

## Residential Appendix RA1

### Appendix RA1 – Special Case HERS Procedures

Note: this draft of RA1 is preliminary. Additional information and refinements to the information below is in process.

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

Refrigerant charging procedures other than that described in Reference Residential Appendix RA3.2 are possible, and when vapor compression air conditioner and heat pump system refrigerant charge and metering device operating performance can be reliably determined by methods and instrumentation other than those specifically defined in section RA3.2, such alternative charging procedures shall be allowed if the air conditioner equipment manufacturer requests approval from the Executive Director. The Executive Director will grant such approval after reviewing submittals from the applicant. Charging procedures that are approved by the Executive Director will be published as an addendum to Reference Residential Appendix RA1.

The applicant 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 shall certify to the Energy Commission that the charging procedure produces 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 alternative charging procedures 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.

#### RA1.1 Liquid Line Temperature Charge Method

##### RA1.1.1 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 must be used to verify refrigerant charge.

For dwelling units with multiple split systems or heat pumps, the procedure shall be applied to each system separately.

The procedures detailed in Section RA1.1 are to 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. The installer shall certify to the builder, building official and HERS rater that he/she has followed the manufacturer's instructions and specifications prior to proceeding with the procedures in this appendix.

##### RA1.1.1RA1.1.2 Liquid Line Temperature Charge Method

This method may be used as an alternate procedure for verifying the refrigerant charge of split system air conditioners and heat pumps. It is in addition to the testing procedures identified in Reference Appendices, RA 3.2.2—Standard Charge Measurement Procedure and RA3.2.3—Alternate Charge Measurement Procedure.

This procedure provides an accurate method for measuring refrigerant charge levels in air conditioners with micro-channel condenser coils. This procedure is used only for systems in which the manufacturer specifies

that this charge method is to be used for the equipment specified and provides a target liquid line temperature based on the equipment's operating conditions.

The HERS rater must verify that the installed air conditioning equipment is designed using micro-channel refrigerant heat exchanger based on the manufacturer's system name, model number, or identification/tag number.

An example of one manufacturer's target liquid line temperature table is provided below. Use of this method improves the accuracy of refrigerant charging particularly in units with low refrigerant volume in the condenser (such as micro-channel heat exchangers).

**4\*\*M3030A1 (\*\* = TT or A7)**

Suction Line Pressure (PSIG)	Outdoor Ambient (°F)													
	60	65	70	75	80	85	90	95	100	105	110	115	120	125
115	69	73	76	80	84	87	91							
120	70	74	77	81	85	88	92							
125	71	75	78	82	86	90	93	97						
130	72	76	80	83	87	91	94	98	102					
135	73	77	81	84	88	92	95	99	103	106				
140	74	78	82	85	89	93	96	100	104	108	111			
145	75	79	83	86	90	94	98	101	105	109	112			
150	76	80	84	87	91	95	99	102	106	110	113	117		
155	77	81	85	89	92	96	100	103	107	111	114	118	122	
160	79	82	86	90	93	97	101	104	108	112	115	119	123	127

\* Charging the unit in this area is not recommended. The liquid temperature is the same as the ambient temperature and overcharging cannot be detected. If charging must be performed then charge to 2 to 3 degrees above ambient temperature (under charge) and return when the charging can be accurately performed.

#### Example Liquid Line Temperature Target Table from Manufacturer

The procedure for charging these units is:

- Follow the manufacturer's directions and adhere to their limitations on indoor and outdoor temperatures appropriate to this procedure.
- Start the unit air conditioner and allow it to stabilize for 15 minutes.
- Measure the liquid line temperature, T<sub>liquid</sub>, and the low side pressure, P<sub>low</sub>.
- Determine the target liquid line temperature from the manufacturer's table.
- Determine the difference between the liquid line temperature and the target liquid line temperature (Actual Temperature – Target Temperature).
- In order to allow for inevitable differences in measurements, the Pass/Fail criteria are different for the Installer and the HERS Rater.
- For the Installer, if the difference is between minus 2°F and plus 2°F (inclusive), then the system passes the required refrigerant charge criterion.
- For the HERS Rater inspecting the system, if the difference is between minus 4°F and plus 4°F (inclusive), then the system passes the required refrigerant charge criterion.
- For the Installer, if the difference is greater than plus 2°F, then the system does not pass the required refrigerant charge criterion; the Installer shall add refrigerant. Adjust refrigerant charge and check the measurements as many times as necessary to pass the test. After the final adjustment has been made, allow the system to run 15 minutes before completing the final measurement procedure.
- For the Installer, if the difference is between minus 2.1°F and minus 100°F, then the system does not pass the required refrigerant charge criterion and the Installer shall remove refrigerant. Adjust refrigerant charge

and check the measurements as many times as necessary to pass the test. After the final adjustment has been made, allow the system to run 15 minutes before completing the final measurement procedure.

