc.)	Duct R-value	Cooling Load (Btu/hr)	Cooling Capacity (Btu/hr)

1. ≥ symbol reads *greater than or equal to what is indicated on the CF-1R value.*

Include both SEER and EER if compliance credit for high EER air conditioner is claimed.

✓  I, the undersigned, verify that equipment listed above is: 1) is the actual equipment installed, 2) equivalent to or more efficient than that specified in the certificate of compliance (Form CF-1R) submitted for compliance with the *Energy Efficiency Standards* for residential buildings, and 3) equipment that meets or exceeds the appropriate requirements for manufactured devices (from the *Appliance Efficiency Regulations* or Part 6), where applicable.

Installing Subcontractor (Co. Name) OR General Contractor (Co. Name) OR Owner	
Signature:	Date:

**Copies to: BUILDING DEPARTMENT, HERS RATER (IF APPLICABLE) BUILDING OWNER AT OCCUPANCY**

Site Address

Permit Number

**INSTALLER COMPLIANCE STATEMENT FOR DUCT LEAKAGE**

**INSTALLER COMPLIANCE STATEMENT**

The building was:  Tested at Final       Tested at Rough-in

**INSTALLER VISUAL INSPECTION AT FINAL CONSTRUCTION STAGE:**

- Remove at least one supply and one return register, and verify that the spaces between the register boot and the interior finishing wall are properly sealed.
- If the house rough-in duct leakage test was conducted without an air handler installed, inspect the connection points between the air handler and the supply and return plenums to verify that the connection points are properly sealed.
- Inspect all joints to ensure that no cloth backed rubber adhesive duct tape is used

**DUCT LEAKAGE REDUCTION**

*Procedures for field verification and diagnostic testing of air distribution systems are available in RACM, Appendix RC4.3*

<b>NEW CONSTRUCTION:</b>			
		Measured Values	
	Duct Pressurization Test Results (CFM @ 25 Pa)		
1	Enter Tested Leakage Flow in CFM:		
2	Fan Flow: Calculated (Nominal: <input checked="" type="checkbox"/> Cooling <input checked="" type="checkbox"/> Heating) or <input checked="" type="checkbox"/> Measured If Fan Flow is Calculated as 400 cfm/ton x number of tons or as 21.7 cfm/(kBtu/hr) x Heating Capacity in Thousands of Btu/hr, enter total calculated or measured fan flow in CFM here:		✓      ✓
3	Pass if Leakage Percentage ≤ 6% for Final or ≤ 4% at Rough-in: [100 x [ _____ (Line # 1) / _____ (Line # 2)]]		<input type="checkbox"/> Pass <input type="checkbox"/> Fail
<b>ALTERATIONS: Duct System and/or HVAC Equipment Change-Out</b>			
4	Enter Tested Leakage Flow in CFM from <b>Pre-Test</b> of Existing Duct System Prior to Duct System Alteration and/or Equipment Change-Out.		
5	Enter Tested Leakage Flow in CFM from <b>Final Test</b> of New Duct System or Altered Duct System for Duct System Alteration and/or Equipment Change-Out.		
6	Enter Reduction in Leakage for Altered Duct System [ _____ (Line # 4) Minus _____ (Line # 5) – (Only if Applicable)		
7	Enter Tested Leakage Flow in CFM to Outside (Only if Applicable)		✓      ✓
8	Entire New Duct System - Pass if Leakage Percentage ≤ 6% for Final or ≤ 4% at Rough-in [100 x [ _____ (Line # 5) / _____ Line # 2)]]		<input type="checkbox"/> Pass <input type="checkbox"/> Fail
<b>TEST OR VERIFICATION STANDARDS: For Altered Duct System and/or HVAC Equipment Change-Out Use one of the following four Test or Verification Standards for compliance:</b>			✓      ✓
9	Pass if Leakage Percentage ≤ 15% [100 x [ _____ (Line # 5) / _____ (Line # 2)]]		<input type="checkbox"/> Pass <input type="checkbox"/> Fail
10	Pass if Leakage to Outside Percentage ≤ 10% [100 x [ _____ (Line # 7) / _____ (Line # 2)]]		<input type="checkbox"/> Pass <input type="checkbox"/> Fail
11	Pass if Leakage Reduction Percentage ≥ 60% [100 x [ _____ (Line # 6) / _____ (Line # 4)]] and Verification by Smoke Test and Visual Inspection		<input type="checkbox"/> Pass <input type="checkbox"/> Fail
12	Pass if Sealing of all Accessible Leaks and Verification by Smoke Test and Visual Inspection		<input type="checkbox"/> Pass <input type="checkbox"/> Fail
<b>Pass if One of Lines # 9 through # 12 pass</b>			<input type="checkbox"/> Pass <input type="checkbox"/> Fail

I, the undersigned, verify that the above diagnostic test results were performed in conformance with the requirements for compliance credit. I, the undersigned, also certify that the newly installed or retrofit Air-Distribution System Ducts, Plenums and Fans comply with Mandatory requirements specified in Section 150 (m) of the 2005 Building Energy Efficiency standards.

