CALIFORNIA
ENERGY
COMMISSION

ASSEMBLY BILL 970 BUILDING ENERGY EFFICIENCY STANDARDS

SPLIT SYSTEM SPACE COOLING REFRIGERANT CHARGE AND AIRFLOW MEASUREMENT

CONTRACTOR'S REPORT

March 20, 2001
P400-01-014

Gray Davis, *Governor*

CALIFORNIA ENERGY COMMISSION

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Contractor Report

Split System Space Cooling
Refrigerant Charge and Airflow Measurement

Energy Commission Publication No. P 400-01-014

This Contractor Report, prepared by Berkeley Solar Group, Enercomp, Inc., and Proctor Engineering presents the analysis to support the proposed 15 day language changes to the Emergency Standards adopted January 3, 2001 that will be considered for adoption by the Energy Commission at its April 4, 2001 Business Meeting. The hearing purpose is to consider adopting, (1) Energy Efficiency Committee-proposed 15-day language and (2) changes to the Alternative Calculation Method Approval Manuals.

March 20, 2001

Split System Space Cooling

Refrigerant Charge and Airflow

Measurement

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March 20, 2001

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1. Introduction

The compliance approach defined in this document allows HVAC contractors to get compliance credit by assuring that residential split system air conditioners are installed with correct refrigerant charge and airflow. The correct installation of these systems has been identified as an important issue in the energy efficiency and peak electrical load of new homes. A large field study in California and smaller studies elsewhere have found the majority of installed systems to have a combination of incorrect charge and low airflow through the indoor coil.[2,9] Laboratory tests show that systems with incorrect charge and low airflow operate at lower efficiency.[1-9] Thermostatic expansion valves (TXVs) were adopted as an alternative component package D requirement in the AB970 emergency rulemaking because it was shown that they mitigate the typical installation problems. This new approach provides contractors and third party raters with the ability to demonstrate that split systems without TXVs are installed with correct charge and airflow and will perform efficiently. The approach uses standard air conditioning industry practice and tools[10,11] to allow HVAC contractors to contribute to energy efficiency by providing superior systems to new home buyers.

This compliance approach applies to split system air conditioners installed without a TXV. It does not apply to single package systems.

2. Justification for Equal Compliance Credit and Application to Alterations

Incorrect refrigerant charge and low airflow to the indoor coil reduce the seasonal and on peak efficiency of air conditioners. Based on a large field survey in California and smaller studies elsewhere, the levels of incorrect refrigerant charge found in split system air conditioners in the field reduce seasonal efficiency an average of 9%. Low airflow in systems in the field reduces seasonal efficiency an average of 8%. If both charge and airflow were corrected in all systems the seasonal efficiency would increase an average of 16% (accounting for interactions between charge and airflow). On peak effects are also significant. As an alternative to correcting charge and airflow, installing TXVs in all systems would increase the seasonal efficiency 11%.

It is reasonable to give equal compliance credit for verifying charge and airflow at time of installation and for installation of a TXV. At the time of installation an air conditioner with proper charge and airflow will perform better than one with improper charge and airflow, but field data shows that some systems, even when initially installed correctly, will develop charge and airflow problems over their life. This is due to a variety of causes thought to include refrigerant lost due to small leaks and maintenance

activity, as well as dirt build up in the coil and fan systems. Over the life of the air conditioner, the TXV will mitigate this degradation.

Installing air-conditioners in existing buildings, including replacing existing air-conditioners is considered an alteration to a building and is included within the scope of section 152 of the Building Efficiency Standards. These alterations have the same risks of inefficiency for incorrect charge and incorrect airflow as air-conditioners for complete new buildings. Assuring proper charge and airflow or installing a TXV mitigates these inefficiencies. For replacement installations, the existing indoor coil is sometimes used with the new outdoor unit. When this occurs, it may be difficult to install a TXV on the indoor coil. Measurement of proper charge and airflow may be the preferred alternative for these cases. The expected savings for installations in existing buildings is expected to be larger than for new buildings since the savings is a function of the total cooling load on the air conditioner and existing buildings, with less efficiency features than a complete new building, have higher cooling loads.

3. Cost

Experience with field programs indicates that it takes about 20 minutes to carry out the tests required for this procedure. The installing contractor should assume he/she can test, adjust refrigerant charge and complete the process by retesting in less that 1 hour. The estimated cost per system for the procedure is $50 to the installer and $20 for the certified HERS rater. With travel costs included, the total costs would be no greater than the cost estimate of $150 that was used for evaluating the cost effectiveness of TXVs. Installations in alterations may include larger travel costs than on new installations, but are expected to average no greater than one hour resulting in costs that are still within the $150 estimated cost for a rater to measure the charge and airflow. [1]

4. HVAC Installer and HERS Rater Responsibilities

Systems meeting the criteria specified in this appendix and documented on a properly completed and signed CF-6R compliance form qualify as meeting the installation verification and diagnostic requirements of the standards when specified in the compliance documentation. The responsibilities of the HVAC installer carrying out this procedure are to perform the measurements accurately, make any required system adjustments in a safe manner and document compliance using the CF-6R.

The responsibility of the HERS rater is to schedule his/her work at a time when outdoor conditions will allow the Charge and Airflow Measurement Procedure, perform the measurements accurately and verify compliance

for systems that pass using form CF-4R. The HERS rater shall not use the Weigh-in Charging procedure.

The HVAC installer shall return to make required system adjustments on any systems found by the HERS rater to fail the procedure.

5. Additions to CF-4R and CF-6R

The following pages are proposed to be added to the CF-6R to allow the HVAC installer to document compliance with these procedures. The same information for the Standard Charge and Airflow Measurement are proposed to be added to the CF-4R to allow the HERS rater to document verification.

Draft CF-6R Installation Certificate.

Site Address_____ Permit _____

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

System # _____
Location _____
Make _____
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)
Outdoor air dry-bulb temperature _____ °F

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

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 ($T_{supply, db}$) _____ °F
Return (evaporator entering) air dry-bulb temperature ($T_{return, db}$) _____ °F
Return (evaporator entering) air wet-bulb temperature ($T_{return, wb}$) _____ °F
Evaporator saturation temperature ($T_{evaporator, sat}$) _____ °F
Suction line temperature ($T_{suction, db}$) _____ °F
Condenser (entering) air dry-bulb temperature ($T_{condenser, db}$) _____ °F

Superheat Charge Method Calculations for Refrigerant Charge

Actual Superheat = $T_{suction, db} - T_{evaporator, sat}$ _____ °F
Target Superheat (from Table 1) _____ °F
Actual Superheat – Target Superheat _____ °F
(System passes if between -5 and +5°F)

Temperature Split Method Calculations for Adequate Airflow

Actual Temperature Split = $T_{return, db} - T_{supply, db}$ _____ °F
Target Temperature Split (from Table 2) _____ °F
Actual Temperature Split - Target Temperature Split _____ °F
(System passes if between -3°F and +3°F or, upon remeasurement, if between -3°F and -100°F)

Standard Charge and Airflow 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

System Passes _____ **yes** or _____**no**

Alternate Charge and Airflow Measurement (outdoor air dry-bulb below 55°F):

Weigh-In Charging Method for Refrigerant Charge

Actual liquid line length: _____ft.
Manufacturers Standard liquid line length: - _____ ft.

Difference (Actual – Standard): _____ ft

Manufactures correction (ounces per foot) _____x difference in length =_____ounces
(+ = add) (- = remove)

Measured Airflow Method for Adequate Airflow

Airflow criteria: Cooling Capacity _____ X 0.032 = _____ CFM

Measured Airflow is _____CFM and passes since it is greater than the criteria.

Alternate Charge and Airflow Measurement Summary:

System charge shall be corrected and it shall also pass measured adequate airflow criteria.

System Passes _____ **yes** or _____**no**

Table 1: Target Superheat (Suction Line Temperature - Evaporator Saturation Temperature)

