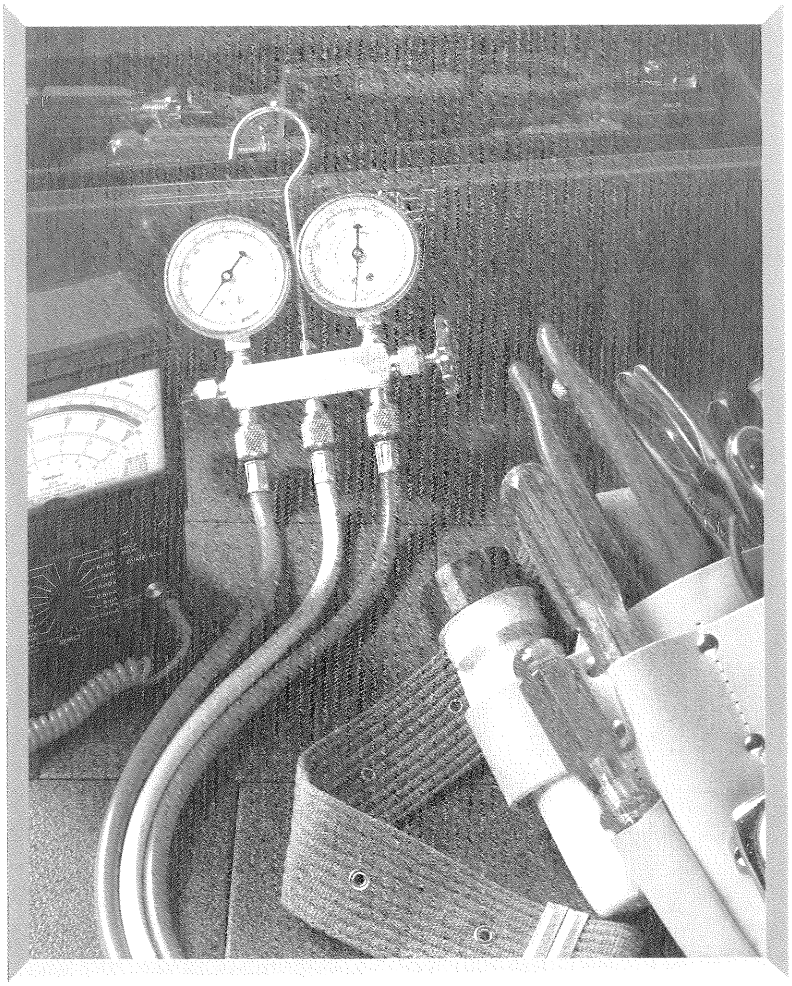
TECH



CHARGING PROCEDURES

FOR RESIDENTIAL CONDENSING UNITS

CHARGING PROCEDURES
FOR
RESIDENTIAL CONDENSING UNITS

This training program (Catalog No. 020-123) describes two methods for charging residential condensing units. The program consists of (1) 20-minute VHS video, (41) 35mm slides and this companion book.

Table of Contents

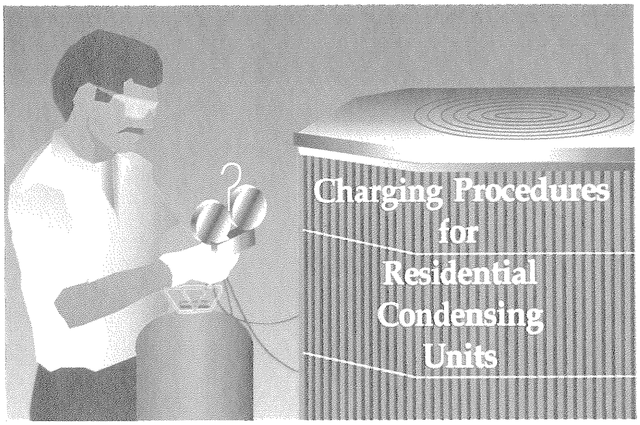
Objectives-
Upon completion of this program, technicians will know how to charge residential condensing units.

Presentation Instructions-
1. Obtain necessary audio-visual equipment, training aids, handout material and a program companion book for each participant.
2. View the video in its entirety.
3. Use the slides to highlight topics of importance.
4. Distribute and review handout materials.
5. Administer quiz, then review using slide/page references noted in the Quiz Key.
6. Distributors may purchase Certificates of Achievement through Literature Distribution.