Installing Subcontractor (Co. Name) OR General Contractor (Co. Name) OR Owner	
Signature:	Date:

**Copies to: BUILDING DEPARTMENT, HERS RATER (IF APPLICABLE) BUILDING OWNER AT OCCUPANCY**

**INSTALLATION CERTIFICATE**

Site Address

Permit Number

**THERMOSTATIC EXPANSION VALVE (TXV)**

*Procedures for field verification of thermostatic expansion valves are available in RACM, Appendix RI.*

<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Access is provided for inspection. The procedure shall consist of visual verification that the TXV is installed on the system and installation of the specific equipment shall be verified.	<input type="checkbox"/>	<input type="checkbox"/>
Yes is a pass				Pass	Fail

**REFRIGERANT CHARGE MEASUREMENT**

Verification for Required Refrigerant Charge and Adequate Airflow for Split System Space Cooling Systems without Thermostatic Expansion Valves

Outdoor Unit Serial #		
Location		
Outdoor Unit Make		
Outdoor Unit Model		
Cooling Capacity		Btu/hr
Date of Verification		
Date of Refrigerant Gauge Calibration		(must be checked monthly)
Date of Thermocouple Calibration		(must be checked monthly)

**Standard Charge Measurement Procedure (outdoor air dry-bulb 55°F and above):**

*Procedures for Determining Refrigerant Charge using the Standard Method are available in RACM, Appendix RD2.*

Note: The system should be installed and charged in accordance with the manufacturer's specifications before starting this procedure.

Measured Temperatures

Supply (evaporator leaving) air dry-bulb temperature (Tsupply, db)		°F
Return (evaporator entering) air dry-bulb temperature (Treturn, db)		°F
Return (evaporator entering) air wet-bulb temperature (Treturn, wb)		°F
Evaporator saturation temperature (Tevaporator, sat)		°F
Suction line temperature (Tsuction, db)		°F
Condenser (entering) air dry-bulb temperature (Tcondenser, db)		°F

Superheat Charge Method Calculations for Refrigerant Charge

Actual Superheat = Tsuction, db – Tevaporator, sat		°F
Target Superheat (from Table RD-2)		°F
Actual Superheat – Target Superheat (System passes if between -5 and +5°F)		°F

Temperature Split Method Calculations for Adequate Airflow

*Split Method Calculation is not necessary if Adequate Airflow credit is taken*

Actual Temperature Split = T return, db Tsupply, db		°F
Target Temperature Split (from Table RD3)		°F
Actual Temperature Split Target Temperature Split (System passes if between -3°F and +3°F or, upon remeasurement, if between -3°F and -100°F)		°F

**INSTALLATION CERTIFICATE****(Page 6 of 12) CF-6R**

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**Standard Charge Measurement Summary:**

System shall pass both refrigerant charge and adequate airflow calculation criteria from the same measurements. If corrective actions were taken, both criteria must be remeasured and recalculated.

 Yes No

System Passes

**Alternate Charge Measurement Procedure** (outdoor air dry-bulb below 55 °F)

Note: The system should be installed and charged in accordance with the manufacturer's specifications and installer verification shall be documented on CF-6R before starting this procedure. If outdoor air dry-bulb is 55 °F or above, installer shall use the Standard Charge Measure Procedure:

*Procedures for Determining Refrigerant Charge using the Alternate Method are available in RACM, Appendix RD3.*

**Weigh-In Charging Method for Refrigerant Charge**

Actual liquid line length:		ft
Manufacturer's Standard liquid line length:		ft
Difference (Actual – Standard):		ft
Manufacturer's correction (ounces per foot) _____ x difference in length = _____ ounces (+ = add) (- = remove)		

**Measured Airflow Method for Adequate Airflow Verification** *available in RACM, Appendix RD2.6*

Calculated Airflow: Cooling Capacity (Btu/hr) _____ X 0.033 (cfm/Btu-hr) = _____ CFM
Measured Airflow is _____ CFM (Measured airflow must be greater than the calculated airflow).

**Alternate Charge Measurement Summary:**

System shall pass both refrigerant charge and adequate airflow calculation criteria from the same measurements. If corrective actions were taken, both criteria must be remeasured and recalculated.

 Yes No

System Passes

Installing Subcontractor (Co. Name) OR General Contractor (Co. Name) OR Owner	
Signature:	Date:

**Copies to: BUILDING DEPARTMENT, HERS RATER (IF APPLICABLE) BUILDING OWNER AT OCCUPANCY**

Site Address

Permit Number

**MISCELLANEOUS CREDITS**

✓  **DIAGNOSTIC SUPPLY DUCT LOCATION, SURFACE AREA AND R-VALUE**

*Procedures for field verification and diagnostic testing for this group compliance credits are available in RACM, Appendix RC, RE & RH.*

✓  **LESS THAN 12 LINEAL FEET OF SUPPLY DUCT OUTSIDE OF CONDITIONED SPACE**

**COMPLIANCE CREDIT**

✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Less than 12 lineal feet of supply duct outside of conditioned space.	Yes to this compliance credit is a pass	✓ <input type="checkbox"/> Pass	✓ <input type="checkbox"/> Fail
---	------------------------------	-----------------------------	---	---	---------------------------------	---------------------------------