Condenser Air Dry-Bulb Temperature (°F) ($T_{condenser, db}$)	Return Air Wet-Bulb Temperature (°F) ($T_{return, wb}$)																													
	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
55	8.8	10.1	11.5	12.8	14.2	15.6	17.1	18.5	20.0	21.5	23.1	24.6	26.2	27.8	29.4	31.0	32.4	33.8	35.1	36.4	37.7	39.0	40.2	41.5	42.7	43.9	45.0
56	8.6	9.9	11.2	12.6	14.0	15.4	16.8	18.2	19.7	21.2	22.7	24.2	25.7	27.3	28.9	30.5	31.8	33.2	34.6	35.9	37.2	38.5	39.7	41.0	42.2	43.4	44.6
57	8.3	9.6	11.0	12.3	13.7	15.1	16.5	17.9	19.4	20.8	22.3	23.8	25.3	26.8	28.3	29.9	31.3	32.6	34.0	35.3	36.7	38.0	39.2	40.5	41.7	43.0	44.2
58	7.9	9.3	10.6	12.0	13.4	14.8	16.2	17.6	19.0	20.4	21.9	23.3	24.8	26.3	27.8	29.3	30.7	32.1	33.5	34.8	36.1	37.5	38.7	40.0	41.3	42.5	43.7
59	7.5	8.9	10.2	11.6	13.0	14.4	15.8	17.2	18.6	20.0	21.4	22.9	24.3	25.7	27.2	28.7	30.1	31.5	32.9	34.3	35.6	36.9	38.3	39.5	40.8	42.1	43.3
60	7.0	8.4	9.8	11.2	12.6	14.0	15.4	16.8	18.2	19.6	21.0	22.4	23.8	25.2	26.6	28.1	29.6	31.0	32.4	33.7	35.1	36.4	37.8	39.1	40.4	41.6	42.9
61	6.5	7.9	9.3	10.7	12.1	13.5	14.9	16.3	17.7	19.1	20.5	21.9	23.3	24.7	26.1	27.5	29.0	30.4	31.8	33.2	34.6	35.9	37.3	38.6	39.9	41.2	42.4
62	6.0	7.4	8.8	10.2	11.7	13.1	14.5	15.9	17.3	18.7	20.1	21.4	22.8	24.2	25.5	27.0	28.4	29.9	31.3	32.7	34.1	35.4	36.8	38.1	39.4	40.7	42.0
63	5.3	6.8	8.3	9.7	11.1	12.6	14.0	15.4	16.8	18.2	19.6	20.9	22.3	23.6	25.0	26.4	27.8	29.3	30.7	32.2	33.6	34.9	36.3	37.7	39.0	40.3	41.6
64	-	6.1	7.6	9.1	10.6	12.0	13.5	14.9	16.3	17.7	19.0	20.4	21.7	23.1	24.4	25.8	27.3	28.7	30.2	31.6	33.0	34.4	35.8	37.2	38.5	39.9	41.2
65	-	5.4	7.0	8.5	10.0	11.5	12.9	14.3	15.8	17.1	18.5	19.9	21.2	22.5	23.8	25.2	26.7	28.2	29.7	31.1	32.5	33.9	35.3	36.7	38.1	39.4	40.8
66	-		6.3	7.8	9.3	10.8	12.3	13.8	15.2	16.6	18.0	19.3	20.7	22.0	23.2	24.6	26.1	27.6	29.1	30.6	32.0	33.4	34.9	36.3	37.6	39.0	40.4
67	-	-	5.5	7.1	8.7	10.2	11.7	13.2	14.6	16.0	17.4	18.8	20.1	21.4	22.7	24.1	25.6	27.1	28.6	30.1	31.5	33.0	34.4	35.8	37.2	38.6	39.9
68	-	-	-	6.3	8.0	9.5	11.1	12.6	14.0	15.5	16.8	18.2	19.5	20.8	22.1	23.5	25.0	26.5	28.0	29.5	31.0	32.5	33.9	35.3	36.8	38.1	39.5
69	-	-	-	5.5	7.2	8.8	10.4	11.9	13.4	14.8	16.3	17.6	19.0	20.3	21.5	22.9	24.4	26.0	27.5	29.0	30.5	32.0	33.4	34.9	36.3	37.7	39.1
70	-	-	-	-	6.4	8.1	9.7	11.2	12.7	14.2	15.7	17.0	18.4	19.7	20.9	22.3	23.9	25.4	27.0	28.5	30.0	31.5	33.0	34.4	35.9	37.3	38.7
71	-	-	-	-	5.6	7.3	8.9	10.5	12.1	13.6	15.0	16.4	17.8	19.1	20.3	21.7	23.3	24.9	26.4	28.0	29.5	31.0	32.5	34.0	35.4	36.9	38.3
72	-	-	-	-	-	6.4	8.1	9.8	11.4	12.9	14.4	15.8	17.2	18.5	19.7	21.2	22.8	24.3	25.9	27.4	29.0	30.5	32.0	33.5	35.0	36.5	37.9
73	-	-	-	-	-	5.6	7.3	9.0	10.7	12.2	13.7	15.2	16.6	17.9	19.2	20.6	22.2	23.8	25.4	26.9	28.5	30.0	31.5	33.1	34.6	36.0	37.5
74	-	-	-	-	-	-	6.5	8.2	9.9	11.5	13.1	14.5	15.9	17.3	18.6	20.0	21.6	23.2	24.8	26.4	28.0	29.5	31.1	32.6	34.1	35.6	37.1
75	-	-	-	-	-	-	5.6	7.4	9.2	10.8	12.4	13.9	15.3	16.7	18.0	19.4	21.1	22.7	24.3	25.9	27.5	29.1	30.6	32.2	33.7	35.2	36.7
76	-	-	-	-	-	-	-	6.6	8.4	10.1	11.7	13.2	14.7	16.1	17.4	18.9	20.5	22.1	23.8	25.4	27.0	28.6	30.1	31.7	33.3	34.8	36.3
77	-	-	-	-	-	-	-	5.7	7.5	9.3	11.0	12.5	14.0	15.4	16.8	18.3	20.0	21.6	23.2	24.9	26.5	28.1	29.7	31.3	32.8	34.4	36.0
78	-	-	-	-	-	-	-	-	6.7	8.5	10.2	11.8	13.4	14.8	16.2	17.7	19.4	21.1	22.7	24.4	26.0	27.6	29.2	30.8	32.4	34.0	35.6
79	-	-	-	-	-	-	-	-	5.9	7.7	9.5	11.1	12.7	14.2	15.6	17.1	18.8	20.5	22.2	23.8	25.5	27.1	28.8	30.4	32.0	33.6	35.2
80	-	-	-	-	-	-	-	-	-	6.9	8.7	10.4	12.0	13.5	15.0	16.6	18.3	20.0	21.7	23.3	25.0	26.7	28.3	29.9	31.6	33.2	34.8
81	-	-	-	-	-	-	-	-	-	6.0	7.9	9.7	11.3	12.9	14.3	16.0	17.7	19.4	21.1	22.8	24.5	26.2	27.9	29.5	31.2	32.8	34.4
82	-	-	-	-	-	-	-	-	-	5.2	7.1	8.9	10.6	12.2	13.7	15.4	17.2	18.9	20.6	22.3	24.0	25.7	27.4	29.1	30.7	32.4	34.0
83	-	-	-	-	-	-	-	-	-	-	6.3	8.2	9.9	11.6	13.1	14.9	16.6	18.4	20.1	21.8	23.5	25.2	26.9	28.6	30.3	32.0	33.7
84	-	-	-	-	-	-	-	-	-	-	5.5	7.4	9.2	10.9	12.5	14.3	16.1	17.8	19.6	21.3	23.0	24.8	26.5	28.2	29.9	31.6	33.3
85	-	-	-	-	-	-	-	-	-	-	-	6.6	8.5	10.3	11.9	13.7	15.5	17.3	19.0	20.8	22.6	24.3	26.0	27.8	29.5	31.2	32.9
86	-	-	-	-	-	-	-	-	-	-	-	5.8	7.8	9.6	11.3	13.2	15.0	16.7	18.5	20.3	22.1	23.8	25.6	27.3	29.1	30.8	32.6
87	-	-	-	-	-	-	-	-	-	-	-	5.0	7.0	8.9	10.6	12.6	14.4	16.2	18.0	19.8	21.6	23.4	25.1	26.9	28.7	30.4	32.2
88	-	-	-	-	-	-	-	-	-	-	-	-	6.3	8.2	10.0	12.0	13.9	15.7	17.5	19.3	21.1	22.9	24.7	26.5	28.3	30.1	31.8
89	-	-	-	-	-	-	-	-	-	-	-	-	5.5	7.5	9.4	11.5	13.3	15.1	17.0	18.8	20.6	22.4	24.3	26.1	27.9	29.7	31.5
90	-	-	-	-	-	-	-	-	-	-	-	-	-	6.8	8.8	10.9	12.8	14.6	16.5	18.3	20.1	22.0	23.8	25.6	27.5	29.3	31.1

Table 1: Target Superheat (Suction Line Temperature - Evaporator Saturation Temperature) (continued)

Condenser Air Dry-Bulb Temperature (°F) ($T_{condenser, db}$)	Return Air Wet-Bulb Temperature (°F) ($T_{return, wb}$)																												
	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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.2	8.3	10.5	12.6	14.8	17.0	19.1	21.3	23.5	25.7
107	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.7	7.9	10.0	12.2	14.4	16.6	18.7	21.0	23.2	25.4
108	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.2	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 2: Target Temperature Split (Return Dry-Bulb – Supply Dry-Bulb)

Return Air Dry–Bulb (ºF) ($T_{return, db}$)	Return Air Wet-Bulb (ºF) ($T_{return, wb}$)																													
	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	20.4	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
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
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
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
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
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

Draft CF-4R HERS Rater Charge and Airflow Measurement Verification Certificate

*** same as CF-6R without ***
*** Alternate Charge and Airflow Measurement Procedure ***

6. References

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[4]Effects of Refrigerant Charge, Duct Leakage, and Evaporator Airflow on the High Temperature Performance Air Conditioners and Heat Pumps, TR-106542 3884, Final Report, July 1996, Rodriguez, O'Neal, Davis, Bain, Texas A & M University

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[7]Design and Construction of a Prototype High Efficiency Air Conditioner, Pacific Gas & Electric Company Report, J. Proctor, T. Downey, C. Boecker, Z. Katsnelson, G. Peterson, June 27, 1996

[8]Hidden Power Drains: Residential Heating and Cooling Fan Power Demand, J. Proctor, D. Parker, ACEEE Proceedings 2000, 1.225

[9]National Energy Savings Potential from Addressing Residential HVAC Installation Problems, C. Neme, J. Proctor, S. Nadel, ACEEE Report to EPA, February 1999

[10]Charging Procedures for Residential Condensing Units, Form Number SK28-01, Catalog Number 020-122, Carrier Corporation, ©1994

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EXCERPTS RELATED TO REFRIGERANT CHARGE
AND AIR FLOW FROM

PROPOSED "15 DAY LANGUAGE" REVISIONS

FOR THE PERMANENT ADOPTION OF THE

AB 970 EMERGENCY BUILDING ENERGY EFFICIENCY STANDARDS

March 19, 2001

Note: "15 Day Language" revisions are marked in double underline and ~~strikeout~~. "45 Day Language" revisions, which were adopted on January 3, 2001 as the emergency regulations and are the original "Express Terms" for the permanent adoption rulemaking, to the sections with proposed "15 Day Language" revisions are marked in single underline and ~~strikeout~~. Only sections with "15 Day Language" revisions are included in this document. Please see the emergency Standards (http://www.energy.ca.gov/reports/2001-01-04_400-01-001.PDF), Residential ACM Manual (http://www.energy.ca.gov/reports/2001-01-04_400-01-004.PDF), and Nonresidential ACM Manual (http://www.energy.ca.gov/reports/2001-01-04_400-01-003.PDF) for "45 day Language" revisions to sections for which "15 Day Language" revisions are not proposed.

PROPOSED REVISIONS TO TITLE 24, PART 6

4. Refrigerant Charge and Airflow Measurement, Residential Package D Requirements, Establishment of an alternative to thermostatic expansion valve requirement

Section 151(f)

~~8~~7 **Space heating and space cooling.** When refrigerant charge and airflow measurement or thermostatic expansion valves are shown as required by Tables 1-Z1 through 1-Z16, ducted split system central air conditioners and ducted split system heat pumps shall either have refrigerant charge and airflow measurement confirmed through field verification and diagnostic testing in accordance with procedures set forth in the ACM Manual or shall be equipped with a thermostatic expansion valve (TXV) with an access door or removable panel to verify installation of the TXV. All TXVs shall be confirmed through field verification and diagnostic testing as specified in the ACM Manual. ~~The requirement for a TXV may be met by an equivalent alternative approved by the Commission.~~ All space-heating and space-cooling systems must comply with minimum appliance efficiency standards as specified in Sections 110 through 112.

TABLE 1-Z1—ALTERNATIVE COMPONENT PACKAGES FOR CLIMATE ZONE 1

COMPONENT	PACKAGE[1]			
	~~A~~	~~B~~	C[1]	D
BUILDING ENVELOPE				
Insulation minimums[2]				
Ceiling	~~R30~~	~~R30~~	R49	R38
Wood-frame walls	~~R19~~	~~R19~~	R29	R21
"Heavy mass" walls	~~(R8.5)~~	~~(R5.0)~~	NA	(R4.76)
"Light mass" walls	~~[R8.5]~~	~~[R6.0]~~	NA	NA
Below-grade walls	~~NA~~	~~NA~~	NA	R0
Slab floor perimeter	~~R7~~	~~R7~~	R7	NR
Raised floors	~~R19~~	~~R19~~	R30	R19[2]
Concrete raised floors	~~NA~~	~~NA~~	NA	R8
Radiant barrier			NR	NR
GLAZING				
Maximum U-~~value~~factor[3]	~~0.65~~	~~0.65~~	0.40	0.65
Maximum total area	~~NR~~	~~16%~~	14%	16%
~~Maximum total nonsouth-facing area~~	~~9.6%~~	~~NR~~	~~NR~~	~~NR~~
~~Minimum south-facing area~~	~~6.4%~~	~~NR~~	~~NR~~	~~NR~~
SOLAR HEAT GAIN COEFFICIENT[4]				
South-facing glazing	~~NR~~	~~NR~~	NR	NR
West-facing glazing	~~NR~~	~~NR~~	NR	NR
East-facing glazing	~~NR~~	~~NR~~	NR	NR
North-facing glazing	~~NR~~	~~NR~~	NR	NR
THERMAL MASS[5]	~~REQ~~	~~NR~~	REQ	NR
~~INFILTRATION CONTROL~~				
~~Continuous barrier~~	~~NR~~	~~REQ~~	~~NR~~	~~NR~~
~~Air-to-air heat exchanger~~	~~NR~~	~~REQ~~	~~NR~~	~~NR~~
SPACE-HEATING SYSTEM[6]				
Electric-resistant allowed	~~No~~	~~No~~	Yes[7]	No
If gas, AFUE =	~~78%~~	~~78%~~	78%	MIN
If heat pump, split system HSPF[8] =	~~6.8~~	~~6.8~~	6.8	MIN
Single package system HSPF =	~~6.6~~	~~6.6~~	6.6	MIN
SPACE-COOLING SYSTEM				
If split system A/C, SEER =	~~10.0~~	~~10.0~~	10.0	MIN
Refrigerant charge and airflow measurement or Thermostatic expansion valve			NR	NR
If single package A/C, SEER =	~~9.7~~	~~9.7~~	9.7	MIN
SPACE CONDITIONING DUCTS				
Duct sealing			REQ	REQ*
DOMESTIC WATER-HEATING TYPE				
System must meet budget, see Section 151 (b) 1 and (f) ~~98~~	~~Any~~	~~Any~~	Any[9]	Any

*As an alternative under Package D, glazing with a maximum 0.55 U-factor and a 90% AFUE furnace or a 7.6 HSPF heat pump can be substituted for duct sealing. All other requirements of Package D must be met.