- Calculate Actual Superheat as the suction line temperature minus the evaporator saturation temperature. Actual Superheat =  $T_{\text{suction}} - T_{\text{evaporator, sat}}$ .
- If possible, determine the Superheat Range specified by the manufacturer.
- In order to allow for inevitable differences in measurements, the Pass/Fail criteria are different for the Installer and the HERS Rater.
- For the Installer, 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.
- For the HERS Rater inspecting the system, if the superheat is between 3°F and 26°F (inclusive), then the system passes the metering device criterion.

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## **RA1.2 Winter Setup for the Standard Charge Measurement Procedure**

### 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 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 must 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 55°F or higher. When outdoor temperatures are below 55°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 when outdoor temperatures are below 55°F.

The Winter Charge Setup creates the right conditions at the unit being tested for outdoor temperatures between 37°F and 55°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 temperature operating conditions.

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 a pressure differential of 160 to 220 psi for R-410A refrigerant and 100 to 145 psi for R-22 refrigerant between the low side pressure and the high side pressure, which is needed 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, with the exception that the minimum airflow requirements in RA3.2.2.7, must be met by use of the direct measurement methods specified in RA3.3; the temperature split method may not be used.

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. An example of such a device is shown below.



Example of a Condenser Outlet Air Restrictor Device

RA1.2.2 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  $\leq$  (P<sub>high</sub> – P<sub>low</sub>)  $\leq$  220 psi for R-410A refrigerant;

100 psi  $\leq$  (P<sub>high</sub> – P<sub>low</sub>)  $\leq$  145 psi for R-22 refrigerant

Allow the unit to stabilize for 15 minutes, make sure the pressure is still

160 psi  $\leq$  (P<sub>high</sub> – P<sub>low</sub>)  $\leq$  220 psi for R-410A refrigerant

100 psi  $\leq$  (P<sub>high</sub> – P<sub>low</sub>)  $\leq$  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 all 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: Similar to the Standard Charge Measurement Procedure for warm weather, the Winter Charge Setup requires verification of minimum cooling coil airflow of 300 CFM per nominal ton; however, use of one of the direct airflow measurement methods in Section RA3.3 must be used. The temperature split method in RA3.2.2.7 may not be used with the Winter Charge Setup.

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 above 70F during the test, as specified in RA3.2.2. Suggestions for methods to accomplish keeping the return air above 70F 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](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.

Attachment AReference Residential Appendix RA 3.2.2.6.2. Variable Metering Device Calculations

Calculate Actual Subcooling as the condenser saturation temperature minus the liquid line temperature. Actual Subcooling =  $T_{\text{condenser, sat}} - T_{\text{liquid}}$ .

Determine the Target Subcooling specified by the manufacturer.

Calculate the difference between actual subcooling and target subcooling (Actual Subcooling - Target Subcooling)

In order to allow for inevitable differences in measurements, the Pass/Fail criteria are different for the Installer and the HERS Rater.

For the Installer, if the difference is between minus 3°F and plus 3°F, then the system passes the required refrigerant charge criterion.

For the HERS Rater inspecting the system, if the difference is between minus 4°F and plus 4°F, then the system passes the required refrigerant charge criterion

For the Installer, if the difference is greater than plus 3°F, then the system does not pass the required refrigerant charge criterion and the Installer shall remove refrigerant. Adjust refrigerant charge and check the measurements as many times as necessary to pass the test. After the final adjustment has been made, allow the system to run 15 minutes before completing the final measurement procedure.

For the Installer, if the difference is between minus 3°F and minus 100°F, then the system does not pass the required refrigerant charge criterion, the Installer shall add refrigerant. Adjust refrigerant charge and check the measurements as many times as necessary to pass the test. After the final adjustment has been made, allow the system to run 15 minutes before completing the final measurement procedure.

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

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

In order to allow for inevitable differences in measurements, the Pass/Fail criteria are different for the Installer and the HERS Rater.

For the Installer, 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, then the system passes the metering device criterion.

For the HERS Rater inspecting the system, if the superheat is between 3°F and 26°F, then the system passes the metering device criterion.