Handout Materials/Additional Training Materials - (Available through Literature Distribution)
1. Cooling Unit Installation Instructions
2. Cooling Unit Service Manual
3. Charging Calculator - Catalog No. 020-434

Self-Instruction -
When using this program for self-instruction, first view the video. Then read the workbook in its entirety and complete the quiz. Quiz answers with paragraph references are located in the Quiz Key on page 20.

INTRODUCTION



1. Today, more than ever, service technicians must be able to accurately check, and if necessary, add or remove charge from residential cooling systems. Refrigerants are becoming scarcer and more expensive. At the same time, new environmental laws are changing the way technicians perform their daily tasks.

PROGRAM OUTLINE

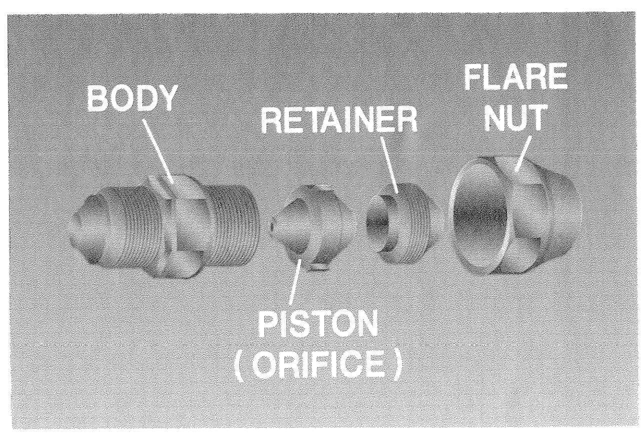
2. In this program we will show two methods for charging residential cooling equipment using a convenient calculator. We will also show how the calculator can be used to check system airflow. These methods can also be used to charge heat pumps operating in the cooling mode only.

SAFETY REVIEW

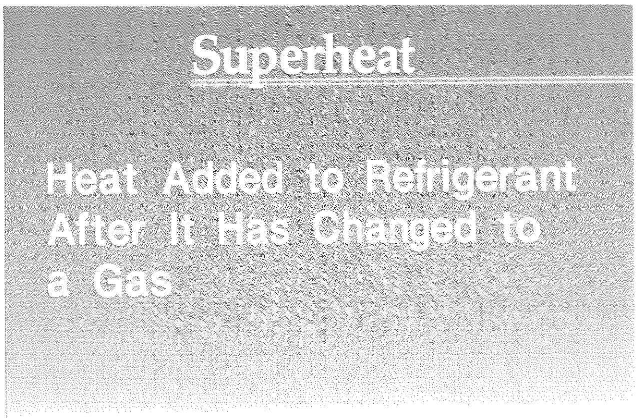
3. Before we get started, let's review some important safety information.

- Only qualified technicians should install or service air conditioning equipment.
- Always wear safety glasses and gloves when handling refrigerant or when brazing.
- **Never** vent refrigerant to the atmosphere. Remove refrigerant with a recovery device such as TOTALCLAIM® or TOTALSAVE®.
- Whenever possible, shut off all power before working on electrical equipment.
- If you must work on energized electrical equipment, remove your watch, rings and other jewelry to prevent shocks.
- Before installing or servicing any air conditioning system, take the time to read the manufacturer's installation or service literature.

SUPERHEAT CHARGING METHOD

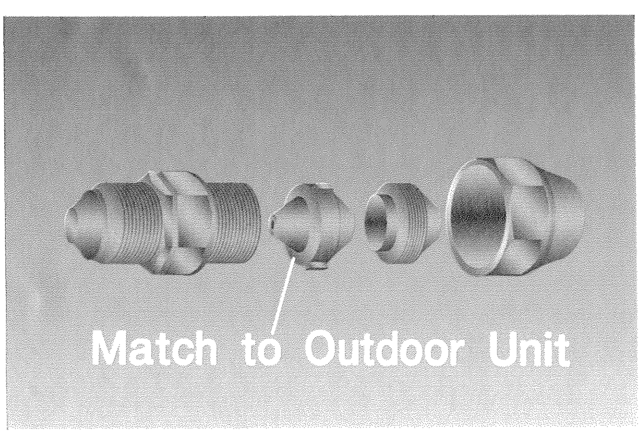


4. The first procedure we will cover is the superheat charging method. The superheat method is used for charging non-TXV systems. That is, systems equipped with fixed-orifice metering devices. These include capillary tubes and piston-type metering devices.



