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STATE OF CALIFORNIA

BUILDING LEAKAGE DIAGNOSTIC TEST

CEC-CF2R-ENV-20-H (Revised 10/16) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF INSTALLATION		CF2R-ENV-20-H
Building Leakage Diagnostic Test		(Page 1 of 3)
Project Name:	Enforcement Agency:	Permit Number:
Dwelling Address:	City:	Zip Code:

A. Building Air Leakage – General Information		
01	Test Procedure Used	
02	Building Air Leakage Target from CF1R	
03	Indoor Temperature During Test (°F)	
04	Outdoor Temperature During Test (°F)	
05	Blower Door Location	
06	Building Elevation (ft)	
07	Building Volume (ft^3)	
08	Date of the Diagnostic Test for this Dwelling	

B. Diagnostic Equipment Information

01	Number of Manometers Used to Measure Home Pressurization				
02	03	04	05	06
Manometer Make	Manometer Model	Manometer Serial Number	Manometer Calibration Date	Manometer Calibration Status

07	Number of Fans Used to Pressurize Home		
08	09	10	11
Fan Make	Fan Model	Fan Serial Number	Fan Configuration (rings)

ENV20e – Repeated Single Point Air Tightness Test With Automatic Meter

C. Envelope Leakage Diagnostic Test		
01	Time Average Period of Meter	
02	Blower Door Software used for calculations?	

03	04
Induced Building Pressure	Nominal CFM50

05	Average Nominal CFM50	

D. Altitude and Temperature Correction		
01	Altitude Correction Factor	
02	Temperature Correction Factor	
03	Corrected CFM50	

CERTIFICATE OF INSTALLATION		CF2R-ENV-20-H
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Project Name:	Enforcement Agency:	Permit Number:
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E. Accuracy Adjustment		
01	Standard Deviation of Nominal CFM 50 Values Above	
02	Percent Uncertainty	
03	Accuracy Level	
04	Accuracy Adjustment Factor	
05	Adjusted CFM50 (measured air leakage rate)	
06	Corrected CFM50 (from software)	
07	Percent Uncertainty @ 95% Confidence Level (from software)	

F. Compliance Statement	
01	

G. Additional Requirements for Compliance	
01	Open all interior doors and access including those to closets and those between a conditioned basement and attic.
02	HVAC supply and return register dampers shall be fully open.
03	Temporarily sealing of combustion flues and intermittent exhaust fans are not allowed. Some examples are: combustion flues, fresh air intakes, dryer vents, bathroom and kitchen exhaust vents and fire place.
04	Continuously operated ventilation devices like energy recovery ventilators may be sealed.
05	Multifamily – Each dwelling unit must be tested individually and shown to meet the leakage requirements. Pressurization of the adjacent dwelling units while conducting this test is not allowed.
The responsible person's signature on this compliance document affirms that all applicable requirements in this table have been met.	

STATE OF CALIFORNIA

BUILDING LEAKAGE DIAGNOSTIC TEST

CEC-CF2R-ENV-20-H (Revised 01/16) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF INSTALLATION	CF2R-ENV-20-H
Building Leakage Diagnostic Test	(Page 3 of 3)

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

DOCUMENTATION AUTHOR'S DECLARATION STATEMENT

1. I certify that this Certificate of Installation documentation is accurate and complete.

Documentation Author Name:	Documentation Author Signature:
Documentation Author Company Name:	Date Signed:
Address:	CEA/HERS Certification Identification (if applicable):
City/State/Zip:	Phone:

RESPONSIBLE PERSON'S DECLARATION STATEMENT

I certify the following under penalty of perjury, under the laws of the State of California:

1. The information provided on this Certificate of Installation is true and correct.
2. I am either: a) a responsible person eligible under Division 3 of the Business and Professions Code in the applicable classification to accept responsibility for the system design, construction, or installation of features, materials, components, or manufactured devices for the scope of work identified on this Certificate of Installation and attest to the declarations in this statement, or b) I am an authorized representative of the responsible person and attest to the declarations in this statement on the responsible person's behalf.
3. The constructed or installed features, materials, components or manufactured devices (the installation) identified on this Certificate of Installation conforms to all applicable codes and regulations and the installation conforms to the requirements given on the Certificate of Compliance, plans, and specifications approved by the enforcement agency.
4. I understand that a HERS rater will check the installation to verify compliance and if such checking determines the installation fails to comply, I am required to offer any necessary corrective action at no charge to the building owner.
5. I will ensure that a registered copy of this Certificate of Installation shall be posted, or made available with the building permit(s) issued for the building, and made available to the enforcement agency for all applicable inspections. I understand that a registered copy of this Certificate of Installation is required to be included with the documentation the builder provides to the building owner at occupancy.

Responsible Builder/Installer Name:	Responsible Builder/Installer Signature:	
Company Name: (Installing Subcontractor or General Contractor or Builder/Owner)	Position With Company (Title):	
Address:	CSLB License:	
City/State/Zip:	Phone:	Date Signed:
Third Party Quality Control Program (TPQCP) Status:	Name of TPQCP (if applicable):	

CF2R-ENV-20e-H User Instructions

Section A. Building Air Leakage – General Information

1. Select the appropriate test procedure. This selection will determine which version of this document will be used (a, b, c, d, or e) and therefore which data must be collected. Note that single-point tests can only be used under certain conditions. Note that newer manometers have automatic functions for compensating for baseline (automatic baseline) and compensating for house pressures other than the target (@50 Pa). It is preferable to use these, when available, however if these automatic functions are to be used, they must BOTH be used.
2. This number is automatically pulled from the CF1R and is the target maximum that was entered by the documentation author. If this number cannot be achieved, the performance compliance calculations can be redone with a higher number or without the requirement for building air leakage.
3. Enter the indoor temperature measured at the time that the building air leakage test was performed.
4. Enter the outdoor temperature measured at the time that the building air leakage test was performed.
5. Provide a brief description of the location where the blower door was installed for the test. Examples: “front entry door on west side of house”, “door between house and garage”, “large window in family room”.
6. Enter the building elevation; use the value for the closest city found in Joint Appendix JA2.2. Only elevations higher than 5,000 feet require an adjustment to the calculations.
7. This number is automatically pulled from the CF1R. It is used to calculate air changes.
8. Enter the date that the building leakage test data was collected.

Section B. Diagnostic Equipment Information

1. Enter the number of manometers used to measure the home pressurization. If more than one system is used, the fan flow numbers need to be manually added together, unless blower door software is used that will accommodate multiple fan systems running simultaneously.
2. Enter the make (brand) of the manometer used to collect the building air leakage data. Examples: Retrotec, Energy Conservatory.
3. Enter the model of the manometer used to collect the building air leakage data. Examples: DM-2 Mark II, DG700.
4. Enter the serial number of the manometer used to collect the building air leakage data.
5. Enter the most recent date that the manometer was calibrated by following manufacturer’s calibration specifications.
6. This field is automatically filled. If the calibration date was more than 12 months prior to the test date entered in Row A.8 above, an error will appear.
7. Enter the number of blower door fan systems required to run simultaneously to pressurize the home for the building air leakage test. If more than one system is used, the fan flow numbers need to be manually added together, unless blower door software is used that will accommodate multiple fan systems running simultaneously.
8. Enter the make (brand) of the fan used to collect the building air leakage data. Examples: Retrotec, Energy Conservatory.
9. Enter the model of the fan used to collect the building air leakage data. Examples: US1000, Q46, BD3, BD4.
10. Enter the serial number of the fan used to collect the building air leakage data.
11. Enter the fan configuration shown on the meter. This is sometimes referred to as “range configuration”, “CONFIG” or “rings”. Examples: Open, A, B, C8.

Section C. Envelope Leakage Test (specific to the ENV-20e)

1. Enter the Time Average Period used on the manometer during the test. Must be at least 10 seconds.
2. If ASTM E779-10 compliant software is being used for the calculations, enter “yes” here. Otherwise, choose “no”.
3. Enter the fan configuration (rings) used during the data acquisition. Examples: Ring A, Ring A1, Ring B2. Note: fan configuration must be the same for all data points described below.