✓  **SUPPLY DUCTS LOCATED IN CONDITIONED SPACE COMPLIANCE CREDIT**

✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Ducts are located within the conditioned volume of building.	Yes to this compliance credit is a pass	✓ <input type="checkbox"/> Pass	✓ <input type="checkbox"/> Fail
---	------------------------------	-----------------------------	--	---	---------------------------------	---------------------------------

**Duct System Design verification is required for a compliance credit for the following:**

1. Supply duct surface area reduction
2. Buried supply ducts on the ceiling
3. Deeply buried supply ducts

✓  **DUCT SYSTEM DESIGN VERIFICATION**

✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Adequate airflow verified
✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	The duct system design plan meets the requirements specified in RACM, Appendix RE, Section RE.4.2
✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	The duct system design plan exists on building plans
✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Duct sizes, duct system layout and locations of supply & return registers match the duct system design plan
Yes to all is a pass			
✓ <input type="checkbox"/> Pass    ✓ <input type="checkbox"/> Fail			

✓  **SUPPLY DUCTS SURFACE AREA REDUCTION COMPLIANCE CREDIT**

Attic	Crawl Space	Basement	Covered	Deeply Covered	Other	Duct Diameter	R-4.2 Surface Area	R-6.0 Surface Area	R-8.0 Surface Area
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
Total Surface Area for Each R-Value =									
✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Matches Performance's CF-1R?					✓	✓
Yes to all is a pass							<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	

✓  **BURIED DUCTS ON THE CEILING COMPLIANCE CREDIT**

<input type="checkbox"/> Yes	<input type="checkbox"/> No	Buried Ducts on the Ceiling
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Verified High Insulation Installation Quality
Yes to duct system design, supply duct surface area reduction and this compliance credit is a pass		✓ <input type="checkbox"/> Pass    ✓ <input type="checkbox"/> Fail

✓  **DEEPLY BURIED DUCTS COMPLIANCE CREDIT**

✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Deeply Buried Ducts
✓	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Verified High Insulation Installation Quality
Yes to duct system design, supply duct surface area reduction and this compliance credit is a pass			✓ <input type="checkbox"/> Pass    ✓ <input type="checkbox"/> Fail

**Copies to: BUILDING DEPARTMENT, HERS RATER (IF APPLICABLE) BUILDING OWNER AT OCCUPANCY**

**INSTALLATION CERTIFICATE**

Site Address	Permit Number
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**FAN WATT DRAW**

*Procedures for measuring the air handler watt draw are available in RACM, Appendix RE3.2.*

<b><input checked="" type="checkbox"/> Method For Fan Watt Draw Measurement</b>				
<input type="checkbox"/>	RE3.2.1	Portable Watt Meter Measurement		
<input type="checkbox"/>	RE3.2.2	Utility Revenue Meter Measurement		
			Measured Fan Watt Draw	
			Measured Fan Flow (enter total cfm from airflow verification)	
			Enter results of Watts/cfm	
			Watts	
			cfm	
			Watts/cfm	
<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	Measured fan watt/cfm draw is equal to or lower than the fan watt/cfm draw documented in CF-1R	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<b>Yes is a pass</b>			<input type="checkbox"/> Pass	<input type="checkbox"/> Fail

**ADEQUATE AIRFLOW VERIFICATION**

*Procedures for measuring the airflow are available in RACM, Appendix RE3.1.*

<b><input checked="" type="checkbox"/> Method For Airflow Measurement</b>				
<input type="checkbox"/>	RE4.1.1	Diagnostic Fan Flow Using Flow Capture Hood		
<input type="checkbox"/>	RE4.1.2	Diagnostic Fan Flow Using Plenum Pressure Matching		
<input type="checkbox"/>	RE4.1.3	Diagnostic Fan Flow Using Flow Grid Measurement		
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Duct design exists on plans		
			Measured Airflow:	
			Rated Tons cfm/ton	
			Total cfm	
			cfm/ton	
<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	Measured airflow is greater than the criteria in Table RE-2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<b>Yes is a pass</b>			<input type="checkbox"/> Pass	<input type="checkbox"/> Fail

**MAXIMUM COOLING CAPACITY**

*Procedures for determining maximum cooling load capacity are available in RACM, Appendix RF3.*

1	<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Adequate airflow verified (see adequate airflow credit)		
2	<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Refrigerant charge or TXV		
3	<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Duct leakage reduction credit verified		
4	<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Cooling capacities of installed systems are ≤ to maximum cooling capacity indicated on the Performance's CF-1R and RF-3.		
5	<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	If the cooling capacities of installed systems are > than maximum cooling capacity in the CF-1R, then the electrical input for the installed systems must be ≤ to electrical input in the CF-1R.	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<b>Yes to 1, 2, and 3; and Yes to either 4 or 5 is a pass</b>					<input type="checkbox"/> Pass	<input type="checkbox"/> Fail

**HIGH EER AIR CONDITIONER**

*Procedures for verification are available in RACM, Appendix RI.*

1	<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	EER values of installed systems match the CF-1R		
2	<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	For split system, indoor coil is matched to outdoor coil	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Time Delay Relay Verified (If Required)	<input type="checkbox"/>	<input type="checkbox"/>
<b>Yes to 1 and 2; and 3 (If Required) is a pass</b>					<input type="checkbox"/> Pass	<input type="checkbox"/> Fail

Installing Subcontractor (Co. Name) OR General Contractor (Co. Name) OR Owner	
Signature:	Date:

**Copies to: BUILDING DEPARTMENT, HERS RATER (IF APPLICABLE) BUILDING OWNER AT OCCUPANCY**

**INSTALLATION CERTIFICATE****(Page 9 of 12) CF-6R**

Site Address

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An installation certificate is required to be posted at the building site or made available for all appropriate inspections. (The information provided on this form is required) After completion of final inspection, a copy must be provided to the building department (upon request) and the building owner at occupancy, per Section 10-103(a).