Legend:
NR = Not Required NA = Not Applicable
REQ = Required MIN = Minimum

See notes following Table 1-Z16

TABLE 1-Z2—ALTERNATIVE COMPONENT PACKAGES FOR CLIMATE ZONE 2

COMPONENT	PACKAGE[1]			
	~~A~~	~~B~~	C[1]	D
BUILDING ENVELOPE				
Insulation minimums[2]				
Ceiling	~~R30~~	~~R30~~	R49	R30
Wood-frame walls	~~R13~~	~~R19~~	R29	R13
"Heavy mass" walls	~~(R2.3)~~	~~(R2.2)~~	NA	(R2.44)
"Light mass" walls	~~[R4.5]~~	~~[R4.5]~~	NA	NA
Below-grade walls	~~NA~~	~~NA~~	NA	R0
Slab floor perimeter	~~R7~~	~~R7~~	R7	NR
Raised floors	~~R13~~	~~R19~~	R30	R19[2]
Concrete raised floors	~~NA~~	~~NA~~	NA	R8
Radiant barrier			REQ	REQ
GLAZING				
Maximum U-~~value~~factor[3]	~~1.10~~	~~0.65~~	0.40	0.65
Maximum total area	~~NR~~	~~14%~~	16%	16%
~~Maximum total nonsouth-facing area~~	~~9.6%~~	~~NR~~	~~NR~~	~~NR~~
~~Minimum south-facing area~~	~~6.4%~~	~~NR~~	~~NR~~	~~NR~~
SOLAR HEAT GAIN COEFFICIENT[4]				
South-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
West-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
East-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
North-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
THERMAL MASS[5]	~~REQ~~	~~NR~~	REQ	NR
~~INFILTRATION CONTROL~~				
~~Continuous barrier~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
~~Air-to-air heat exchanger~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
SPACE-HEATING SYSTEM[6]				
Electric-resistant allowed	~~No~~	~~No~~	Yes[7]	No
If gas, AFUE =	~~78%~~	~~78%~~	78%	MIN
If heat pump, split system HSPF[8] =	~~6.8~~	~~6.8~~	6.8	MIN
Single package system HSPF =	~~6.6~~	~~6.6~~	6.6	MIN
SPACE-COOLING SYSTEM				
If split system A/C, SEER =	~~10.0~~	~~10.0~~	10.0	MIN
Refrigerant charge and airflow measurement or Thermostatic expansion valve			REQ	REQ*
If single package A/C, SEER =	~~9.7~~	~~9.7~~	9.7	MIN
SPACE CONDITIONING DUCTS				
Duct sealing			REQ	REQ*
DOMESTIC WATER-HEATING TYPE				
System must meet budget, see Section 151 (b) 1 and (f) ~~98~~	~~Any~~	~~Any~~	Any[9]	Any

*As an alternative under Package D, glazing with a maximum 0.40 U-factor and maximum 0.35 Solar Heat Gain Coefficient can be substituted for duct sealing and either refrigerant charge and airflow measurement or a thermostatic expansion valve. All other requirements of Package D must be met.

Legend:
NR = Not Required NA = Not Applicable
REQ = Required MIN = Minimum

See notes following Table 1-Z16

TABLE 1-Z3—ALTERNATIVE COMPONENT PACKAGES FOR CLIMATE ZONE 3

COMPONENT	PACKAGE[1]			
	~~A~~	~~B~~	C[1]	D
BUILDING ENVELOPE				
Insulation minimums[2]				
Ceiling	~~R30~~	~~R30~~	R38	R30
Wood-frame walls	~~R13~~	~~R19~~	R25	R13
"Heavy mass" walls	~~(R4.5)~~	~~(R3.5)~~	NA	(R2.44)
"Light mass" walls	~~[R5.0]~~	~~[R5.0]~~	NA	NA
Below-grade walls	~~NA~~	~~NA~~	NA	R0
Slab floor perimeter	~~R7~~	~~R7~~	R7	NR
Raised floors	~~R13~~	~~R19~~	R30	R19[2]
Concrete raised floors	~~NA~~	~~NA~~	NA	R0
Radiant barrier			NR	NR
GLAZING				
Maximum U-~~value~~factor[3]	~~1.10~~	~~0.65~~	0.40	0.75
Maximum total area	~~NR~~	~~16%~~	14%	20%
~~Maximum total nonsouth-facing area~~	~~9.6%~~	~~NR~~	~~NR~~	~~NR~~
~~Minimum south-facing area~~	~~6.4%~~	~~NR~~	~~NR~~	~~NR~~
SOLAR HEAT GAIN COEFFICIENT[4]				
South-facing glazing	~~NR~~	~~NR~~	NR	NR
West-facing glazing	~~NR~~	~~NR~~	NR	NR
East-facing glazing	~~NR~~	~~NR~~	NR	NR
North-facing glazing	~~NR~~	~~NR~~	NR	NR
THERMAL MASS[5]	~~REQ~~	~~NR~~	REQ	NR
~~INFILTRATION CONTROL~~				
~~Continuous barrier~~	~~NR~~	~~REQ~~	~~NR~~	~~NR~~
~~Air-to-air heat exchanger~~	~~NR~~	~~REQ~~	~~NR~~	~~NR~~
SPACE-HEATING SYSTEM[6]				
Electric-resistant allowed	~~No~~	~~No~~	Yes[7]	No
If gas, AFUE =	~~78%~~	~~78%~~	78%	MIN
If heat pump, split system HSPF[8] =	~~6.8~~	~~6.8~~	6.8	MIN
Single package system HSPF =	~~6.6~~	~~6.6~~	6.6	MIN
SPACE-COOLING SYSTEM				
If split system A/C, SEER =	~~10.0~~	~~10.0~~	10.0	MIN
Refrigerant charge and airflow measurement or Thermostatic expansion valve			NR	NR
If single package A/C, SEER =	~~9.7~~	~~9.7~~	9.7	MIN
SPACE CONDITIONING DUCTS				
Duct sealing			REQ	REQ*
DOMESTIC WATER-HEATING TYPE				
System must meet budget, see Section 151 (b) 1 and (f) ~~98~~	~~Any~~	~~Any~~	Any[9]	Any

*As an alternative under Package D, glazing with a maximum 0.55 U-factor can be substituted for duct sealing. All other requirements of Package D must be met.

Legend:
NR = Not Required NA = Not Applicable
REQ = Required MIN = Minimum

See notes following Table 1-Z16

TABLE 1-Z4—ALTERNATIVE COMPONENT PACKAGES FOR CLIMATE ZONE 4

COMPONENT	PACKAGE[1]			
	~~A~~	~~B~~	C[1]	D
BUILDING ENVELOPE				
Insulation minimums[2]				
Ceiling	~~R30~~	~~R30~~	R38	R30
Wood-frame walls	~~R13~~	~~R19~~	R25	R13
"Heavy mass" walls	~~(R3.5)~~	~~(R3.5)~~	NA	(R2.44)
"Light mass" walls	~~[R5.0]~~	~~[R5.0]~~	NA	NA
Below-grade walls	~~NA~~	~~NA~~	NA	R0
Slab floor perimeter	~~R7~~	~~R7~~	R7	NR
Raised floors	~~R19~~	~~R19~~	R30	R19[2]
Concrete raised floors	~~NA~~	~~NA~~	NA	R0
Radiant barrier			REQ	REQ
GLAZING				
Maximum U-~~value~~factor[3]	~~1.10~~	~~0.65~~	0.40	0.75
Maximum total area	~~NR~~	~~16%~~	14%	20%
~~Maximum total nonsouth-facing area~~	~~9.6%~~	~~NR~~	~~NR~~	~~NR~~
~~Minimum south-facing area~~	~~6.4%~~	~~NR~~	~~NR~~	~~NR~~
SOLAR HEAT GAIN COEFFICIENT[4]				
South-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
West-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
East-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
North-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
THERMAL MASS[5]	~~REQ~~	~~NR~~	REQ	NR
~~INFILTRATION CONTROL~~				
~~Continuous barrier~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
~~Air-to-air heat exchanger~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
SPACE-HEATING SYSTEM[6]				
Electric-resistant allowed	~~No~~	~~No~~	Yes[7]	No
If gas, AFUE =	~~78%~~	~~78%~~	78%	MIN
If heat pump, split system HSPF[8] =	~~6.8~~	~~6.8~~	6.8	MIN
Single package system HSPF =	~~6.6~~	~~6.6~~	6.6	MIN
SPACE-COOLING SYSTEM				
If split system A/C, SEER =	~~10.0~~	~~10.0~~	10.0	MIN
Refrigerant charge and airflow measurement or Thermostatic expansion valve			NR	NR
If single package A/C, SEER =	~~9.7~~	~~9.7~~	9.7	MIN
SPACE CONDITIONING DUCTS				
Duct sealing			REQ	REQ*
DOMESTIC WATER-HEATING TYPE				
System must meet budget, see Section 151 (b) 1 and (f) ~~98~~	~~Any~~	~~Any~~	Any[9]	Any

*As an alternative under Package D, glazing with a maximum 0.40 U-factor and maximum 0.35 Solar Heat Gain Coefficient can be substituted for duct sealing. All other requirements of Package D must be met.

Legend:
NR = Not Required NA = Not Applicable
REQ = Required MIN = Minimum

See notes following Table 1-Z16

TABLE 1-Z5—ALTERNATIVE COMPONENT PACKAGES FOR CLIMATE ZONE 5

COMPONENT	PACKAGE[1]			
	~~A~~	~~B~~	C[1]	D
BUILDING ENVELOPE				
Insulation minimums[2]				
Ceiling	~~R30~~	~~R30~~	R38	R30
Wood-frame walls	~~R19~~	~~R19~~	R25	R13
"Heavy mass" walls	~~(R2.4)~~	~~(R2.3)~~	NA	(R2.44)
"Light mass" walls	~~[R4.5]~~	~~[R4.5]~~	NA	NA
Below-grade walls	~~NA~~	~~NA~~	NA	R0
Slab floor perimeter	~~R7~~	~~R7~~	R7	NR
Raised floors	~~R13~~	~~R19~~	R30	R19[2]
Concrete raised floors	~~NA~~	~~NA~~	NA	R0
Radiant barrier			NR	NR
GLAZING				
Maximum U-~~value~~factor[3]	~~1.10~~	~~0.65~~	0.40	0.75
Maximum total area	~~NR~~	~~14%~~	16%	16%
~~Maximum total nonsouth-facing area~~	~~9.6%~~	~~NR~~	~~NR~~	~~NR~~
~~Minimum south-facing area~~	~~6.4%~~	~~NR~~	~~NR~~	~~NR~~
SOLAR HEAT GAIN COEFFICIENT[4]				
South-facing glazing	~~NR~~	~~NR~~	NR	NR
West-facing glazing	~~NR~~	~~NR~~	NR	NR
East-facing glazing	~~NR~~	~~NR~~	NR	NR
North-facing glazing	~~NR~~	~~NR~~	NR	NR
THERMAL MASS[5]	~~REQ~~	~~NR~~	REQ	NR
~~INFILTRATION CONTROL~~				
~~Continuous barrier~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
~~Air-to-air heat exchanger~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
SPACE-HEATING SYSTEM[6]				
Electric-resistant allowed	~~No~~	~~No~~	Yes[7]	No
If gas, AFUE =	~~78%~~	~~78%~~	78%	MIN
If heat pump, split system HSPF[8] =	~~6.8~~	~~6.8~~	6.8	MIN
Single package system HSPF =	~~6.6~~	~~6.6~~	6.6	MIN
SPACE-COOLING SYSTEM				
If split system A/C, SEER =	~~10.0~~	~~10.0~~	10.0	MIN
Refrigerant charge and airflow measurement or Thermostatic expansion valve			NR	NR
If single package A/C, SEER =	~~9.7~~	~~9.7~~	9.7	MIN
SPACE CONDITIONING DUCTS				
Duct sealing			REQ	REQ*
DOMESTIC WATER-HEATING TYPE				
System must meet budget, see Section 151 (b) 1 and (f) ~~98~~	~~Any~~	~~Any~~	Any[9]	Any

*As an alternative under Package D, glazing with a maximum 0.55 U-factor can be substituted for duct sealing. All other requirements of Package D must be met.