Note: A minimum of five and a maximum of nine data points are required for items C.4, C.5, C.6, C.7, and C.8 below for this test.

4. Enter the induced building pressure from the manometer (automatic baseline feature turned on). It should be close to 50 Pa, but no less than 15 Pa.
5. This field is automatically calculated. The equation used to calculate this value in the field equals ($C.5_1$+$C.5_2$+ $C.5_3$+ $C.5_4$+ $C.5_5$+$C.5_6$+ $C.5_7$+ $C.5_8$+ $C.5_9$)/N or the number of tests = Average Nominal CFM50.

Section D. Altitude and Temperature Correction (If Row C.2 = No)

1. This field is automatically calculated. The equation used to calculate this value in the field equals:
   a. If the elevation entered in Row A.6 ≤ 5,000 ft, then enter 1 as Altitude Correction Factor in box D. 1
   b. If the elevation entered in Row A.6 > 5,000 ft, Altitude Correction equation equals 1 + (0.000006 * A.6)
2. Enter the Temperature Correction Factor from Table RA3.8-2 or RA3.8-3 using the indoor and outdoor temperatures entered in Rows A.3 and A.4.

Table RA3.8-2 ***Temperature Correction Factors for Pressurization Testing****- Calculated according to ASTM E779-10*

		Inside Temperature (F)								
		50	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**
Outside Temp (F)	**-20**	1.062	1.072	1.081	1.090	1.099	1.108	1.117	1.127	1.136
	-15	1.056	1.066	1.075	1.084	1.093	1.102	1.111	1.120	1.129
	-10	1.051	1.060	1.069	1.078	1.087	1.096	1.105	1.114	1.123
	-5	1.045	1.054	1.063	1.072	1.081	1.090	1.099	1.108	1.117
	0	1.039	1.048	1.057	1.066	1.075	1.084	1.093	1.102	1.111
	5	1.033	1.042	1.051	1.060	1.069	1.078	1.087	1.096	1.105
	10	1.028	1.037	1.046	1.055	1.064	1.072	1.081	1.090	1.099
	15	1.023	1.031	1.040	1.049	1.058	1.067	1.076	1.084	1.093
	20	1.017	1.026	1.035	1.044	1.052	1.061	1.070	1.079	1.087
	25	1.012	1.021	1.029	1.038	1.047	1.056	1.064	1.073	1.082
	30	1.007	1.015	1.024	1.033	1.041	1.050	1.059	1.067	1.076
	35	1.002	1.010	1.019	1.028	1.036	1.045	1.054	1.062	1.071
	40	0.997	1.005	1.014	1.023	1.031	1.040	1.048	1.057	1.065
	45	0.992	1.000	1.009	1.017	1.026	1.035	1.043	1.051	1.060
	50	0.987	0.995	1.004	1.012	1.021	1.029	1.038	1.046	1.055
	55	0.982	0.990	0.999	1.008	1.016	1.024	1.033	1.041	1.050
	60	0.997	0.986	0.994	1.003	1.011	1.019	1.028	1.036	1.045
	65	0.973	0.981	0.989	0.998	1.006	1.015	1.023	1.031	1.040
	70	0.968	0.976	0.985	0.993	1.001	1.010	1.018	1.026	1.035
	75	0.963	0.972	0.980	0.988	0.997	1.005	1.013	1.022	1.030
	80	0.959	0.967	0.976	0.984	0.992	1.000	1.009	1.017	1.025
	85	0.955	0.963	0.971	0.979	0.988	0.996	1.004	1.012	1.020
	90	0.950	0.958	0.967	0.975	0.983	0.991	0.999	1.008	1.016
	95	0.946	0.954	0.962	0.970	0.979	0.987	0.995	1.003	1.011
	100	0.942	0.950	0.958	0.966	0.970	0.982	0.990	0.998	1.007
	105	0.938	0.946	0.954	0.962	0.970	0.978	0.986	0.994	1.002
	110	0.933	0.942	0.950	0.952	0.966	0.974	0.982	0.990	0.998