**BUILDING ENVELOPE LEAKAGE DIAGNOSTICS** **ENVELOPE SEALING INFILTRATION REDUCTION**

*Procedures for field verification and diagnostic testing of envelope leakage are available in RACM, Appendix RC.*

**Diagnostic Testing Results**

		✓	✓	Building Envelope Leakage (CFM @ 50 Pa) as measured by Rater:		
1.	<input type="checkbox"/> Yes	<input type="checkbox"/> No		Measured envelope leakage less than or equal to the required level from CF-1R?		
2.	<input type="checkbox"/> Yes	<input type="checkbox"/> No		Is Mechanical Ventilation shown as required on the CF-1R?		
2a.	<input type="checkbox"/> Yes	<input type="checkbox"/> No		If Mechanical Ventilation is required on the CF-1R ('Yes' in line 2), has it been installed?		
2b.	<input type="checkbox"/> Yes	<input type="checkbox"/> No		Check this box 'yes' if mechanical ventilation is required ('Yes' in line 2) and ventilation fan watts are no greater than shown on CF-1R. Measured Watts =		
3.	<input type="checkbox"/> Yes	<input type="checkbox"/> No		Check this box "yes" if measured building infiltration (CFM @ 50 Pa) is greater than the CFM @ 50 values shown for an SLA of 1.5 on CF-1R (If this box is checked no, mechanical ventilation is required.)		
4.	<input type="checkbox"/> Yes	<input type="checkbox"/> No		Check this box "yes" if measured building infiltration (CFM @ 50 Pa) is less than the CFM @ 50 values shown for an SLA of 1.5 on CF-1R, mechanical ventilation is installed and house pressure is greater than minus 5 Pascal with all exhaust fans operating.		
				Pass if: a. Yes in line 1 and line 3, or b. Yes in line 1 and line2, 2a, and 2b, or c. Yes in line 1 and Yes in line 4. Otherwise fail.	✓	✓
					<input type="checkbox"/> Pass	<input type="checkbox"/> Fail

I, the undersigned, verify that the building envelope leakage meets the requirements claimed for building leakage reduction below default assumptions as used for compliance on the CF-1R. This is to certify that the above diagnostic test results and the work I performed associated with the test(s) is in conformance with the requirements for compliance credit. (The builder shall provide the HERS provider a copy of the CF-6R signed by the builder employees or subcontractors certifying that diagnostic testing and installation meet the requirements for compliance credit.)

Test Performed	
Installing Subcontractor (Co. Name) OR General Contractor (Co. Name) OR Owner	
Signature:	Date:

**Copies to: BUILDING DEPARTMENT, HERS RATER (IF APPLICABLE), BUILDING OWNER AT OCCUPANCY**

Site Address

Permit Number

**Insulation Installation Quality Certificate**

- ✓  Description of Insulation, (CF-6R, formerly IC-1) signed by the installer stating: insulation manufacturer’s name, material identification, installed R-values, and for loose-fill insulation: minimum weight per square foot and minimum inches
- ✓  Installation meets all applicable requirements as specified in the High Quality Insulation Installation Procedures (ACM, Appendix RH)

<b>✓ FLOOR</b>			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	All floor joist cavity insulation installed to uniformly fit the cavity side-to-side and end-to-end
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Insulation in contact with the subfloor or rim joists insulated
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Insulation properly supported to avoid gaps, voids, and compression
Yes	No	NA	
<b>✓ WALLS</b>			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<i>Wall stud cavities caulked or foamed to provide an air tight envelope</i>
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Wall stud cavity insulation uniformly fills the cavity side-to-side, top-to-bottom, and front-to-back
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	No gaps
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	No voids over 3/4" deep or more than 10% of the batt surface area.
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Hard to access wall stud cavities such as; corner channels, wall intersections, and behind tub/shower enclosures insulated to proper R-Value
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Small spaces filled
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Rim-joists insulated
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Loose fill wall insulation meets or exceeds manufacturer's minimum weight-per-square-foot requirement
Yes	No	NA	
<b>✓ ROOF/CEILING PREPARATION</b>			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	All draft stops in place to form a continuous ceiling and wall air barrier
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	All drops covered with hard covers
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	All draft stops and hard covers caulked or foamed to provide an air tight envelope
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	All recessed light fixtures IC and air tight (AT) rated and sealed with a gasket or caulk between the housing and the ceiling
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Floor cavities on multiple-story buildings have air tight draft stops to all adjoining attics
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Eave vents prepared for blown insulation - maintain net free-ventilation area
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Knee walls insulated or prepared for blown insulation
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Area under equipment platforms and cat-walks insulated or accessible for blown insulation
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Attic rulers installed
Yes	No	NA	