5. So what is superheat and why is it so critical when charging? Simply put, superheat is the heat added to refrigerant after it has changed to a gas. It raises the temperature of the gas but does not change it's state.

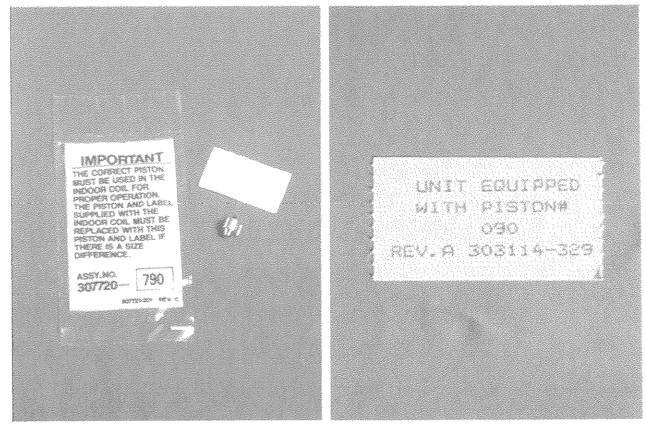
By knowing the amount of superheat in the return gas within the vapor line for a given condition, it can be determined if the system is properly charged and operating at the correct capacity and efficiency. If liquid refrigerant returns to the compressor (a condition called flooding) it can cause damage and possible failure. That is why only superheated **gas** should return to the compressor.



6. With the superheat method, it is important that the metering orifice be sized correctly. On capillary-equipped evaporators, what you see is what you get since capillary tubes cannot be easily changed.

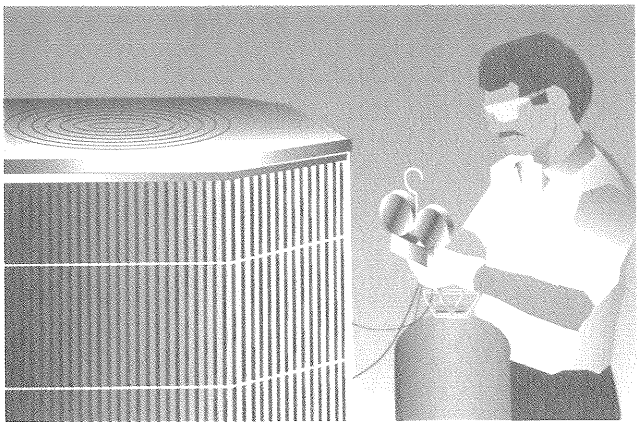
However, the indoor coil should be an approved match with the condensing unit.

Piston-type metering devices are a different story. They must be correctly matched to the outdoor unit for the system to operate properly.

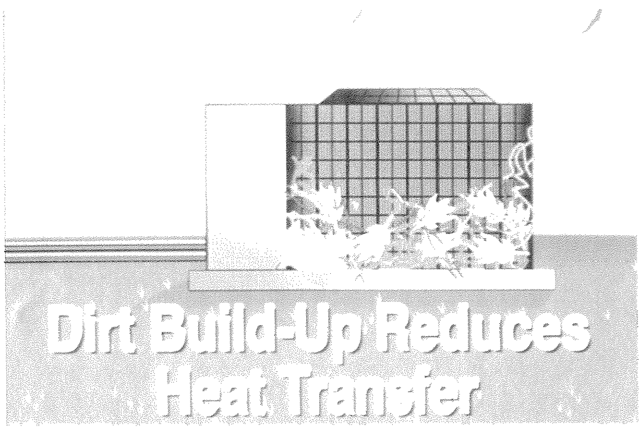


7. On new installations, the correct indoor coil metering piston will **always** be shipped with the outdoor unit.

If the indoor coil has a different sized piston than the one that comes with the outdoor unit, the installer **must** remove the piston from the indoor coil and replace it with the correct one. When done, attach the label that comes with the correct piston, to the indoor coil.

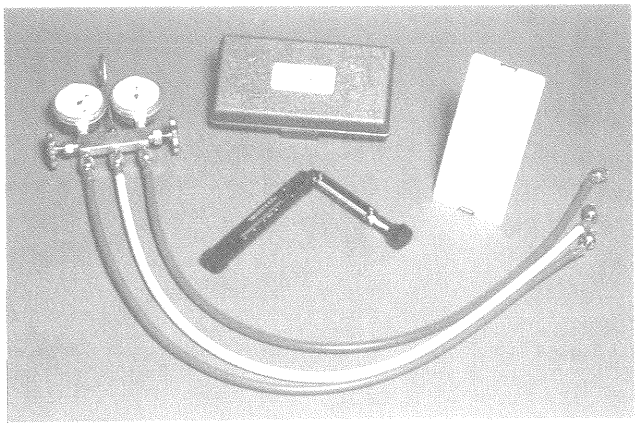


8. With the correct piston installed, the charge can be checked. Assuming the indoor and outdoor units are approved matches and the interconnecting refrigerant line-set does not exceed 15 feet, no adjustments to the factory charge will be needed. However, it is a good idea to **always** check system charge as part of the initial start-up and checkout of any new installation.