Table RA3.8-3 ***Temperature Correction Factors for Depressurization Testing****- Calculated according to ASTM E779-10*

		Inside Temperature (F)								
		50	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**
Outside Temp (F)	**-20**	0.865	0.861	0.857	0.853	0.849	0.845	0.841	0.837	0.833
	-15	0.874	0.870	0.866	0.862	0.858	0.854	0.850	0.846	0.842
	-10	0.883	0.879	0.874	0.870	0.866	0.862	0.858	0.854	0.850
	-5	0.892	0.887	0.883	0.879	0.875	0.871	0.867	0.863	0.859
	0	0.900	0.896	0.892	0.887	0.883	0.879	0.875	0.871	0.867
	5	0.909	0.905	0.900	0.896	0.892	0.888	0.883	0.879	0.875
	10	0.918	0.913	0.909	0.905	0.900	0.896	0.892	0.888	0.884
	15	0.927	0.922	0.918	0.913	0.909	0.905	0.900	0.896	0.892
	20	0.935	0.931	0.926	0.922	09.17	0.913	0.909	0.905	0.900
	25	0.944	0.939	0.935	0.930	0.926	0.922	0.917	0.913	0.909
	30	0.952	0.948	0.943	0.939	0.934	0.930	0.926	0.921	0.917
	35	0.961	0.956	0.952	0.947	0.943	0.938	0.934	0.930	0.926
	40	0.970	0.965	0.960	0.956	0.951	0.947	0.942	0.938	0.934
	45	0.978	0.974	0.961	0.964	0.960	0.955	0.951	0.946	0.942
	50	0.987	0.982	0.977	0.973	0.968	0.963	0.959	0.955	0.950
	55	0.995	0.990	0.986	0.981	0.976	0.972	0.967	0.963	0.958
	60	1.004	0.999	0.994	0.998	0.985	0.980	0.976	0.971	0.967
	65	1.012	1.008	1.003	0.998	0.993	0.988	0.984	0.979	0.975
	70	1.021	1.016	1.011	1.006	1.001	0.997	0.992	0.988	0.983
	75	1.029	1.024	1.019	1.015	1.010	1.005	1.000	0.996	0.991
	80	1.038	1.033	1.028	1.023	1.018	1.013	1.009	1.004	0.999
	85	1.046	1.041	1.036	1.031	1.026	1.022	1.017	1.012	1.008
	90	1.055	1.050	1.045	1.040	1.035	1.030	1.025	1.020	1.016
	95	1.063	1.058	1.053	1.048	1.043	1.038	1.033	1.028	1.024
	100	1.072	1.066	1.061	1.056	1.051	1.046	1.041	1.037	1.032
	105	1.080	1.075	1.070	1.064	1.059	1.054	1.050	1.045	1.040
	110	1.088	1.083	1.078	1.073	1.068	1.063	1.058	1.053	1.048

3. This field is automatically calculated. The equation used to calculate this value in the field equals the product of C.6 * D.1 * D.2.

Section E. Accuracy Adjustment (If Row C.2 = No)

1. This field is automatically calculated. It is the Standard Deviation of the Nominal CFM50 values from Rows $C.5_1$ through $C.5_9$. The equation used to calculate this value in the field equals the square root of {[(C.6- $C.5_1$)^2+(C.6- $C.5_2$)^2+(C.6- $C.5_3$)^2+(C.6- $C.5_4$)^2+(C.6- $C.5_5$)^2+(C.6- $C.5_6$)^2+(C.6- $C.5_7$)^2+(C.6- $C.5_8$)^2+(C.6- $C.5_9$)^2]/N-1 or the number of tests minus one} = Standard Deviation of the Nominal CFM50.
2. This field is automatically calculated. It is the Percent Uncertainty and the equation used to calculate this value in the field equals {[(C.1/ square root N or the number of tests)x t-statistic look up from table RA 3.8-1]/D.3 Corrected CFM50} = Percent Uncertainty