**INSTALLATION CERTIFICATE**

**(Page 11 of 12) CF-6R**

Site Address

Permit Number

**✓ ROOF/CEILING BATTS**

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	No gaps
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	No voids over ¼ in. deep or more than 10% of the batt surface area.
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Insulation in contact with the air-barrier
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Recessed light fixtures covered
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<i>Net free-ventilation area maintained at eave vents</i>
Yes	No	NA	

**✓ ROOF/CEILING LOOSE-FILL**

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Insulation uniformly covers the entire ceiling (or roof) area from the outside of all exterior walls.
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Baffles installed at eaves vents or soffit vents - maintain net free-ventilation area of eave vent
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Attic access insulated
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Recessed light fixtures covered
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Insulation at proper depth – insulation rulers visible and indicating proper depth and R-value
Yes	No	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<i>Loose-fill insulation meets or exceeds manufacturer's minimum weight and thickness requirements for the target R-value. Target R-value _____. Manufacturer's minimum required weight for the target R-value _____ (pounds-per-square-foot). Manufacturer's minimum required thickness at time of installation _____. Manufacturer's minimum required settled thickness _____. Note: To receive compliance credit the HERS rater shall verify that the manufacturer's minimum weight and thickness has been achieved for the target R-value. (CF-6R only)</i>
Yes	No	NA	

**DECLARATION**

✓  I hereby certify that the installation meets all applicable requirements as specified in the Insulation Installation Procedures.

Installing Subcontractor (Co. Name) OR General Contractor (Co. Name) OR Owner	
Signature:	Date:

**Copies to: BUILDING DEPARTMENT, HERS RATER (IF APPLICABLE), BUILDING OWNER AT OCCUPANCY**

**INSTALLATION CERTIFICATE****(Page 12 of 12) CF-6R**

Site Address \_\_\_\_\_

Permit Number \_\_\_\_\_

County Subdivision \_\_\_\_\_

Lot Number \_\_\_\_\_

**Description of Insulation (Formerly IC-1 Form)**

## 1. RAISED FLOOR

Material \_\_\_\_\_

Thickness (inches) \_\_\_\_\_

Brand Name \_\_\_\_\_

Thermal Resistance (R-Value) \_\_\_\_\_

## 2. SLAB FLOOR/PERIMETER

Material \_\_\_\_\_

Thickness (inches) \_\_\_\_\_

Perimeter Insulation Depth (inches) \_\_\_\_\_

Brand Name \_\_\_\_\_

Thermal Resistance (R-Value) \_\_\_\_\_

## 3. EXTERIOR WALL

Frame Type \_\_\_\_\_

## A. Cavity Insulation

Material \_\_\_\_\_

Thickness (inches) \_\_\_\_\_

Brand Name \_\_\_\_\_

Thermal Resistance (R-Value) \_\_\_\_\_

## B. Exterior Foam Sheathing

Material \_\_\_\_\_

Thickness (inches) \_\_\_\_\_

Brand Name \_\_\_\_\_

Thermal Resistance (R-Value) \_\_\_\_\_

## 4. FOUNDATION WALL

Material \_\_\_\_\_

Thickness (inches) \_\_\_\_\_

Brand Name \_\_\_\_\_

Thermal Resistance (R-Value) \_\_\_\_\_

## 5. CEILING

Batt or Blanket Type \_\_\_\_\_

Thickness (inches) \_\_\_\_\_

Loose Fill Type \_\_\_\_\_

Contractor's min installed weight/ft<sup>2</sup> \_\_\_\_\_ lb

Manufacturer's installed weight per square foot to achieve Thermal Resistance (R-Value) \_\_\_\_\_

Brand Name \_\_\_\_\_

Thermal Resistance (R-Value) \_\_\_\_\_

Brand \_\_\_\_\_

Minimum thickness \_\_\_\_\_ inches

## 6. ROOF

Material \_\_\_\_\_

Thickness (inches) \_\_\_\_\_

Brand Name \_\_\_\_\_

Thermal Resistance (R-Value) \_\_\_\_\_

**Declaration**

✓  I hereby certify that the above insulation was installed in the building at the above location in conformance with the current *Energy Efficiency Standards* for residential buildings (Title 24, Part 6, California Code of Regulations) as indicated on the Certificate of Compliance, where applicable.

Item #s (if applicable)	Signature _____	Date _____	Installing Subcontractor (Co. Name) OR General Contractor (Co. Name) OR Owner OR Window Distributor
Item #s (if applicable)	Signature _____	Date _____	Installing Subcontractor (Co. Name) OR General Contractor (Co. Name) OR Owner OR Window Distributor
Item #s (if applicable)	Signature _____	Date _____	Installing Subcontractor (Co. Name) OR General Contractor (Co. Name) OR Owner OR Window Distributor

**TITLE 20 - CALIFORNIA HOME ENERGY RATING  
SYSTEM REGULATIONS**



CALIFORNIA CODE OF REGULATIONS  
TITLE 20  
Chapter 4, Article 8, Sections 1670 - 1675

**CALIFORNIA HOME ENERGY RATING SYSTEM PROGRAM**

Approved Final Text

**1670. Scope.**

These regulations establish the California Home Energy Rating System Program pursuant to Public Resources Code Section 25942, including procedures for the training and certification of raters, and a certification program for home energy rating system organizations (herein referred to as providers) and for home energy rating services (herein referred to as rating systems). These regulations apply only to field verification and diagnostic testing services pursuant to Chapter 7 of the ACM Manual for demonstrating compliance with Title 24 building energy performance standards. Regulations for other home energy rating services will be addressed in a subsequent rulemaking proceeding. Until the subsequent rulemaking is concluded, home energy rating system services other than field verification and diagnostic testing are not required to be certified.