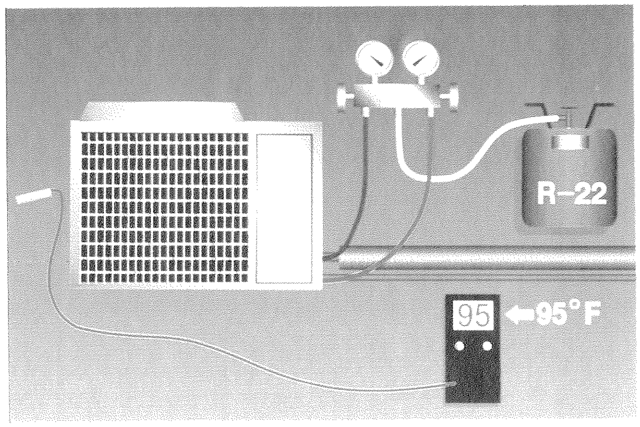


9. Charge adjustments may be required if the interconnecting refrigerant line set exceeds 15 feet or if a filter-drier is installed in the liquid line.

This program also assumes there are no system defects present such as refrigerant leaks, a dirty condensing coil or inadequate airflow across the evaporator. Any system defects should be corrected before performing the following procedures.

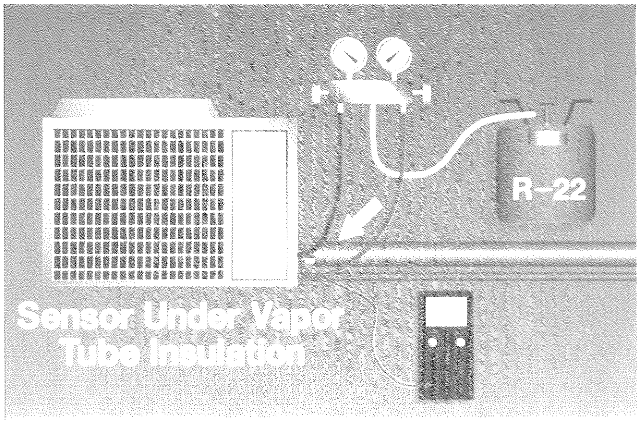


10. The tools needed to check or adjust the charge are ones that every good service technician should have. They include a gauge manifold set to monitor system pressures, an accurate digital thermometer to check system temperatures, a sling psychrometer to measure wet-bulb temperature, and a charging calculator. The calculator is for use with systems containing R-22 refrigerant only.



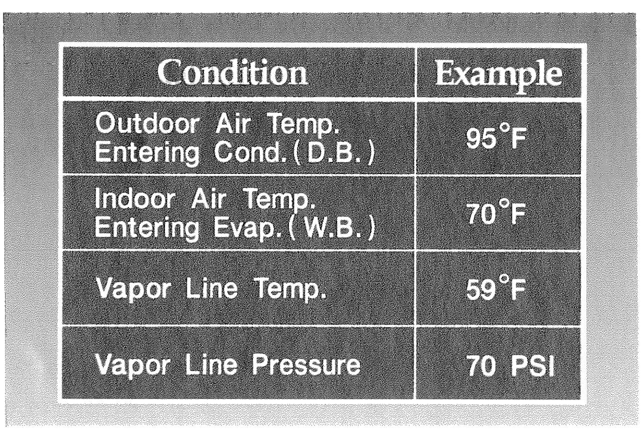
11. With the system off, connect the gauge manifold to the unit's service valves.

Using the digital thermometer, measure and record the temperature of the air entering the condenser coil. In this example it is 95°F.



12. When done, attach the thermometer's sensor to the vapor line near the vapor line service valve. Insulate it for an accurate reading.