Legend:
NR = Not Required NA = Not Applicable
REQ = Required MIN = Minimum

See notes following Table 1-Z16

TABLE 1-Z6—ALTERNATIVE COMPONENT PACKAGES FOR CLIMATE ZONE 6

COMPONENT	PACKAGE[1]			
	~~A~~	~~B~~	C[1]	D
BUILDING ENVELOPE				
Insulation minimums[2]				
Ceiling	~~R19~~	~~R30~~	R38	R30
Wood-frame walls	~~R13~~	~~R19~~	R21	R13
"Heavy mass" walls	~~(R1.5)~~	~~(R1.6)~~	NA	(R2.44)
"Light mass" walls	~~[R4.0]~~	~~[R4.5]~~	NA	NA
Below-grade walls	~~NA~~	~~NA~~	NA	R0
Slab floor perimeter	~~R7~~	~~R7~~	R7	NR
Raised floors	~~R13~~	~~R19~~	R21	R19[2]
Concrete raised floors	~~NA~~	~~NA~~	NA	R0
Radiant barrier			NR	NR
GLAZING				
Maximum U-~~value~~factor[3]	~~1.10~~	~~0.65~~	0.50	0.75
Maximum total area	~~NR~~	~~16%~~	14%	20%
~~Maximum total nonsouth-facing area~~	~~9.6%~~	~~NR~~	~~NR~~	~~NR~~
~~Minimum south-facing area~~	~~6.4%~~	~~NR~~	~~NR~~	~~NR~~
SOLAR HEAT GAIN COEFFICIENT[4]				
South-facing glazing	~~NR~~	~~NR~~	NR	NR
West-facing glazing	~~NR~~	~~NR~~	NR	NR
East-facing glazing	~~NR~~	~~NR~~	NR	NR
North-facing glazing	~~NR~~	~~NR~~	NR	NR
THERMAL MASS[5]	~~REQ~~	~~NR~~	REQ	NR
~~INFILTRATION CONTROL~~				
~~Continuous barrier~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
~~Air-to-air heat exchanger~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
SPACE-HEATING SYSTEM[6]				
Electric-resistant allowed	~~No~~	~~No~~	Yes[7]	No
If gas, AFUE =	~~78%~~	~~78%~~	78%	MIN
If heat pump, split system HSPF[8] =	~~6.8~~	~~6.8~~	6.8	MIN
Single package system HSPF =	~~6.6~~	~~6.6~~	6.6	MIN
SPACE-COOLING SYSTEM				
If split system A/C, SEER =	~~10.0~~	~~10.0~~	10.0	MIN
Refrigerant charge and airflow measurement or Thermostatic expansion valve			NR	NR
If single package A/C, SEER =	~~9.7~~	~~9.7~~	9.7	MIN
SPACE CONDITIONING DUCTS				
Duct sealing			REQ	REQ*
DOMESTIC WATER-HEATING TYPE				
System must meet budget, see Section 151 (b) 1 and (f) ~~98~~	~~Any~~	~~Any~~	Any[9]	Any

*As an alternative under Package D, glazing with a maximum 0.55 U-factor can be substituted for duct sealing. All other requirements of Package D must be met.

Legend:
NR = Not Required NA = Not Applicable
REQ = Required MIN = Minimum

See notes following Table 1-Z16

TABLE 1-Z7—ALTERNATIVE COMPONENT PACKAGES FOR CLIMATE ZONE 7

COMPONENT	PACKAGE[1]			
	~~A~~	~~B~~	C[1]	D
BUILDING ENVELOPE				
Insulation minimums[2]				
Ceiling	~~R19~~	~~R30~~	R38	R30
Wood-frame walls	~~R13~~	~~R13~~	R21	R13
"Heavy mass" walls	~~(R1.7)~~	~~(R1.4)~~	NA	(R2.44)
"Light mass" walls	~~[R4.0]~~	~~[R3.5]~~	NA	NA
Below-grade walls	~~NA~~	~~NA~~	NA	R0
Slab floor perimeter	~~NR~~	~~R7~~	R7	NR
Raised floors	~~R13~~	~~R13~~	R21	R19[2]
Concrete raised floors	~~NA~~	~~NA~~	NA	R0
Radiant barrier			NR	NR
GLAZING				
Maximum U-~~value~~factor[3]	~~1.10~~	~~0.65~~	0.50	0.75
Maximum total area	~~NR~~	~~14%~~	14%	20%
~~Maximum total nonsouth-facing area~~	~~9.6%~~	~~NR~~	~~NR~~	~~NR~~
~~Minimum south-facing area~~	~~6.4%~~	~~NR~~	~~NR~~	~~NR~~
SOLAR HEAT GAIN COEFFICIENT[4]				
South-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
West-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
East-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
North-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
THERMAL MASS[5]	~~REQ~~	~~NR~~	REQ	NR
~~INFILTRATION CONTROL~~				
~~Continuous barrier~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
~~Air-to-air heat exchanger~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
SPACE-HEATING SYSTEM[6]				
Electric-resistant allowed	~~No~~	~~No~~	Yes[7]	No
If gas, AFUE =	~~78%~~	~~78%~~	78%	MIN
If heat pump, split system HSPF[8] =	~~6.8~~	~~6.8~~	6.8	MIN
Single package system HSPF =	~~6.6~~	~~6.6~~	6.6	MIN
SPACE-COOLING SYSTEM				
If split system A/C, SEER =	~~10.0~~	~~10.0~~	10.0	MIN
Refrigerant charge and airflow measurement or Thermostatic expansion valve			NR	NR
If single package A/C, SEER =	~~9.7~~	~~9.7~~	9.7	MIN
SPACE CONDITIONING DUCTS				
Duct sealing			REQ	REQ*
DOMESTIC WATER-HEATING TYPE				
System must meet budget, see Section 151 (b) 1 and (f) ~~98~~	~~Any~~	~~Any~~	Any[9]	Any

*As an alternative under Package D, glazing with a maximum 0.40 U-factor and maximum 0.35 Solar Heat Gain Coefficient can be substituted for duct sealing. All other requirements of Package D must be met.

Legend:
NR = Not Required NA = Not Applicable
REQ = Required MIN = Minimum

See notes following Table 1-Z16

TABLE 1-Z8—ALTERNATIVE COMPONENT PACKAGES FOR CLIMATE ZONE 8

COMPONENT	PACKAGE[1]			
	~~A~~	~~B~~	C[1]	D
BUILDING ENVELOPE				
Insulation minimums[2]				
Ceiling	~~R30~~	~~R30~~	R38	R30
Wood-frame walls	~~R13~~	~~R19~~	R21	R13
"Heavy mass" walls	~~(R1.6)~~	~~(R1.6)~~	NA	(R2.44)
"Light mass" walls	~~[R4.0]~~	~~[R4.5]~~	NA	NA
Below-grade walls	~~NA~~	~~NA~~	NA	R0
Slab floor perimeter	~~NR~~	~~R7~~	R7	NR
Raised floors	~~R13~~	~~R19~~	R21	R19[2]
Concrete raised floors	~~NA~~	~~NA~~	NA	R0
Radiant barrier			REQ	REQ
GLAZING				
Maximum U-~~value~~factor[3]	~~1.10~~	~~0.65~~	0.50	0.75
Maximum total area	~~NR~~	~~14%~~	14%	20%
~~Maximum total nonsouth-facing area~~	~~9.6%~~	~~NR~~	~~NR~~	~~NR~~
~~Minimum south-facing area~~	~~6.4%~~	~~NR~~	~~NR~~	~~NR~~
SOLAR HEAT GAIN COEFFICIENT[4]				
South-facing glazing	~~0.40~~	~~0.40~~	0.40	~~NR~~0.40
West-facing glazing	~~0.40~~	~~0.40~~	0.40	0.40
East-facing glazing	~~NR~~	~~NR~~	0.40	0.40
North-facing glazing	~~NR~~	~~NR~~	0.40	~~NR~~0.40
THERMAL MASS[5]	~~REQ~~	~~NR~~	REQ	NR
~~INFILTRATION CONTROL~~				
~~Continuous barrier~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
~~Air-to-air heat exchanger~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
SPACE-HEATING SYSTEM[6]				
Electric-resistant allowed	~~No~~	~~No~~	Yes[7]	No
If gas, AFUE =	~~78%~~	~~78%~~	78%	MIN
If heat pump, split system HSPF[8] =	~~6.8~~	~~6.8~~	6.8	MIN
Single package system HSPF =	~~6.6~~	~~6.6~~	6.6	MIN
SPACE-COOLING SYSTEM				
If split system A/C, SEER =	~~10.0~~	~~10.0~~	10.0	MIN
Refrigerant charge and airflow measurement or Thermostatic expansion valve			REQ	REQ*
If single package A/C, SEER =	~~9.7~~	~~9.7~~	9.7	MIN
SPACE CONDITIONING DUCTS				
Duct sealing			REQ	REQ*
DOMESTIC WATER-HEATING TYPE				
System must meet budget, see Section 151 (b) 1 and (f) ~~98~~	~~Any~~	~~Any~~	Any[9]	Any

*As an alternative under Package D, glazing with a maximum 0.40 U-factor and maximum 0.35 Solar Heat Gain Coefficient can be substituted for duct sealing and either refrigerant charge and airflow measurement or a thermostatic expansion valve. All other requirements of Package D must be met.

Legend:
NR = Not Required NA = Not Applicable
REQ = Required MIN = Minimum

See notes following Table 1-Z16

TABLE 1-Z9—ALTERNATIVE COMPONENT PACKAGES FOR CLIMATE ZONE 9

COMPONENT	PACKAGE[1]			
	~~A~~	~~B~~	C[1]	D
BUILDING ENVELOPE				
Insulation minimums[2]				
Ceiling	~~R30~~	~~R30~~	R38	R30
Wood-frame walls	~~R13~~	~~R19~~	R21	R13
"Heavy mass" walls	~~(R1.4)~~	~~(R1.5)~~	NA	(R2.44)
"Light mass" walls	~~[R4.0]~~	~~[R4.0]~~	NA	NA
Below-grade walls	~~NA~~	~~NA~~	NA	R0
Slab floor perimeter	~~R7~~	~~R7~~	R7	NR
Raised floors	~~R13~~	~~R19~~	R21	R19[2]
Concrete raised floors	~~NA~~	~~NA~~	NA	R0
Radiant barrier			REQ	REQ
GLAZING				
Maximum U-~~value~~factor[3]	~~1.10~~	~~0.65~~	0.50	0.75
Maximum total area	~~NR~~	~~14%~~	14%	20%
~~Maximum total nonsouth facing area~~	~~9.6%~~	~~NR~~	~~NR~~	~~NR~~
~~Minimum south facing area~~	~~6.4%~~	~~NR~~	~~NR~~	~~NR~~
SOLAR HEAT GAIN COEFFICIENT[4]				
South-facing glazing	~~0.40~~	~~0.40~~	~~NR~~0.40	~~NR~~0.40
West-facing glazing	~~0.40~~	~~0.40~~	0.40	0.40
East-facing glazing	~~NR~~	~~NR~~	0.40	0.40
North-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
THERMAL MASS[5]	~~REQ~~	~~NR~~	REQ	NR
~~INFILTRATION CONTROL~~				
~~Continuous barrier~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
~~Air to air heat exchanger~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
SPACE-HEATING SYSTEM[6]				
Electric-resistant allowed	~~No~~	~~No~~	Yes[7]	No
If gas, AFUE =	~~78%~~	~~78%~~	78%	MIN
If heat pump, split system HSPF[8] =	~~6.8~~	~~6.8~~	6.8	MIN
Single package system HSPF =	~~6.6~~	~~6.6~~	6.6	MIN
SPACE-COOLING SYSTEM				
If split system A/C, SEER =	~~10.0~~	~~10.0~~	10.0	MIN
Refrigerant charge and airflow measurement or Thermostatic expansion valve			REQ	REQ*
If single package A/C, SEER =	~~9.7~~	~~9.7~~	9.7	MIN
SPACE CONDITIONING DUCTS				
Duct sealing			REQ	REQ*
DOMESTIC WATER-HEATING TYPE				
System must meet budget, see Section 151 (b) 1 and (f) ~~98~~	~~Any~~	~~Any~~	Any[9]	Any

*As an alternative under Package D, glazing with a maximum 0.40 U-factor and maximum 0.35 Solar Heat Gain Coefficient, and an 11.0 SEER space-cooling system can be substituted for duct sealing and either refrigerant charge and airflow measurement or a thermostatic expansion valve. All other requirements of Package D must be met.