NOTE: Authority: Public Resources Code Sections 25942 and 25213.

Reference: Public Resources Code Sections 25942 and 25213.

**1671. Definitions.**

For the purposes of these regulations, the following definitions shall apply:

**ACM Manual** means the *Low-Rise Residential Alternative Calculation Method Approval Manual* (Energy Commission Publication No. P-400-98-003) adopted in Section 10-109(b)(2) of Title 24, Part 1 of the California Code of Regulations.

**Certified**, as to a provider and rating system, means having successfully completed the certification requirements as specified by Section 1674.

**Commission** means the State of California Energy Resources Conservation and Development Commission, commonly known as the California Energy Commission.

**Financial Interest** means an ownership interest, debt agreement, or employer/employee relationship. Financial interest does not include ownership of less than 5% of the outstanding equity securities of a publicly traded corporation.

**Independent Entity** means having no financial interest in, and not advocating or recommending the use of any product or service as a means of gaining increased business with, firms or persons specified in Section 1673(i).

NOTE: The definitions of "independent entity" and "financial interest," together with Section 1673(i), prohibit conflicts of interest between providers and raters, or between providers/raters and builders/subcontractors.

**Provider** means an organization that administers a home energy rating system in compliance with these regulations (referred to as a "home energy rating service organization" in Section 25942 of the Public Resources Code).

**Rater** means a person performing the site inspection and data collection required to produce a home energy rating or the field verification and diagnostic testing required for demonstrating compliance with the Title 24 energy performance standards, who is listed on a registry in compliance with Section 1673(c).

**Rating** means a representation on a 0 to 100 scale of the annual source energy efficiency of a home, as specified in Section 1672(c).

**Rating System** means the materials, analytical tools, diagnostic tools and procedures to produce home energy ratings and provide home energy rating and field verification and diagnostic testing services (referred to as "home energy rating services" in Section 25942 of the Public Resources Code).

**Service Water Heating** means service water heating as defined in Section 101(b) of Title 24, Part 6 of the California Code of Regulations.

**Source Energy** means source energy as defined in Section 101(b) and calculated as specified in Section 102 of Title 24, Part 6 of the California Code of Regulations.

NOTE: Authority: Public Resources Code Sections 25942 and 25213.

Reference: Public Resources Code Sections 25942 and 25213.

### **1672. Requirements for Rating Systems.**

- a. Rating Site Inspections and Diagnostic Testing. Each rating shall be based on a site inspection of the home, and diagnostic testing as specified by the rating system. Each rating system shall have documented procedures for site inspection and diagnostic testing of rated homes.

(b) Energy Uses Rated. Each rating system shall rate the total combined energy efficiency of the following energy uses of each home rated:

- (1) space heating;
- (2) space cooling; and
- (3) service hot water.

(c) Rating Scale. Each rating system shall rate the annual source energy efficiency of homes on a scale of 0 to 100. The rating shall be for the combined total of the three energy uses described in Section 1672(b).

(d) Field Verification and Diagnostic Testing. The provider and rater shall provide field verification and diagnostic testing of energy efficiency improvements as a condition for those improvements to qualify for Title 24 building energy performance standards compliance credit, as required by Chapter 7, Appendix F, and Sections 3.8.3 and 3.9 of the ACM Manual. Providers and raters shall not knowingly provide untrue, inaccurate or incomplete field verification or diagnostic testing information or report field verification or test results that were not conducted in compliance with these regulations. Providers and raters shall not knowingly accept payment or consideration in exchange for reporting a rating or field verification and diagnostic test result that was not in fact conducted and reported in compliance with these regulations.

NOTE: Authority: Public Resources Code Sections 25942 and 25213.

Reference: Public Resources Code Sections 25942 and 25213.

### **1673. Requirements for Providers.**

(a) Training and Certification Procedures for Raters. Each provider shall conduct the following rater training and certification procedures.

- (1) Each provider's training program shall include classroom and field training for rater applicants in analysis, theory and practical application in at least the following areas:
  - (A) home energy consumption and efficiency data collection, organization and analysis;
  - (B) principles of heat transfer;

- (C) building energy feature design and construction practice, including construction quality assurance and "house as a system" concepts;
- (D) safety practices relevant to home energy auditing procedures and equipment; (E) home energy audit procedures;
- (F) energy efficiency effects of building site characteristics;
- (G) types and characteristics of space heating, space cooling, service hot water and hard wired lighting systems;
- (H) mathematical calculations necessary to utilize the rating system;
- (I) the function and proper use of diagnostic devices including but not necessarily limited to: duct leakage testing equipment, blower doors and air flow and pressure measurement devices;
- (J) construction types, equipment types and their associated energy efficiency ramifications;
- (K) field verification and diagnostic testing requirements of Chapter 7, Appendix F, and Sections 3.8.3 and 3.9 of the ACM Manual; and
- (L) California Home Energy Rating System Program requirements specified in these regulations.

