

Residential Appendix RA1

Appendix RA1 – Special Case Residential Field Verification and Diagnostic Test Protocols

Note: The HVAC Sizing procedures previously assigned to the 2008 version of RA1 have been moved to the 2013 ACM reference manual.

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RA1.1 Special Case Protocol Approval

Field verification and diagnostic test protocols other than those described in Reference Residential Appendix RA3 are possible, and when field verification or diagnostic testing measurements can be reliably determined by methods/procedures and instrumentation other than those specifically defined in Reference Residential Appendix RA3, such alternative protocols shall be allowed if approved by the Executive Director. The Executive Director will grant such approval after reviewing submittals from the applicant. Special Case Protocols that are approved by the Executive Director will be published as an addendum to Reference Residential Appendix RA1.

RA1.1.1 Special Case Refrigerant Charge Protocol Approval

The applicant for a special case refrigerant charge verification protocol shall provide information that specifies the required instrumentation, the instrumentation accuracy, the parameters measured, the required calculations, the allowable deviations from target values for system operating parameters, and the requirements for system fault indication. Manufacturers that elect to utilize the special case protocol for compliance with refrigerant charge verification requirements in the Standards shall certify to the Energy Commission that use of the special case charging procedure produces equipment performance at a sensible EER at 95/80/67 that is within 5% of the sensible EER produced in a laboratory test at 95/80/67 of the air conditioner with the designated refrigerant weight. Manufacturers using special case charge verification protocols shall, upon request, provide comprehensive engineering specification documentation, installation and technical field service documentation, and user instructions documentation to installers and service personnel that utilize the procedure.

RA1.2 Liquid Line Temperature Charging Method

RA1.2.1 Purpose and Scope

The purpose of this procedure is to determine and verify that residential split system space cooling systems and heat pumps have the required refrigerant charge. The procedure applies only to ducted split system central air conditioners and ducted split system central heat pumps for which the equipment manufacturer has specified that this procedure must be used to verify refrigerant charge.

The procedures detailed in Section RA1.2 shall be used by the HVAC installer after installing and charging the air conditioner or heat pump system in accordance with the manufacturer's instructions and specifications, and shall also be used by the HERS Rater for verification of the system's refrigerant charge when HERS verification is required for compliance.

The procedures in RA1.2 apply to systems for which the equipment manufacturer has specified the use of the Liquid Line Temperature method as replacement for the subcooling method specified in the Standard Charge Measurement procedure in Reference Residential Appendix RA3.2 sections RA3.2.2.5 (Charge Measurement) and RA3.2.2.6 (Variable Metering Device Calculations). All other applicable requirements specified in Reference Residential Appendix RA3.2 shall also apply to systems that use the procedures in RA1.2.

RA1.2.2 Liquid Line Temperature Charging Method

The Liquid Line Temperature Charging Method is for use only for systems for which the manufacturer specifies use of the Liquid Line Temperature Charging Method and provides target liquid line temperature charging data based on the equipment's operating conditions. A simulated target liquid line temperature table is shown in Figure RA1.2-1. This method improves the accuracy of refrigerant charging (as compared to the subcooling method) for some units, particularly in units with low refrigerant volume in the condenser (such as in micro-channel heat exchangers).

The HERS rater shall refer to manufacturer's published technical documentation or equipment labeling data, and the Energy Commission's published listings of manufacturers approved to use the Liquid Line Temperature Charging Method to verify that the installed air conditioning equipment manufacturer's system name, and model number, indicates the system is required use the Liquid Line Temperature Charging Method to demonstrate compliance when HERS Rater field verification and diagnostic testing of refrigerant charge is required.

		Model Number ABCDEFG											
		Outdoor Ambient (°F)											
		60	65	70	75	80	85	90	95	100	105	110	115
		MINIMUM LIQUID LINE TEMPERATURE (°F)											
Suction Line Pressure (psig)	<=115	T11	T12	T13	T14	T15	T16	T17	T18	T19	T110	T111	T112
	120	T21	T22	T23	T24	T25	T26	T27	T28	T29	T210	T211	T212
	125	T31	T32	T33	T34	T35	T36	T37	T38	T39	T310	T311	T312
	130	T41	T42	T43	T44	T45	T46	T47	T48	T49	T410	T411	T412
	135	T51	T52	T53	T54	T55	T56	T57	T58	T59	T510	T511	T512
	140	T61	T62	T63	T64	T65	T66	T67	T68	T69	T610	T611	T612
	145	T71	T72	T73	T74	T75	T76	T77	T78	T79	T710	T711	T712
	150	T81	T82	T83	T84	T85	T86	T87	T88	T89	T810	T811	T812
	155	T91	T92	T93	T94	T95	T96	T97	T98	T99	T910	T911	T912
	160	T101	T102	T103	T104	T105	T106	T107	T108	T109	T1010	T1011	T1012
MAX. LIQUID PRESS.		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
DO NOT EXCEED MAXIMUM ALLOWABLE LIQUID PRESSURE (psig)													