Legend:
NR = Not Required NA = Not Applicable
REQ = Required MIN = Minimum

See notes following Table 1-Z16

TABLE 1-Z10—ALTERNATIVE COMPONENT PACKAGES FOR CLIMATE ZONE 10

COMPONENT	PACKAGE[1]			
	~~A~~	~~B~~	C[1]	D
BUILDING ENVELOPE				
Insulation minimums[2]				
Ceiling	~~R30~~	~~R30~~	R49	R30
Wood-frame walls	~~R13~~	~~R19~~	R25	R13
"Heavy mass" walls	~~(R1.9)~~	~~(R2.0)~~	NA	(R2.44)
"Light mass" walls	~~[R4.5]~~	~~[R4.5]~~	NA	NA
Below-grade walls	~~NA~~	~~NA~~	NA	R0
Slab floor perimeter	~~R7~~	~~R7~~	R7	NR
Raised floors	~~R13~~	~~R19~~	R30	R19[2]
Concrete raised floors	~~NA~~	~~NA~~	NA	R0
Radiant barrier			REQ	REQ
GLAZING				
Maximum U-~~value~~factor[3]	~~1.10~~	~~0.65~~	0.40	0.~~76~~5
Maximum total area	~~NR~~	~~16%~~	16%	20%
~~Maximum total nonsouth facing area~~	~~9.6%~~	~~NR~~	~~NR~~	~~NR~~
~~Minimum south facing area~~	~~6.4%~~	~~NR~~	~~NR~~	~~NR~~
SOLAR HEAT GAIN COEFFICIENT[4]				
South-facing glazing	~~0.40~~	~~0.40~~	~~NR~~0.40	~~NR~~0.40
West-facing glazing	~~0.40~~	~~0.40~~	0.40	0.40
East-facing glazing	~~NR~~	~~NR~~	0.40	0.40
North-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
THERMAL MASS[5]	~~REQ~~	~~NR~~	REQ	NR
~~INFILTRATION CONTROL~~				
~~Continuous barrier~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
~~Air to air heat exchanger~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
SPACE-HEATING SYSTEM[6]				
Electric-resistant allowed	~~No~~	~~No~~	Yes[7]	No
If gas, AFUE =	~~78%~~	~~78%~~	78%	MIN
If heat pump, split system HSPF[8] =	~~6.8~~	~~6.8~~	6.8	MIN
Single package system HSPF =	~~6.6~~	~~6.6~~	6.6	MIN
SPACE-COOLING SYSTEM				
If split system A/C, SEER =	~~10.0~~	~~10.0~~	10.0	MIN
Refrigerant charge and airflow measurement or Thermostatic expansion valve			REQ	REQ*
If single package A/C, SEER =	~~9.7~~	~~9.7~~	9.7	MIN
SPACE CONDITIONING DUCTS				
Duct sealing			REQ	REQ*
DOMESTIC WATER-HEATING TYPE				
System must meet budget, see Section 151 (b) 1 and (f) ~~9~~8	~~Any~~	~~Any~~	Any[9]	Any

*As an alternative under Package D, glazing with a maximum 0.40 U-factor and maximum 0.35 Solar Heat Gain Coefficient, and an 11.0 SEER space-cooling system can be substituted for duct sealing and either refrigerant charge and airflow measurement or a thermostatic expansion valve. All other requirements of Package D must be met.

Legend:
NR = Not Required NA = Not Applicable
REQ = Required MIN = Minimum

See notes following Table 1-Z16

TABLE 1-Z11—ALTERNATIVE COMPONENT PACKAGES FOR CLIMATE ZONE 11

COMPONENT	PACKAGE[1]			
	~~A~~	~~B~~	C[1]	D
BUILDING ENVELOPE				
Insulation minimums[2]				
Ceiling	~~R30~~	~~R30~~	R49	R38
Wood-frame walls	~~R13~~	~~R19~~	R29	R19
"Heavy mass" walls	~~(R5.0)~~	~~(R5.5)~~	NA	(R4.76)
"Light mass" walls	~~[R6.0]~~	~~[R6.5]~~	NA	NA
Below-grade walls	~~NA~~	~~NA~~	NA	R0
Slab floor perimeter	~~R7~~	~~R7~~	R7	NR
Raised floors	~~R13~~	~~R19~~	R30	R19[2]
Concrete raised floors	~~NA~~	~~NA~~	NA	R8
Radiant barrier			REQ	REQ
GLAZING				
Maximum U-~~value~~factor[3]	~~0.65~~	~~0.65~~	0.40	0.65
Maximum total area	~~NR~~	~~14%~~	16%	16%
~~Maximum total nonsouth facing area~~	~~9.6%~~	~~NR~~	~~NR~~	~~NR~~
~~Minimum south facing area~~	~~6.4%~~	~~NR~~	~~NR~~	~~NR~~
SOLAR HEAT GAIN COEFFICIENT[4]				
South-facing glazing	~~0.40~~	~~0.40~~	~~NR~~0.40	~~NR~~0.40
West-facing glazing	~~0.40~~	~~0.40~~	0.40	0.40
East-facing glazing	~~NR~~	~~NR~~	0.40	0.40
North-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
THERMAL MASS[5]	~~REQ~~	~~NR~~	REQ	NR
~~INFILTRATION CONTROL~~				
~~Continuous barrier~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
~~Air to air heat exchanger~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
SPACE-HEATING SYSTEM[6]				
Electric-resistant allowed	~~No~~	~~No~~	Yes[7]	No
If gas, AFUE =	~~78%~~	~~78%~~	78%	MIN
If heat pump, split system HSPF[8] =	~~6.8~~	~~6.8~~	6.8	MIN
Single package system HSPF =	~~6.6~~	~~6.6~~	6.6	MIN
SPACE-COOLING SYSTEM				
If split system A/C, SEER =	~~10.0~~	~~10.0~~	10.0	MIN
Refrigerant charge and airflow measurement or Thermostatic expansion valve			REQ	REQ*
If single package A/C, SEER =	~~9.7~~	~~9.7~~	9.7	MIN
SPACE CONDITIONING DUCTS				
Duct sealing			REQ	REQ*
DOMESTIC WATER-HEATING TYPE				
System must meet budget, see Section 151 (b) 1 and (f) ~~9~~8	~~Any~~	~~Any~~	Any[9]	Any

*As an alternative under Package D, glazing with a maximum 0.40 U-factor and maximum 0.35 Solar Heat Gain Coefficient, and an 11.0 SEER space-cooling system can be substituted for duct sealing and either refrigerant charge and airflow measurement or a thermostatic expansion valve. All other requirements of Package D must be met.

Legend:
NR = Not Required NA = Not Applicable
REQ = Required MIN = Minimum

See notes following Table 1-Z16

TABLE 1-Z12—ALTERNATIVE COMPONENT PACKAGES FOR CLIMATE ZONE 12

COMPONENT	PACKAGE[1]			
	~~A~~	~~B~~	C[1]	D
BUILDING ENVELOPE				
Insulation minimums[2]				
Ceiling	~~R30~~	~~R30~~	R49	R38
Wood-frame walls	~~R13~~	~~R19~~	R29	R19
"Heavy mass" walls	~~(R3.5)~~	~~(R3.5)~~	NA	(R4.76)
"Light mass" walls	~~[R5.0]~~	~~[R5.5]~~	NA	NA
Below-grade walls	~~NA~~	~~NA~~	NA	R0
Slab floor perimeter	~~NR~~	~~R7~~	R7	NR
Raised floors	~~R13~~	~~R19~~	R30	R19[2]
Concrete raised floors	~~NA~~	~~NA~~	NA	R4
Radiant barrier			REQ	REQ
GLAZING				
Maximum U-~~value~~factor[3]	~~0.65~~	~~0.65~~	0.40	0.65
Maximum total area	~~NR~~	~~14%~~	16%	16%
~~Maximum total nonsouth facing area~~	~~9.6%~~	~~NR~~	~~NR~~	~~NR~~
~~Minimum south facing area~~	~~6.4%~~	~~NR~~	~~NR~~	~~NR~~
SOLAR HEAT GAIN COEFFICIENT[4]				
South-facing glazing	~~0.40~~	~~0.40~~	~~NR~~0.40	~~NR~~0.40
West-facing glazing	~~0.40~~	~~0.40~~	0.40	0.40
East-facing glazing	~~NR~~	~~NR~~	0.40	0.40
North-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
THERMAL MASS[5]	~~REQ~~	~~NR~~	REQ	NR
~~INFILTRATION CONTROL~~				
~~Continuous barrier~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
~~Air to air heat exchanger~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
SPACE-HEATING SYSTEM[6]				
Electric-resistant allowed	~~No~~	~~No~~	Yes[7]	No
If gas, AFUE =	~~78%~~	~~78%~~	78%	MIN
If heat pump, split system HSPF[8] =	~~6.8~~	~~6.8~~	6.8	MIN
Single package system HSPF =	~~6.6~~	~~6.6~~	6.6	MIN
SPACE-COOLING SYSTEM				
If split system A/C, SEER =	~~10.0~~	~~10.0~~	10.0	MIN
Refrigerant charge and airflow measurement or Thermostatic expansion valve			REQ	REQ*
If single package A/C, SEER =	~~9.7~~	~~9.7~~	9.7	MIN
SPACE CONDITIONING DUCTS				
Duct sealing			REQ	REQ*
DOMESTIC WATER-HEATING TYPE				
System must meet budget, see Section 151 (b) 1 and (f) ~~98~~	~~Any~~	~~Any~~	Any[9]	Any

*As an alternative under Package D, glazing with a maximum 0.40 U-factor and maximum 0.35 Solar Heat Gain Coefficient, and an 11.0 SEER space-cooling system can be substituted for duct sealing and either refrigerant charge and airflow measurement or a thermostatic expansion valve. All other requirements of Package D must be met.

Legend:
NR = Not Required NA = Not Applicable
REQ = Required MIN = Minimum

See notes following Table 1-Z16

TABLE 1-Z13—ALTERNATIVE COMPONENT PACKAGES FOR CLIMATE ZONE 13

COMPONENT	PACKAGE[1]			
	~~A~~	~~B~~	C[1]	D
BUILDING ENVELOPE				
Insulation minimums[2]				
Ceiling	~~R30~~	~~R30~~	R49	R38
Wood-frame walls	~~R13~~	~~R19~~	R29	R19
"Heavy mass" walls	~~(R4.0)~~	~~(R4.0)~~	NA	(R4.76)
"Light mass" walls	~~[R5.5]~~	~~[R6.0]~~	NA	NA
Below-grade walls	~~NA~~	~~NA~~	NA	R0
Slab floor perimeter	~~NR~~	~~R7~~	R7	NR
Raised floors	~~R13~~	~~R19~~	R30	R19[2]
Concrete raised floors	~~NA~~	~~NA~~	NA	R8
Radiant barrier			REQ	REQ
GLAZING				
Maximum U-~~value~~factor[3]	~~0.65~~	~~0.65~~	0.40	0.65
Maximum total area	~~NR~~	~~14%~~	16%	16%
~~Maximum total nonsouth facing area~~	~~9.6%~~	~~NR~~	~~NR~~	~~NR~~
~~Minimum south facing area~~	~~6.4%~~	~~NR~~	~~NR~~	~~NR~~
SOLAR HEAT GAIN COEFFICIENT[4]				
South-facing glazing	~~0.40~~	~~0.40~~	~~NR~~0.40	~~NR~~0.40
West-facing glazing	~~0.40~~	~~0.40~~	0.40	0.40
East-facing glazing	~~NR~~	~~NR~~	0.40	0.40
North-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
THERMAL MASS[5]	~~REQ~~	~~NR~~	REQ	NR
~~INFILTRATION CONTROL~~				
~~Continuous barrier~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
~~Air to air heat exchanger~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
SPACE-HEATING SYSTEM[6]				
Electric-resistant allowed	~~No~~	~~No~~	Yes[7]	No
If gas, AFUE =	~~78%~~	~~78%~~	78%	MIN
If heat pump, split system HSPF[8] =	~~6.8~~	~~6.8~~	6.8	MIN
Single package system HSPF =	~~6.6~~	~~6.6~~	6.6	MIN
SPACE-COOLING SYSTEM				
If split system A/C, SEER =	~~10.0~~	~~10.0~~	10.0	MIN
Refrigerant charge and airflow measurement or Thermostatic expansion valve			REQ	REQ*
If single package A/C, SEER =	~~9.7~~	~~9.7~~	9.7	MIN
SPACE CONDITIONING DUCTS				
Duct sealing			REQ	REQ*
DOMESTIC WATER-HEATING TYPE				
System must meet budget, see Section 151 (b) 1 and (f) ~~98~~	~~Any~~	~~Any~~	Any[9]	Any

*As an alternative under Package D, glazing with a maximum 0.40 U-factor and maximum 0.35 Solar Heat Gain Coefficient, and a 12.0 SEER space-cooling system can be substituted for duct sealing and either refrigerant charge and airflow measurement or a thermostatic expansion valve. All other requirements of Package D must be met.