(2) The training shall include thorough instruction in the use of the provider's rating system.

(3) The training shall require rater applicants to satisfactorily perform field verification and diagnostic testing for at least two homes in the presence and under the direct supervision of the provider's trainer. The provider shall review and approve this field verification and diagnostic testing for accuracy and completeness.

(4) The provider shall require each rater applicant to take a written and practical test that demonstrates his or her competence in all subjects specified in Section 1673(a)(1). The provider shall retain all results of these tests for five years from the date of the test.

(5) Each provider may establish a Commission-approved challenge test that evaluates competence in each area addressed by the provider's training program. If a rater applicant successfully passes this challenge test, the provider may waive the classroom training requirement and the written and practical test requirements for that applicant. An applicant who passes this challenge test must also successfully meet the requirements specified in Section 1673(a)(3).

(b) Rater Agreements. As a condition of rater registry under Section 1673(c), each provider shall ensure that a rater applicant who has met the requirements of Section 1673(a) has entered into an agreement with the provider to provide home energy rating and field verification and diagnostic services in compliance with these regulations. The agreement shall require raters to:

- (1) provide home energy rating and field verification services in compliance with these regulations;
- (2) provide true, accurate, and complete ratings, field verification and diagnostic testing; and
- (3) comply with the conflict of interest requirements as specified in Section 1673(i).

(c) Rater Registry. As a condition of rater registry, each provider shall certify to the Commission that a rater applicant has met the requirements of Section 1673(a) and entered into an agreement meeting the requirements of Section 1673(b). The provider shall maintain a registry of all raters who meet these requirements, provide an electronic copy of the registry to

the Commission, and make that registry available in printed or electronic form upon written request.

(d) Field Verification and Diagnostic Testing Data Collection. Each provider shall collect and maintain for a period of five years, the following information for each home for which field verification and diagnostic testing service is provided:

- (1) *Certificates of Field Verification and Diagnostic Testing;*
- (2) *Certificates of Compliance;*
- (3) *Installation Certificates;* and
- (4) other reports made pursuant to Chapter 7 of the ACM Manual.

Alternatively, the information contained in these documents may be collected and stored electronically as long as all of the content and certification signatures from the specified documents are retained.

(e) Field Verification and Diagnostic Testing Evaluation. Providers shall maintain a database of the information specified in Section 1673(d) for a minimum 10% random sample of the homes actually field verified and diagnostically tested annually, or 500 such homes annually, whichever is less. Each provider shall provide this information annually in electronic form to the Commission for evaluating the effectiveness of field verification and diagnostic testing. To the extent that the Commission makes this information public, it will do so only in aggregated form. All of this information shall be organized according to climate zones as defined in Section 101(b) of Title 24, Part 6 of the California Code of Regulations.

(f) Data Submittal. Upon the Commission's request, but not more frequently than annually, a provider shall submit to the Commission the total of the number of homes for which field verification and diagnostic testing services were provided since the last data submittal, and a report of the following information for each home for which field verification and diagnostic testing service was provided:

- (1) the energy efficiency improvements field verified and diagnostic tested;
- (2) whether or not the builder chose to include the home in a sample for field verification and diagnostic testing as specified in Section 7.4 of the ACM Manual;
- (3) whether or not initial field verification and testing as specified in Section 7.4.1 of the ACM Manual was conducted on the home;
- (4) whether or not the home in a sample was actually selected and field verified and diagnostically tested as specified in Section 7.4.2 of the ACM Manual;
- (5) whether or not the home in a sample was actually selected for resampling and field verified and diagnostically tested after a sampling failure was found in the sample as specified in Section 7.4.3 of the ACM Manual;
- (6) whether or not the home in a sample was field verified and diagnostically tested and corrective action was taken after a resampling failure was found in the sample as specified in Section 7.4.3 of the ACM Manual;
- (7) whether or not the homeowner declined to have field verification, diagnostic testing and corrective action taken after occupancy as specified in Section 7.4.3 of the ACM Manual.

All of this information shall be organized according to climate zones as defined in Section 101(b) of Title 24, Part 6 of the California Code of Regulations. To the extent the Commission makes this information public, it will do so only in an aggregated form.

(g) Training Materials Retention. Each provider shall retain for at least five years after the last date they are used at least one copy of all materials used to train raters.

(h) Quality Assurance. Each provider shall have a quality assurance program that provides for at least the following:

(1) Initial review. The provider shall review and approve for accuracy and completeness the field verification and diagnostic testing documentation for at least the first five homes which a rater performs after completion of the requirements specified in Section 1673(a)(1), (2) and (3), not including those homes field verified and diagnostically tested under the provider's direct supervision as specified in Section 1673(a)(3).