Figure RA1.2-1 Simulated Liquid Line Temperature Target Table

RA1.2.2.1 Charge Measurement

The procedure for charging these units shall be:

1. Follow the manufacturer’s directions and adhere to their limitations on indoor and outdoor temperatures appropriate to this procedure.
2. Connect the refrigerant gauges to the service ports, taking normal precautions to not introduce air into the system.
3. Attach one pipe temperature sensor to the suction line near the suction line service valve and attach one pipe temperature sensor to the liquid line near the liquid line service valve.
4. Attach a temperature sensor 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.
5. Be sure that all cabinet panels that affect airflow are in place before making measurements. The temperature sensors shall remain attached to the system until the final charge is determined.
6. Start the unit air conditioner and allow it to stabilize for 15 minutes.
7. Using the low side gauge, measure and record the low side pressure (P_{low}) and record the evaporator saturation temperature ($T_{evaporator, sat}$).
8. Using the high side gauge, measure and record the high side pressure (P_{high}).
9. Using the pipe temperature sensor already in place, measure and record the suction line temperature ($T_{suction}$).
10. Using the pipe temperature sensor already in place, measure and record the liquid line temperature (T_{liquid}).
11. Record the unit make and model number.

12. If possible, determine the Superheat Range specified by the manufacturer.

RA1.2.2.2 Calculations

- Determine and record the minimum liquid line temperature ($T_{\text{liquid min}}$) and maximum high side pressure ($P_{\text{high,max}}$) from the manufacturer's table.
- Calculate Actual Superheat as the suction line temperature minus the evaporator saturation temperature.
Actual Superheat = $T_{\text{suction}} - T_{\text{evaporator, sat}}$

RA1.2.2.2.1 Installer Compliance

The installer shall compare the measured liquid line temperature (T_{liquid}) to the manufacturer's ($T_{\text{liquid Min}}$) and compare the measured liquid pressure (P_{high}) to the manufacturer's ($P_{\text{high.Max}}$). The installer shall follow the specifications of the manufacturer to adjust the refrigerant charge to within the manufacturer's allowable limits.

If the superheat is within the manufacturer's superheat range, then the system passes the metering device criterion. If the manufacturer's specification is not available and the superheat is between 4°F and 25°F (inclusive), then the system passes the metering device criterion.

RA1.2.2.2.2 HERS Rater Compliance

The HERS rater shall consult the specifications of the manufacturer. The HERS Rater shall compare the measured liquid line temperature (T_{liquid}) to the manufacturer's ($T_{\text{liquid min}}$) and compare the measured liquid pressure (P_{high}) to the manufacturer's ($P_{\text{high.Max}}$). If the measured liquid line temperature (T_{liquid}) is within a tolerance of plus or minus 2°F of the manufacturer's ($T_{\text{liquid min}}$) target, and the high side pressure is equal to or below the manufacturer's maximum high side pressure, then system passes the refrigerant charge criterion. Otherwise the system fails the refrigerant charge criterion.

If the superheat is within the manufacturer's superheat range, then the system passes the metering device criterion. If the manufacturer's specification is not available and the superheat is between 3°F and 26°F (inclusive), then the system passes the metering device criterion.

RA1.3 Winter Setup for the Standard Charge Measurement Procedure

RA1.3.1 Purpose and Scope

The purpose of this procedure is to determine and verify that residential split system space cooling systems and heat pumps have the required refrigerant charge and that the metering device is working as designed. The procedures only apply to ducted split system central air conditioners and ducted split system central heat pumps for which that manufacturer has specified that this procedure may be used to verify refrigerant charge..

The Standard Charge Measurement Procedure (Section RA3.2.2 of the Reference Appendices) calls for the outdoor temperature to be within the manufacturer's specified range. When outdoor temperatures are below 70°F, the setup for the Standard Charge Measurement Procedure must be modified in order to achieve the proper system pressure differential needed for the procedure. The Winter Setup for the Standard Charge Measurement Procedure (Winter Charge Setup) allows both installers and HERS raters to utilize the Standard Charge Measurement Procedure of RA3.2.2 in the winter. Note that the Alternate Charge Measurement Procedure specified in Section RA3.2.3 (Weigh-In Charging Method) may also be used only by the installer.