Legend:
NR = Not Required NA = Not Applicable
REQ = Required MIN = Minimum

See notes following Table 1-Z16

TABLE 1-Z14—ALTERNATIVE COMPONENT PACKAGES FOR CLIMATE ZONE 14

COMPONENT	PACKAGE[1]			
	~~A~~	~~B~~	C[1]	D
BUILDING ENVELOPE				
Insulation minimums[2]				
Ceiling	~~R38~~	~~R38~~	R49	R38
Wood-frame walls	~~R19~~	~~R19~~	R29	R21
"Heavy mass" walls	~~(R7.0)~~	~~(R5.5)~~	NA	(R4.76)
"Light mass" walls	~~[R8.0]~~	~~[R6.5]~~	NA	NA
Below-grade walls	~~NA~~	~~NA~~	NA	R0
Slab floor perimeter	~~R7~~	~~R7~~	R7	NR
Raised floors	~~R19~~	~~R19~~	R30	R19[2]
Concrete raised floors	~~NA~~	~~NA~~	NA	R8
Radiant barrier			REQ	REQ
GLAZING				
Maximum U-~~value~~factor[3]	~~0.65~~	~~0.65~~	0.40	0.65
Maximum total area	~~NR~~	~~16%~~	14%	16%
~~Maximum total nonsouth facing area~~	~~9.6%~~	~~NR~~	~~NR~~	~~NR~~
~~Minimum south facing area~~	~~6.4%~~	~~NR~~	~~NR~~	~~NR~~
SOLAR HEAT GAIN COEFFICIENT[4]				
South-facing glazing	~~0.15~~	~~0.15~~	~~NR~~0.40	~~NR~~0.40
West-facing glazing	~~0.15~~	~~0.15~~	0.40	0.40
East-facing glazing	~~NR~~	~~NR~~	0.40	0.40
North-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
THERMAL MASS[5]	~~REQ~~	~~NR~~	REQ	NR
~~INFILTRATION CONTROL~~				
~~Continuous barrier~~	~~NR~~	~~REQ~~	~~NR~~	~~NR~~
~~Air to air heat exchanger~~	~~NR~~	~~REQ~~	~~NR~~	~~NR~~
SPACE-HEATING SYSTEM[6]				
Electric-resistant allowed	~~No~~	~~No~~	Yes[7]	No
If gas, AFUE =	~~78%~~	~~78%~~	78%	MIN
If heat pump, split system HSPF[8] =	~~6.8~~	~~6.8~~	6.8	MIN
Single package system HSPF =	~~6.6~~	~~6.6~~	6.6	MIN
SPACE-COOLING SYSTEM				
If split system A/C, SEER =	~~10.0~~	~~10.0~~	10.0	MIN
Refrigerant charge and airflow measurement or Thermostatic expansion valve			REQ	REQ*
If single package A/C, SEER =	~~9.7~~	~~9.7~~	9.7	MIN
SPACE CONDITIONING DUCTS				
Duct sealing			REQ	REQ*
DOMESTIC WATER-HEATING TYPE				
System must meet budget, see Section 151 (b) 1 and (f) ~~9~~8	~~Any~~	~~Any~~	Any[9]	Any

*As an alternative under Package D, glazing with a maximum 0.40 U-factor and maximum 0.30 Solar Heat Gain Coefficient, and a 12.0 SEER space-cooling system can be substituted for duct sealing and either refrigerant charge and airflow measurement or a thermostatic expansion valve. All other requirements of Package D must be met.

Legend:
NR = Not Required NA = Not Applicable
REQ = Required MIN = Minimum

See notes following Table 1-Z16

TABLE 1-Z15—ALTERNATIVE COMPONENT PACKAGES FOR CLIMATE ZONE 15

COMPONENT	PACKAGE[1]			
	~~A~~	~~B~~	C[1]	D
BUILDING ENVELOPE				
Insulation minimums[2]				
Ceiling	~~R30~~	~~R38~~	R49	R38
Wood-frame walls	~~R19~~	~~R19~~	R29	R21
"Heavy mass" walls	~~(R5.5)~~	~~(R4.5)~~	NA	(R4.76)
"Light mass" walls	~~[R7.0]~~	~~[R6.0]~~	NA	NA
Below-grade walls	~~NA~~	~~NA~~	NA	R0
Slab floor perimeter	~~R7~~	~~R7~~	R7	NR
Raised floors	~~R19~~	~~R19~~	R21	R19[2]
Concrete raised floors	~~NA~~	~~NA~~	NA	R4
Radiant barrier			REQ	REQ
GLAZING				
Maximum U-~~value~~factor[3]	~~0.65~~	~~0.65~~	0.40	0.65
Maximum total area	~~NR~~	~~16%~~	16%	16%
~~Maximum total nonsouth facing area~~	~~9.6%~~	~~NR~~	~~NR~~	~~NR~~
~~Minimum south facing area~~	~~6.4%~~	~~NR~~	~~NR~~	~~NR~~
SOLAR HEAT GAIN COEFFICIENT[4]				
South-facing glazing	~~0.15~~	~~0.15~~	0.40	0.40
West-facing glazing	~~0.15~~	~~0.15~~	0.40	0.40
East-facing glazing	~~NR~~	~~NR~~	0.40	0.40
North-facing glazing	~~NR~~	~~NR~~	~~NR~~0.40	~~NR~~0.40
THERMAL MASS[5]	~~REQ~~	~~NR~~	REQ	NR
~~INFILTRATION CONTROL~~				
~~Continuous barrier~~	~~NR~~	~~REQ~~	~~NR~~	~~NR~~
~~Air to air heat exchanger~~	~~NR~~	~~REQ~~	~~NR~~	~~NR~~
SPACE-HEATING SYSTEM[6]				
Electric-resistant allowed	~~No~~	~~No~~	Yes[7]	No
If gas, AFUE =	~~78%~~	~~78%~~	78%	MIN
If heat pump, split system HSPF[8] =	~~6.8~~	~~6.8~~	6.8	MIN
Single package system HSPF =	~~6.6~~	~~6.6~~	6.6	MIN
SPACE-COOLING SYSTEM				
If split system A/C, SEER =	~~10.0~~	~~10.0~~	10.0	MIN
Refrigerant charge and airflow measurement or Thermostatic expansion valve			REQ	REQ*
If single package A/C, SEER =	~~9.7~~	~~9.7~~	9.7	MIN
SPACE CONDITIONING DUCTS				
Duct sealing			REQ	REQ*
DOMESTIC WATER-HEATING TYPE				
System must meet budget, see Section 151 (b) 1 and (f) ~~9~~8	~~Any~~	~~Any~~	Any[9]	Any

*As an alternative under Package D, glazing with a maximum 0.40 U-factor and maximum 0.30 Solar Heat Gain Coefficient, and a 13.0 SEER space-cooling system can be substituted for duct sealing and either refrigerant charge and airflow measurement or a thermostatic expansion valve. All other requirements of Package D must be met.

Legend:
NR = Not Required NA = Not Applicable
REQ = Required MIN = Minimum

See notes following Table 1-Z16

TABLE 1-Z16—ALTERNATIVE COMPONENT PACKAGES FOR CLIMATE ZONE 16

COMPONENT	PACKAGE[1]			
	~~A~~	~~B~~	C[1]	D
BUILDING ENVELOPE				
Insulation minimums[2]				
Ceiling	~~R38~~	~~R38~~	R49	R38
Wood-frame walls	~~R19~~	~~R19~~	R29	R21
"Heavy mass" walls	~~(R9.5)~~	~~(R7.0)~~	NA	(R4.76)
"Light mass" walls	~~[R9.5]~~	~~[R7.5]~~	NA	NA
Below-grade walls	~~NA~~	~~NA~~	NA	R13
Slab floor perimeter	~~R7~~	~~R7~~	R7	R7
Raised floors	~~R19~~	~~R19~~	R30	R19[2]
Concrete raised floors	~~NA~~	~~NA~~	NA	R8
Radiant barrier			NR	NR
GLAZING				
Maximum U-~~value~~factor[3]	~~0.65~~	~~0.65~~	0.40	0.60
Maximum total area	~~NR~~	~~16%~~	14%	16%
~~Maximum total nonsouth facing area~~	~~9.6%~~	~~NR~~	~~NR~~	~~NR~~
~~Minimum south facing area~~	~~6.4%~~	~~NR~~	~~NR~~	~~NR~~
SOLAR HEAT GAIN COEFFICIENT[4]				
South-facing glazing	~~NR~~	~~NR~~	NR	NR
West-facing glazing	~~NR~~	~~NR~~	NR	NR
East-facing glazing	~~NR~~	~~NR~~	NR	NR
North-facing glazing	~~NR~~	~~NR~~	NR	NR
THERMAL MASS[5]	~~REQ~~	~~NR~~	REQ	NR
~~INFILTRATION CONTROL~~				
~~Continuous barrier~~	~~NR~~	~~REQ~~	~~NR~~	~~NR~~
~~Air to air heat exchanger~~	~~NR~~	~~REQ~~	~~NR~~	~~NR~~
SPACE-HEATING SYSTEM[6]				
Electric-resistant allowed	~~No~~	~~No~~	Yes[7]	No
If gas, AFUE =	~~78%~~	~~78%~~	78%	MIN
If heat pump, split system HSPF[8] =	~~6.8~~	~~6.8~~	6.8	MIN
Single package system HSPF =	~~6.6~~	~~6.6~~	6.6	MIN
SPACE-COOLING SYSTEM				
If split system A/C, SEER =	~~10.0~~	~~10.0~~	10.0	MIN
Refrigerant charge and airflow measurement or Thermostatic expansion valve			NR	NR
If single package A/C, SEER =	~~9.7~~	~~9.7~~	9.7	MIN
SPACE CONDITIONING DUCTS				
Duct sealing			REQ	REQ*
DOMESTIC WATER-HEATING TYPE				
System must meet budget, see Section 151 (b) 1 and (f) ~~9~~8	~~Any~~	~~Any~~	Any[9]	Any

*As an alternative under Package D, glazing with a maximum 0.55 U-factor and a 90% AFUE furnace or a 7.6 HSPF heat pump can be substituted for duct sealing. All other requirements of Package D must be met.

Legend:
NR = Not Required
NA = Not Applicable
REQ = Required
MIN = Minimum

See notes following Table 1-Z16

3. Thermostatic Expansion Valves or Refrigerant Charge and Airflow Measurement, Alterations in Existing Residential Buildings, Establishment of prescriptive requirement

Section 152(b)1

B. New space-conditioning systems or components shall:

i. Meet the requirements of Sections 150 (h) and (i) and Section 151(f)7; and

2. Refrigerant Charge and Airflow Measurement, Establishment of an alternative to Thermostatic Expansion Valves

2.1 Certificate of Compliance (CF-1R)

…

HVAC Systems. This listing provides data on the heating and cooling systems in the building. These data are identical to those in the Computer Method Summary (Report C-2R) under "HVAC Systems" described on Page 2-34.