(2) Field checks of raters. For each rater, the provider shall annually evaluate the greater of one home or one percent of the rater's annual total of homes for which field verification and diagnostic testing services were provided. The provider shall independently repeat the field verification and diagnostic testing to check whether field verification and diagnostic testing was accurately completed by the rater, and determine whether information was completely collected and reported as required by Chapter 7 of the ACM Manual.

(3) Complaint response system. Each provider shall have a system for receiving complaints. The provider shall respond to and resolve complaints related to ratings and field verification and diagnostic testing services and reports. Providers shall ensure that raters inform purchasers and recipients of ratings and field verifications and diagnostic testing services about the complaint system. Each provider shall retain all records of complaints received and responses to complaints for five years after the date the complaint is presented to the provider.

(i) Conflict of Interest.

(1) Providers shall be independent entities from raters who provide field verification and diagnostic testing.

(2) Providers and raters shall be independent entities from the builder and from the subcontractor installer of energy efficiency improvements field verified or diagnostically tested.

NOTE: Authority: Public Resources Code Sections 25942 and 25213.

Reference: Public Resources Code Sections 25942 and 25213.

#### **1674. Certification of Providers and Rating Systems.**

(a) Application. A person or entity wishing to be certified as a provider and wishing to have a rating system certified shall submit four copies of an application to the Commission. The application shall contain:

(1) a complete copy of all field verification and diagnostic testing procedures, manuals, handbooks, rating system descriptions, and training materials;

(2) a detailed explanation of how the rating system meets each requirement of Section 1672;

(3) a detailed explanation of how the provider meets each requirement of Section 1673;

(4) the name, address, and telephone number of the provider and a statement of where its principal place of business is and where and upon whom service of legal process can be made;

(5) upon Commission request, if the provider is a corporation, a copy of the articles of incorporation and the current by-laws;

(6) if the provider is a partnership, the names, addresses, telephone numbers, and partnership status (for example, general, managing) of all the partners, and a copy of the current partnership agreement;

(7) the names, addresses, telephone numbers, and business relationships of all the provider's owners, parents, subsidiaries, and affiliates;

(8) a statement that ratings are accurate, consistent and uniform, utility bill estimates are reasonable, and recommendations on cost-effective energy efficiency improvement measures are reliable;

(9) a statement that the provider understands and will not knowingly fail to comply with the requirements of these regulations; and

(10) a statement under penalty of perjury that all statements in the application are true, provided in the form specified by Section 2015.5 of the Code of Civil Procedure.

(b) Confidentiality of Information. Any provider who submits the required application information and wishes to have that information treated as confidential in order to limit its disclosure shall, at the time of submitting the information, apply for a confidential designation as specified in Section 2505 of Title 20 of the California Code of Regulations.

(c) Commission Consideration.

(1) The Commission's Executive Director may request additional information from the applicant necessary to evaluate the application.

(2) The Executive Director shall provide a copy of its evaluation to interested persons. The Executive Director may convene a workshop to receive comments from interested persons.

(4) Within 90 days of receiving the complete application, the Executive Director shall send to the Commission and to the applicant a written recommendation that the Commission certify the provider and its rating system or deny that certification.

(5) The Executive Director shall recommend certifying the provider and rating system if it finds the following:

(A) the rating system meets all of the requirements of Section 1672; and

(B) the provider meets all of the requirements of Section 1673.

(6) The Commission shall act on the recommendation at its next regularly scheduled Business Meeting that is at least fifteen days after the date that the recommendation was mailed to the applicant.

(7) The Commission shall certify the proposed provider and rating system if it confirms the Executive Director's findings in Section 1674(c)(5).

(8) Upon certification the Commission shall assign the provider a three-digit identification number.

(d) Re-certification. A certified provider shall notify the Commission whenever any change occurs in any of the information, documentation, or materials, the provider submitted to the Commission under Section 1674(a), and shall submit the changed information to the Commission. Where this changed information could affect the provider's compliance with these regulations, the Commission may require that the provider and the rating system be re-certified under the process described in Section 1674. The Executive Director may waive re-certification for non-substantive changes. The Commission may also require that providers and rating systems be re-certified if the requirements of these regulations are amended or modified.

NOTE: Authority: Public Resources Code Sections 25942 and 25213.

Reference: Public Resources Code Sections 25942 and 25213.

**1675. Review by the Commission.**

(a) Annual Review. The Commission may annually review the performance of providers certified under Section 1674 to determine whether the providers comply with the requirements of these regulations. This review may include interviewing recipients of ratings and field verification and diagnostic testing services and reports on a voluntary basis.

(b) Complaint Proceedings. Any person or entity may file a complaint concerning any violation of these regulations as provided for in Section 1230 et. seq. of Title 20 of the California Code of Regulations. The Commission may, for good cause, conduct an investigation and, if necessary, hearing, under the procedures established in Section 1230 et. seq. of Title 20 of the California Code of Regulations.

Each provider shall provide all information requested by the Commission regarding any annual review or complaint proceeding.

(c) Commission Determination. If the Commission determines there is a violation of these regulations or that a provider is no longer providing rating, field verification and diagnostic testing services, the Commission may revoke the certification of the provider pursuant to Section 1230 et. seq. of Title 20 of the California Code of Regulations.

NOTE: Authority: Public Resources Code Sections 25942 and 25213.

Reference: Public Resources Code Sections 25942 and 25213.