The Winter Charge Setup creates the right conditions at the unit being tested for outdoor temperatures above 37°F and below 71°F that allow the system to operate in the same range of pressure differences between the low side pressure and the high side pressure as occurs during warm outdoor temperatures.

The Winter Charge Setup is used only for units equipped with variable metering devices, which include Thermostatic Expansion Valves (TXV) and Electronic Expansion Valves (EXV) for which the manufacturer specifies subcooling as the means for determining the proper charge for the unit, including units equipped with micro-channel heat exchangers. The Winter Charge Setup achieves an appropriate high side - low side pressure differential to conduct the Standard Charge Measurement Procedure, by restricting the airflow at the condenser fan outlet through the use of a Condenser Outlet Air Restrictor. Once this pressure differential is achieved, the Variable Metering Device Calculations are conducted in the same way as the procedures described in Reference Residential Appendix RA 3.2.2.6.2. All other requirements of Section RA3.2.2 remain the same and must also be completed when using the Winter Charge Setup.

Definition - Condenser Outlet Air Restrictor: A device which restricts the free area of the outlet from the condenser fan to reduce the air flow, but does not interfere with air entering the condenser coil. The amount of restriction shall be adjustable to allow the operator to vary the airflow to achieve the target refrigerant pressure difference.

RA1.3.2 Winter Setup for the Standard Charge Measurement Procedure

Install the condenser outlet air restrictor on the outlet from the condenser fan:

Position the restrictor so it does not interfere with the inlet airflow to the condenser.

Start the air conditioner or heat pump in the cooling mode and restrict the outlet until the difference between the high side pressure and the low side pressure is between 160 psi and 220 psi for R-410A refrigerant and 100 to 145 psi for R-22 refrigerant.

160 psi \leq (Phigh, – Plow) \leq 220 psi for R-410A refrigerant;

100 psi \leq (Phigh, – Plow) \leq 145 psi for R-22 refrigerant

Allow the unit to stabilize for 15 minutes, watching the pressures to make sure the differential achieves and remains within

160 psi \leq (Phigh, – Plow) \leq 220 psi for R-410A refrigerant

100 psi \leq (Phigh, – Plow) \leq 145 psi for R-22 refrigerant

Follow the test procedures specified in the Reference Residential Appendix, Section RA3.2.2.6.2, Variable Metering Device Calculations (see Attachment A below).

Note 1: The Winter Charge Setup may only be used for equipment for which the air conditioning manufacturers approve the use of the Winter Charge Setup. Refer to Energy Commissions website for the list of split system air condition units approved by the manufacturers to use the Winter Charge Setup. In addition to the requirements of this document, manufacturers may issue additional instructions/clarification for the equipment and procedures to be used to conduct the Winter Charge Setup. These additional instruction/clarifications are also available on the Energy Commission website.

<http://www.energy.ca.gov/title24/>

Note 2: Winter Charge Setup may be used for systems that use a target subcooling for refrigerant charge, including units equipped with micro-channel heat exchangers where the manufacturer specifies subcooling for measuring refrigerant charge.

Note 3: Similar to the Standard Charge Measurement Procedure for warm weather, the Winter Charge Setup may be used by the Installer and/or the HERS Rater.

Note 4: .For new or replacement space-conditioning systems, The minimum system airflow shall first be verified by demonstrating compliance with either the mandatory return duct sizing requirements in Section 150.0(m)13A, or the alternate mandatory Fan Watt draw and airflow verification requirements in Section 150.0(m)13B using the procedures in RA3.3.

For altered space conditioning systems, the minimum system airflow requirement shall first be verified by one of the air handler airflow measurements in **Error! Reference source not found.RA3-3** with a measured airflow equal to or greater than 300 cfm/ton. If a system fails, then remedial actions shall be taken to ensure the system conforms to the minimum 300 cfm/ton airflow requirement. If

Note 5: Similar to the Standard Charge Measurement Procedure for warm weather, the Winter Charge Setup requires that the return air dry bulb temperature must be maintained within the manufacturer's specification during the test, as specified in RA3.2.2. Suggestions for methods to accomplish warmer return air are posted on the Energy Commission website at the following link:

http://www.energy.ca.gov/title24/2008standards/changeout/documents/Refrigerant_Charge_Verification_Protocol.pdf

Note 6: Similar to the Standard Charge Measurement Procedure for warm weather, the Winter Charge Setup procedure does not relieve the installing contractor from any obligations to follow manufacturers' specifications. This procedure is used to assure conformance to Title 24.