HVAC SYSTEMS

System Name	System Type	Refrigerant Charge and Airflow ~~TXV~~	Minimum Equipment Efficiency	Distribution Type and Location	Duct R-value
Zone=Living					
LowerHeat	GasFurnace	N/A	0.78 AFUE	DuctsCrawl	4.2
LowerAC	AirCond-Split	Yes	10.0 SEER	DuctsCrawl	4.2
Zone=Sleep					
UpperHeat	Electric	N/A	1.00 COP	Baseboard	
UpperAC	AirCond-Split	No	10.0 SEER	DuctsAttic	4.2

…

- ~~*TXV*~~*Refrigerant Charge and Airflow*: Whether the refrigerant charge and airflow is verified or a thermostatic expansion valve is included for ducted central systems. The choices are 'yes' or 'no' where "yes" means that either refrigerant charge and airflow are verified or a TXV is installed. Only split system equipment *(SplitAirCond and SplitHeatPump)* can be modeled with refrigerant charge and airflow verification. Six equipment types can be modeled with a TXV. They are: *SplitAirCond, PkgAirCond, LrgPkgAirCond, SplitHeatPump, PkgHeatPump, LrgPkgHeatPump.* See Table 2-3 for a description of equipment.

…

2.1.1 Computer Method Summary (C-2R)

…

HVAC Systems

…

HVAC SYSTEMS

Equipment Type	Minimum Equipment Efficiency (or Water Heating System Name)	Refrigerant Charge and Airflow ~~Thermostatic Expansion Valve~~	Distribution Type and Location	Duct R-value
Zone=Living				
Furnace	0.78 AFUE	N/A	DuctsCrawl	4.2
AirCond-Split	10.0 SEER	Yes	DuctsCrawl	4.2
Zone=Sleep				
CombHydro	Upper Floors	N/A	Baseboard	na.
AirCond-Split	10.0 SEER	No	DuctsAttic	4.2

…

- *Refrigerant Charge and Airflow* ~~*Thermostatic Expansion Valve*~~. The choices ~~for TXV~~ are 'yes' or 'no' where "yes" means that either refrigerant charge and airflow are verified or a TXV is installed. See Section 2.1 for system types for which ~~TXV~~this credit can be claimed.

…

3.8.2 Cooling Equipment

-

…

The ~~thermostatic expansion valve (TXV)~~ refrigerant charge and airflow factor (F_{TXV}), which adjusts the system performance ~~to account for the presence of a TXV~~, shall be 1.0 for systems without refrigerant charge and airflow measurement or a TXV. For systems with refrigerant charge and airflow measurement or a TXV, the ~~thermostatic expansion valve~~ refrigerant charge and airflow factor shall be 1.07 for duct systems designed according to ACCA Manual D and 1.11 for all other duct systems.

3.8.3 ~~Thermostatic Expansion Valves~~ Refrigerant Charge and Airflow

Proposed Design: The ACM must allow the user to enter a central ducted cooling system with a refrigerant charge and airflow option ~~thermostatic expansion valve (TXV)~~. The~~e~~is option requires either measuring charge and airflow using procedures set forth in Appendix K (for split system equipment only) or requires the presence of a thermostatic expansion valve (TXV). These features require~~s~~ verification by the HERS rater and must be reported in the *Special Features and Modeling Assumptions and HERS Required Verification* listings on the CF-1R and C-2R.

Standard Design: If a split system ducted central air conditioner or heat pump (*SplitAirCond* or *SplitHeatPump*) is used for the *Proposed Design* then the cooling system used in the *Standard Design* building shall have either refrigerant charge and air flow measurement or be equipped with a thermostatic expansion valve if required by Package D.

Adjustments to the source seasonal energy efficiency ratio due to refrigerant charge and airflow or thermostatic expansion valves are described in section 3.8.2.

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

…

7.2 HERS Required Verification and Diagnostic Testing

HERS diagnostic testing and field verification is required for ~~compliance credit for~~:

- Duct sealing
- ACCA Manual D and installation
- Refrigerant charge and airflow measurement, and
- ~~And b~~Building envelope sealing beyond improvements covered by default assumptions.

7.3 Install~~ation~~ation~~r~~ Certification

When compliance ~~credit has been claimed for~~ includes duct sealing, ACCA Manual D design and installation, refrigerant charge and airflow measurement ~~and~~or 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 K, Section 3. 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.

…

7.4 HERS Verification Procedures

… Field verification and diagnostic testing for compliance credit for duct sealing shall use the diagnostic duct leakage from fan pressurization of ducts in Section 4.3.8.2.1 of Appendix F.

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 Appendix K. 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.

…

7.5.3 Building Department

…

For ~~house~~dwelling units that have used a compliance alternative that requires field verification and diagnostic testing, the building department shall not approve a ~~house~~dwelling unit for occupancy until the building department has received from the builder 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 Appendix K, Section 3. This approval will be on the condition that installers provide a signed agreement (CF-6R) 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.

Appendix K Procedures for Determining Required Refrigerant Charge and Adequate Airflow for Split System Space Cooling Systems without Thermostatic Expansion Valves

1. Overview

Failure to maintain proper refrigerant charge or proper airflow across the coil reduces the seasonal energy efficiency for an air conditioner (whether a cooling only air conditioner or a heat pump). In addition, excessive refrigerant charge can cause premature compressor failure, while insufficient refrigerant charge allows compressors to overheat. Very low airflow can result in icing of the coil and compressor failure.

To help avoid these problems and to provide a compliance credit for correctly installed systems, this appendix describes procedures for determining if a residential split system space cooling system has the required refrigerant charge and adequate airflow across the evaporator coil. The applicability of these procedures have the following limitations:

- The procedures detailed in this appendix only apply to ducted split system central air conditioners and ducted split system central heat pumps that do not have thermostatic expansion valves (TXVs).
- As an alternative to the procedures detailed in this appendix, systems may substitute a TXV installed and confirmed through field verification and diagnostic testing.
- The procedures detailed in this appendix do not apply to single packaged systems.

Note that the procedures detailed in this appendix are intended to be used after the HVAC installer has installed and charged the system in accordance with the manufacturer's specifications.

The installer shall install and charge the air conditioner and heat pump equipment 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 they have followed these instruction and specifications prior to proceeding with the procedures in this appendix.

For dwelling units with multiple systems, this procedure must be applied to each system separately.

This appendix defines two procedures, the Standard Charge and Airflow Measurement procedure in Section 2 and the Alternate Charge and Airflow Measurement procedure in Section 3. 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.

2. Standard Charge and Airflow Measurement Procedure

This section specifies the Standard charge and airflow measurement procedure. Under this procedure, required refrigerant charge is calculated using the *Superheat Charging Method* and adequate airflow across the evaporator coil is calculated using the *Temperature Split Method.*

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. All HERS rater verifications are required to use this Standard procedure.

2.1 Minimum Qualifications for this Procedure

Persons carrying out this procedure need to 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 lineset.
- 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.

2.2 Instrumentation Specifications

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

2.2.1 Digital Thermometer

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

- Accuracy: ±(0.1% of reading + 1.3º F)
- Resolution: 0.2º F

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.

2.2.3 Refrigerant Manifold Gauge Set

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

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.

2.3.1 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.

Step 1. Fill an insulated cup (foam) with crushed ice. The ice shall completely fill the cup. Add water to fill the cup.

Step 2. Insert two thermocouples into the center of the ice bath and attach them to the digital thermometer.

Step 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.

Step 4. Switch the thermocouples and ensure that the temperatures read on T1 and T2 are still within +/- 1°F of 32°F.

Step 5. Affix sticker with calibration check date onto thermocouple.

Step 6. Repeat the process for all thermocouples.

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.

Step 1. Place a refrigerant cylinder in a stable environment and let it sit for 4 hours minimum to stabilize to the ambient conditions.

Step 2. Attach a thermocouple to the refrigerant cylinder using duct tape so that there is good contact between the cylinder and the thermocouple.

Step 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).

Step 4. Zero the low side compound gauge with all ports open to atmospheric pressure (no hoses attached).

Step 5. Re-install the hose and attach the low side gauge to the refrigerant cylinder.

Step 6. Read the temperature of the thermocouple.

Step 7. Using a pressure/temperature chart for the refrigerant, look up the pressure that corresponds to the temperature measured.

Step 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.

Step 9. Repeat the process in steps 4 through 8 for the high side gauge.

Step 10. Affix sticker with calibration check date onto refrigerant gauge.

2.4 Charge and Airflow Measurements

The following procedure shall be used to obtain measurements necessary to adjust required refrigerant charge and adequate airflow as described in the following sections.

Step 1. Establish a return air dry bulb temperature sufficiently high that the return air dry bulb temperature will be not less than 70^{o}F prior to the measurements at the end of the 15 minute period in step 2.

Step 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.

Step 3. Connect the refrigerant gauge manifold to the suction line service valve.

Step 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.

Step 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.

Step 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.

Step 7. Place wet-bulb thermocouple in water to ensure it is saturated when needed. **Do not get the dry-bulb thermocouples wet.**

Step 8. Insert the dry-bulb thermocouple in the supply plenum at the center of the airflow.

Step 9. At 12 minutes, insert a dry-bulb thermocouple and a wet-bulb thermocouple into the return plenum at the center of the airflow.

Step 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 ($T_{return,\ db}$) and the return (evaporator entering) air wet-bulb temperature ($T_{return,\ wb}$).

Step 11. Using the dry-bulb thermocouple already in place, measure and record the supply (evaporator leaving) air dry-bulb temperature ($T_{supply,\ db}$).

Step 12. Using the refrigerant gauge already attached, measure and record the evaporator saturation temperature ($T_{evaporator,\ sat}$) from the low side gauge.

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

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

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

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 2.4. 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 2.4 before re-testing the airflow. Both the airflow and charge must be re-tested until they both sequentially pass.

Step 1. Calculate Actual Superheat as the suction line temperature minus the evaporator saturation temperature.
Actual Superheat = $T_{suction,\ db} - T_{evaporator,\ sat}$.

Step 2. Determine the Target Superheat using Table K-1 using the return air wet-bulb temperature ($T_{return, wb}$) and condenser air dry-bulb temperature ($T_{condenser, db}$).

Step 3. If a dash mark is read from Table K-1, 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 K-1 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.

Step 4. Calculate the difference between actual superheat and target superheat (Actual Superheat - Target Superheat)

Step 5. If the difference is between minus 5 and plus 5°F, then the system **passes** the required refrigerant charge criteria.

Step 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.

Step 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.