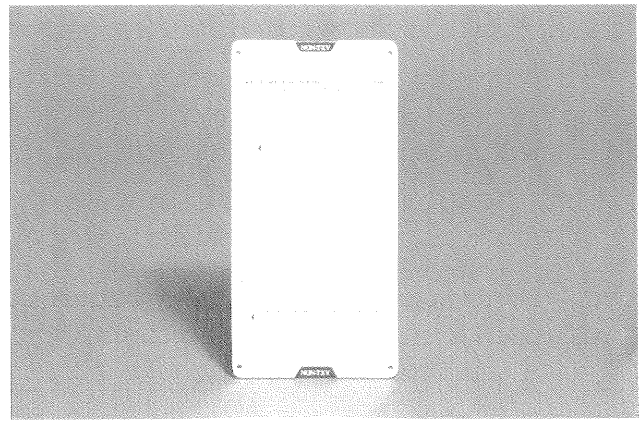
Then turn the system on and let it run at least 15 minutes so that temperatures and pressures can stabilize. The gauges and thermometer should remain attached to the system until the final charge is determined.



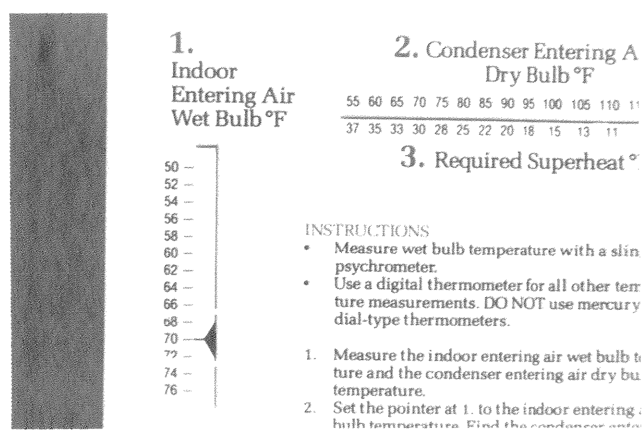
Condition	Example
Outdoor Air Temp. Entering Cond. (D.B.)	95°F
Indoor Air Temp. Entering Evap. (W.B.)	70°F
Vapor Line Temp.	59°F
Vapor Line Pressure	70 PSI

13. During the 15-minute interval, the indoor entering-air wet-bulb temperature can be checked. Wet-bulb temperature is a better indication of the load on the evaporator coil than a simple dry-bulb reading because it takes into account the latent heat load as well as the sensible load. In this example, a 70°F wet-bulb temperature is measured.

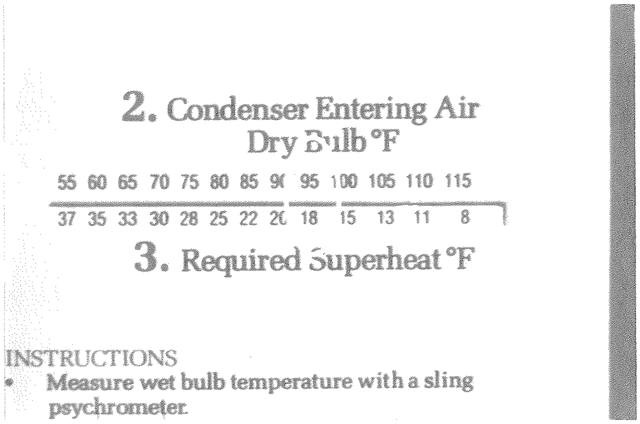
Back outside, with temperatures and pressures stabilized, the vapor line pressure is 70 PSI while the vapor line temperature is 59°F.



14. Using the charging calculator, find the side used for calculating superheat. Complete instructions are printed on the calculator.

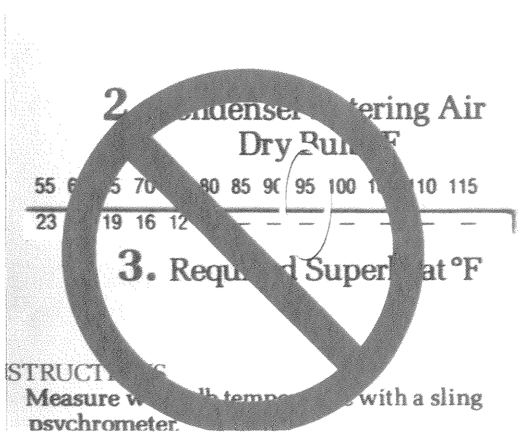


15. Step one requires that the pointer be set at the indoor entering-air wet-bulb temperature. In this example it is 70°F.