Table 3.8-1 Precision Uncertainty: *Values of t-statistic*

Number of Readings	t-statistic
5	2.78
6	2.57
7	2.45
8	2.37
9	2.31

3. This field is automatically calculated. The equation used to calculate this value in the field equals:
    a. If the Percent Uncertainty in E.2 ≤ 10, then enter "standard" as Accuracy Level in box E. 3.
    b. If the Percent Uncertainty in E.2 > 10, then enter "reduced" as Accuracy Level in box E. 3.
4. This field is automatically calculated. The equation used to calculate this value in the field equals:
    a. If the Accuracy Level E.3 = Standard, then enter 1 as Accuracy Adjustment factor in box E.4.
    b. If the Accuracy Level E.3 = Reduced, Accuracy Adjustment Factor equation equals 1+(E.2/100).
5. This field is automatically calculated. The equation used to calculate this value in the field equals the D.3 * E.4 = Adjusted CFM50.

Section E. Accuracy Adjustment (If Row C.2 = Yes)

6. Enter the Corrected CFM50 from manometer software.
7. Enter the Percent Uncertainty from manometer software.

Section F. Compliance Statement

1. This field is automatically calculated. A check is performed to make sure that the meter has been properly calibrated and that the measured infiltration is less than the target infiltration.

Section G. Additional Requirements for Compliance

1. This statement must be true (or not applicable) for the test to conform to the protocols.
2. This statement must be true (or not applicable) for the test to conform to the protocols.
3. This statement must be true (or not applicable) for the test to conform to the protocols.
4. This statement must be true (or not applicable) for the test to conform to the protocols.
5. This statement must be true (or not applicable) for the test to conform to the protocols.

A. Building Air Leakage – General Information		
01	Test Procedure Used	<<user input, pull down list: Single-Point Test with Manual Meter – Display ENV-20a below; Single-Point Test with Automatic Meter – Display ENV-20b below; Multi-Point Test – Display ENV-20c below; Repeated Single Point with Manual Meter – Display ENV-20d below; Repeated Single Point with Automatic Meter – Display ENV-20e below
02	Building Air Leakage Target from CF1R	<<number pulled from CF1R>>
03	Indoor Temperature During Test (°F)	<<user input, degF>>
04	Outdoor Temperature During Test (°F)	<<user input, degF>>
05	Blower Door Location	<<user input, text, maximum 50 characters>>
06	Building Elevation (ft)	<<user input, Ft>>
07	Building Volume (ft^3)	<<pull from CF1R>>
08	Date of the Diagnostic Test for this Dwelling	<<user input: date (use date format validation control)>>

B. Diagnostic Equipment Information					
01	Number of Manometers Used to Measure Home Pressurization		<<user input, integer>> For entries >1, duplicate lines B. 2-6		
02	03	04	05	06	
Manometer Make	Manometer Model	Manometer Serial Number	Manometer Calibration Date	Manometer Calibration Status	
<<user input, text, maximum 50 characters>>	<<user input, text, maximum 50 characters>>	<<user input, text, maximum 50 characters>>	<<user input, text (Date), maximum 50 characters>>	<<calculated field: if manometer Calibration Date in B. 5 is within 12 months of the date of the diagnostic test A. 8, then display message: Manometer Calibration is valid"; else display message: "WARNING - Manometer Calibration is expired. A manometer with current calibration is required in order to comply with this Building Leakage Diagnostic test">>	

07	Number of Fans Used to Pressurize Home	<<user input, integer>> For entries >1, duplicate lines B. 8-11	
08	09	10	11
Fan Make	Fan Model	Fan Serial Number	Fan Configuration (rings)
<<user input, text, maximum 50 characters>>	<<user input, text, maximum 50 characters>>	<<user input, text, maximum 50 characters>>	<<user input, text, maximum 50 characters>>

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C. Envelope Leakage Diagnostic Test		
01	Time Average Period of Meter	<user entry but must be no less than 10, in second>>
02	Blower Door Software used for Calculations?	<<user entry, choices are "yes" or "no">