Table K-1: Target Superheat (Suction Line Temperature - Evaporator Saturation Temperature)

Condenser Air Dry-Bulb Temperature (°F) ($T_{condenser-db}$)	Return Air Wet-Bulb Temperature (°F) (T_{return_wb})																												
	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
55	8.8	10.1	11.5	12.8	14.2	15.6	17.1	18.5	20.0	21.5	23.1	24.6	26.2	27.8	29.4	31.0	32.4	33.8	35.1	36.4	37.7	39.0	40.2	41.5	42.7	43.9	45.0
56	8.6	9.9	11.2	12.6	14.0	15.4	16.8	18.2	19.7	21.2	22.7	24.2	25.7	27.3	28.9	30.5	31.8	33.2	34.6	35.9	37.2	38.5	39.7	41.0	42.2	43.4	44.6
57	8.3	9.6	11.0	12.3	13.7	15.1	16.5	17.9	19.4	20.8	22.3	23.8	25.3	26.8	28.3	29.9	31.3	32.6	34.0	35.3	36.7	38.0	39.2	40.5	41.7	43.0	44.2
58	7.9	9.3	10.6	12.0	13.4	14.8	16.2	17.6	19.0	20.4	21.9	23.3	24.8	26.3	27.8	29.3	30.7	32.1	33.5	34.8	36.1	37.5	38.7	40.0	41.3	42.5	43.7
59	7.5	8.9	10.2	11.6	13.0	14.4	15.8	17.2	18.6	20.0	21.4	22.9	24.3	25.7	27.2	28.7	30.1	31.5	32.9	34.3	35.6	36.9	38.3	39.5	40.8	42.1	43.3
60	7.0	8.4	9.8	11.2	12.6	14.0	15.4	16.8	18.2	19.6	21.0	22.4	23.8	25.2	26.6	28.1	29.6	31.0	32.4	33.7	35.1	36.4	37.8	39.1	40.4	41.6	42.9
61	6.5	7.9	9.3	10.7	12.1	13.5	14.9	16.3	17.7	19.1	20.5	21.9	23.3	24.7	26.1	27.5	29.0	30.4	31.8	33.2	34.6	35.9	37.3	38.6	39.9	41.2	42.4
62	6.0	7.4	8.8	10.2	11.7	13.1	14.5	15.9	17.3	18.7	20.1	21.4	22.8	24.2	25.5	27.0	28.4	29.9	31.3	32.7	34.1	35.4	36.8	38.1	39.4	40.7	42.0
63	5.3	6.8	8.3	9.7	11.1	12.6	14.0	15.4	16.8	18.2	19.6	20.9	22.3	23.6	25.0	26.4	27.8	29.3	30.7	32.2	33.6	34.9	36.3	37.7	39.0	40.3	41.6
64	-	6.1	7.6	9.1	10.6	12.0	13.5	14.9	16.3	17.7	19.0	20.4	21.7	23.1	24.4	25.8	27.3	28.7	30.2	31.6	33.0	34.4	35.8	37.2	38.5	39.9	41.2
65	-	5.4	7.0	8.5	10.0	11.5	12.9	14.3	15.8	17.1	18.5	19.9	21.2	22.5	23.8	25.2	26.7	28.2	29.7	31.1	32.5	33.9	35.3	36.7	38.1	39.4	40.8
66	-		6.3	7.8	9.3	10.8	12.3	13.8	15.2	16.6	18.0	19.3	20.7	22.0	23.2	24.6	26.1	27.6	29.1	30.6	32.0	33.4	34.9	36.3	37.6	39.0	40.4
67	-	-	5.5	7.1	8.7	10.2	11.7	13.2	14.6	16.0	17.4	18.8	20.1	21.4	22.7	24.1	25.6	27.1	28.6	30.1	31.5	33.0	34.4	35.8	37.2	38.6	39.9
68	-	-	-	6.3	8.0	9.5	11.1	12.6	14.0	15.5	16.8	18.2	19.5	20.8	22.1	23.5	25.0	26.5	28.0	29.5	31.0	32.5	33.9	35.3	36.8	38.1	39.5
69	-	-	-	5.5	7.2	8.8	10.4	11.9	13.4	14.8	16.3	17.6	19.0	20.3	21.5	22.9	24.4	26.0	27.5	29.0	30.5	32.0	33.4	34.9	36.3	37.7	39.1
70	-	-	-	-	6.4	8.1	9.7	11.2	12.7	14.2	15.7	17.0	18.4	19.7	20.9	22.3	23.9	25.4	27.0	28.5	30.0	31.5	33.0	34.4	35.9	37.3	38.7
71	-	-	-	-	5.6	7.3	8.9	10.5	12.1	13.6	15.0	16.4	17.8	19.1	20.3	21.7	23.3	24.9	26.4	28.0	29.5	31.0	32.5	34.0	35.4	36.9	38.3
72	-	-	-	-	-	6.4	8.1	9.8	11.4	12.9	14.4	15.8	17.2	18.5	19.7	21.2	22.8	24.3	25.9	27.4	29.0	30.5	32.0	33.5	35.0	36.5	37.9
73	-	-	-	-	-	5.6	7.3	9.0	10.7	12.2	13.7	15.2	16.6	17.9	19.2	20.6	22.2	23.8	25.4	26.9	28.5	30.0	31.5	33.1	34.6	36.0	37.5
74	-	-	-	-	-	-	6.5	8.2	9.9	11.5	13.1	14.5	15.9	17.3	18.6	20.0	21.6	23.2	24.8	26.4	28.0	29.5	31.1	32.6	34.1	35.6	37.1
75	-	-	-	-	-	-	5.6	7.4	9.2	10.8	12.4	13.9	15.3	16.7	18.0	19.4	21.1	22.7	24.3	25.9	27.5	29.1	30.6	32.2	33.7	35.2	36.7
76	-	-	-	-	-	-	-	6.6	8.4	10.1	11.7	13.2	14.7	16.1	17.4	18.9	20.5	22.1	23.8	25.4	27.0	28.6	30.1	31.7	33.3	34.8	36.3
77	-	-	-	-	-	-	-	5.7	7.5	9.3	11.0	12.5	14.0	15.4	16.8	18.3	20.0	21.6	23.2	24.9	26.5	28.1	29.7	31.3	32.8	34.4	36.0
78	-	-	-	-	-	-	-	-	6.7	8.5	10.2	11.8	13.4	14.8	16.2	17.7	19.4	21.1	22.7	24.4	26.0	27.6	29.2	30.8	32.4	34.0	35.6
79	-	-	-	-	-	-	-	-	5.9	7.7	9.5	11.1	12.7	14.2	15.6	17.1	18.8	20.5	22.2	23.8	25.5	27.1	28.8	30.4	32.0	33.6	35.2
80	-	-	-	-	-	-	-	-	-	6.9	8.7	10.4	12.0	13.5	15.0	16.6	18.3	20.0	21.7	23.3	25.0	26.7	28.3	29.9	31.6	33.2	34.8
81	-	-	-	-	-	-	-	-	-	6.0	7.9	9.7	11.3	12.9	14.3	16.0	17.7	19.4	21.1	22.8	24.5	26.2	27.9	29.5	31.2	32.8	34.4
82	-	-	-	-	-	-	-	-	-	5.2	7.1	8.9	10.6	12.2	13.7	15.4	17.2	18.9	20.6	22.3	24.0	25.7	27.4	29.1	30.7	32.4	34.0
83	-	-	-	-	-	-	-	-	-	-	6.3	8.2	9.9	11.6	13.1	14.9	16.6	18.4	20.1	21.8	23.5	25.2	26.9	28.6	30.3	32.0	33.7
84	-	-	-	-	-	-	-	-	-	-	5.5	7.4	9.2	10.9	12.5	14.3	16.1	17.8	19.6	21.3	23.0	24.8	26.5	28.2	29.9	31.6	33.3
85	-	-	-	-	-	-	-	-	-	-	-	6.6	8.5	10.3	11.9	13.7	15.5	17.3	19.0	20.8	22.6	24.3	26.0	27.8	29.5	31.2	32.9
86	-	-	-	-	-	-	-	-	-	-	-	5.8	7.8	9.6	11.3	13.2	15.0	16.7	18.5	20.3	22.1	23.8	25.6	27.3	29.1	30.8	32.6
87	-	-	-	-	-	-	-	-	-	-	-	5.0	7.0	8.9	10.6	12.6	14.4	16.2	18.0	19.8	21.6	23.4	25.1	26.9	28.7	30.4	32.2
88	-	-	-	-	-	-	-	-	-	-	-	-	6.3	8.2	10.0	12.0	13.9	15.7	17.5	19.3	21.1	22.9	24.7	26.5	28.3	30.1	31.8
89	-	-	-	-	-	-	-	-	-	-	-	-	5.5	7.5	9.4	11.5	13.3	15.1	17.0	18.8	20.6	22.4	24.3	26.1	27.9	29.7	31.5
90	-	-	-	-	-	-	-	-	-	-	-	-	-	6.8	8.8	10.9	12.8	14.6	16.5	18.3	20.1	22.0	23.8	25.6	27.5	29.3	31.1

Table K-1: Target Superheat (Suction Line Temperature - Evaporator Saturation Temperature) (continued)

Condenser Air Dry-Bulb Temperature (°F) ($T_{condenser,db}$)	Return Air Wet-Bulb Temperature (°F) ($T_{return,wb}$)																											
	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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.2	8.3	10.5	12.6	14.8	17.0	19.1	21.3	23.5	25.7
107	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.7	7.9	10.0	12.2	14.4	16.6	18.7	21.0	23.2	25.4
108	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.2	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

2.6 Adequate Airflow Calculations

The temperature split method is designed to provide an efficient check to see if airflow is above the required minimum. The following steps describe the calculations using the measurement procedure described in section 2.4. 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 2.4 before re-testing the refrigerant charge. Both the airflow and charge must be re-tested until they both sequentially pass.

Step 1. Calculate the Actual Temperature Split as the return air dry-bulb temperature minus the supply air dry-bulb temperature. Actual Temperature Split = $T_{return,\ db} - T_{supply,\ db}$

Step 2. Determine the Target Temperature Split from Table K-2 using the return air wet-bulb temperature ($T_{return,\ wb}$) and return air dry-bulb temperature ($T_{return,\ db}$).

Step 3. If a dash mark is read from Table K-2, 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 3.4 below.

Step 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.

Step 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.

Step 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.

Step 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).

Table K-2: Target Temperature Split (Return Dry-Bulb – Supply Dry-Bulb)

Return Air Dry-Bulb (°F) ($T_{return, db}$)	Return Air Wet-Bulb (°F) ($T_{return, wb}$)																												
	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	20.4	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
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
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
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
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
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

3. Alternate Charge and Airflow Measurement Procedure

This section specifies the Alternate charge and airflow measurement procedure. Under this procedure, the required refrigerant charge is calculated using the *Weigh-In Charging Method* and adequate airflow across the evaporator coil is calculated using the *Measured Airflow 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.

3.1 Minimum Qualifications for this Procedure

HVAC installation technicians need to be qualified to perform the following:

- Transfer and recovery of refrigerant (including a valid Environmental Protection Agency (EPA) certification for transition and recovery of refrigerant).
- Accurately weigh the amount of refrigerant added or removed using an electronic scale.
- 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.

3.2 Instrumentation Specifications

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

3.2.1 Digital Charging Scale

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 ± 0.25 oz.

3.3 Weigh-In Method

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

Step 1. Obtain manufacturer's standard liquid line length and charge adjustment for alternate liquid line lengths.

Step 2. Measure and record the actual liquid line length (L_{actual}).

Step 3. Record the manufacturer's standard liquid line length ($L_{standard}$).

Step 4. Calculate the difference between actual and standard liquid line lengths ($L_{actual} - L_{standard}$).

Step 5. Record the manufacturer's adjustment for liquid line length difference per foot (A_{length}).

Step 6. Calculate the amount of refrigerant to add or remove and document the calculations on the CF-6R.

Step 7. Weigh in or remove the correct amount of refrigerant

3.4 Airflow Measurement

The airflow across the indoor evaporator coil shall be measured using one of the 2 methods described Appendix F - Standard Procedure for Determining the Seasonal Energy Efficiencies of Residential Air Distribution Systems:

Section 4.3.7.2.1 Diagnostic Fan Flow Using Flow Hood

Section 4.3.7.2.2 Diagnostic Fan Flow Using Plenum Pressure Matching

3.5 Adequate Airflow Calculation

The measured airflow method is used to provide a check to see if airflow is above the required minimum of 385 CFM per nominal ton of capacity (assumes coil is dry). The following steps describe the calculations using the measurement procedure described in Section 3.4. If a system fails, then remedial actions must be taken. The airflow must be re-tested until it passes.

Step 1. Record the measured airflow ($F_{measured}$) obtained from the measurement procedures described in Section 3.4.

Step 2. Obtain and record the rated cooling capacity ($C_{cooling}$) in Btu.

Step 3. Calculate the required airflow as the product of the rated cooling capacity in Btu times 0.032.

Step 4. Compare the airflow measured according to section 3.4 with the required airflow.

Step 5. If the measured airflow is greater than the required airflow, then the system **passes** the adequate airflow criteria.

Step 6. If the measured airflow is less than the required airflow, 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.