03 Induced Building Pressure	04 Nominal CFM50
<< required data>> (Resolution of 0.1 Pa)	<< required data>> (Resolution of 1 CFM)
<< required data>> (Resolution of 0.1 Pa)	<< required data>> (Resolution of 1 CFM)
<< required data>> (Resolution of 0.1 Pa)	<< required data>> (Resolution of 1 CFM)
<< required data>> (Resolution of 0.1 Pa)	<< required data>> (Resolution of 1 CFM)
<< required data>> (Resolution of 0.1 Pa)	<< required data>> (Resolution of 1 CFM)
<< 6-9 optional data>> (Resolution of 0.1 Pa)	<< 6-9 optional data>> (Resolution of 1 CFM)

05	Average Nominal CFM50	<<calculated value, = ($C.4_1$+$C.4_2$+ $C.4_3$+ $C.4_4$+ $C.4_5$+$C.4_6$+ $C.4_7$+ $C.4_8$+ $C.4_9$)/N (N equals the number of tests)>>

D. Altitude and Temperature Correction		
<<if row C. 2 = "no", use this section>>		
01	Altitude Correction Factor	<<calculated value, if row A. 6 ≤ 5000 Ft = 1; row A. 6 > 5000 =, 1 + .000006 * row A. 6
02	Temperature Correction Factor	<<from tables RA3.8-2 and RA3.8-3, possible look up? showing both input and output for user to double check>>
03	Corrected CFM50	<<calculated value, Row C. 5*altitude correction D. 1 * temperature correction D. 2>>

E. Accuracy Adjustment		
<<if row C. 2 = "no", use this section>>		
01	Standard Deviation of Nominal CFM 50 Values Above	<<calculated, equals the square root of {[(C.5- $C.4_1$)^2+(C.5- $C.4_2$)^2+(C.5- $C.4_3$)^2+(C.5- $C.4_4$)^2+(C.5- $C.4_5$)^2+(C.5- $C.4_6$)^2+(C.5- $C.4_7$)^2+(C.5- $C.4_8$)^2+(C.5- $C.4_9$)^2]/N-1 (N equals the number of tests)>>
02	Percent Uncertainty	<<calculated, {[std dev C. 1/sqrt(N)] * look up table RA 3.8-1}/corrected CFM50 (N equals the number of tests)`>>
03	Accuracy Level	<<calculated, if % uncertainty ≤10, "Standard"; if % uncertainty > 10, "Reduced">>
04	Accuracy Adjustment Factor	<<calculated, if row E. 3 is "Standard"=1; If it is "Reduced", 1+ (% uncertainty/100)>>
05	Adjusted CFM50 (measured air leakage rate)	<<calculated, row D. 3 * row E. 4>>
<<if row C. 2 = "yes", use next two lines>>		
06	Corrected CFM50 (from software)	<<user entry of value calculated by software>>
07	Percent Uncertainty @ 95% Confidence Level (from software)	<<user entry of value calculated by software>>

F. Compliance Statement	
01	<< if manometer Calibration Date in B. 5 is within 12 months of the date of the diagnostic test A. 8 and if Adjusted CFM50 Leakage in E. 5 or if corrected CFM50 Leakage in E. 6 is less than or equal to the Building Air Leakage Rate Target in A. 2 then display text: "Building Passes Envelope Leakage Test"; if manometer Calibration Date in B. 5 is more than 12 months from the date of the diagnostic test A. 8 or if Adjusted CFM50 Leakage in E. 5 or if corrected CFM50 Leakage in E. 6 is more than the Building Air Leakage Rate Target in A. 2 then display text: "Building Fails Envelope Leakage Test">>

G. Additional Requirements for Compliance	
01	Open all interior doors and access including those to closets and those between a conditioned basement and attic.
02	HVAC supply and return register dampers shall be fully open.
03	Temporarily sealing of combustion flues and intermittent exhaust fans are not allowed. Some examples are: combustion flues, fresh air intakes, dryer vents, bathroom and kitchen exhaust vents and fire place.
04	Continuously operated ventilation devices like energy recovery ventilators may be sealed.
05	Multifamily – Each dwelling unit must be tested individually and shown to meet the leakage requirements. Pressurization of the adjacent dwelling units while conducting this test is not allowed.
The responsible person's signature on this compliance document affirms that all applicable requirements in this table have been met.	