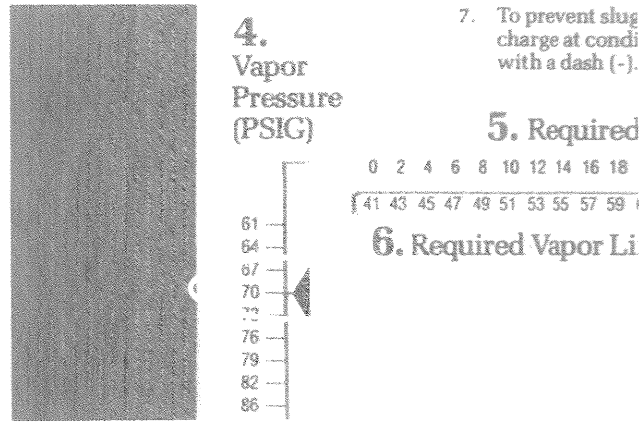


16. Step two requires us to find the condenser entering-air dry bulb temperature, 95°F in this example.

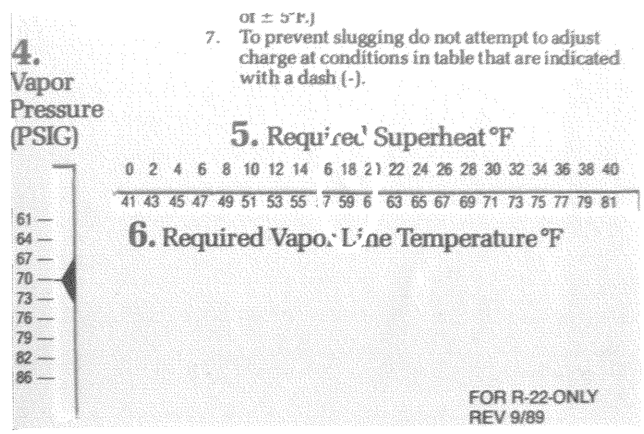
In step three, the required superheat of 18°F is read directly below the 95°F dry-bulb temperature. Record this required superheat temperature because it will be needed in a few moments.



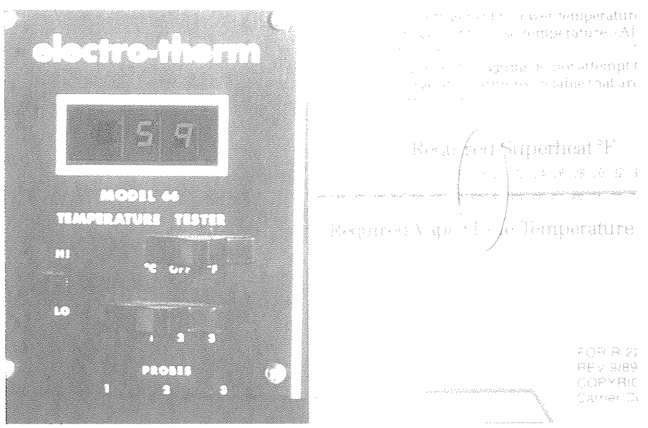
17. If a dash mark appears for a required superheat, the unit **cannot** be charged at these conditions because liquid refrigerant will flood back to the compressor causing damage or failure. Either wait until conditions change so that a required superheat value is obtained, or recover any refrigerant in the system and weigh in the correct charge.



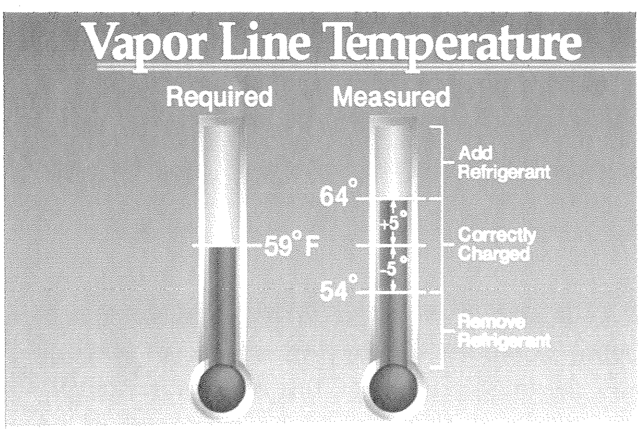
18. Step four requires that the lower pointer be set at the 70 PSI vapor tube pressure.



19. In step five the 18°F required superheat is found. Directly below this value (in step 6) is read the required vapor line temperature (59° in this example) that should be observed at these conditions.



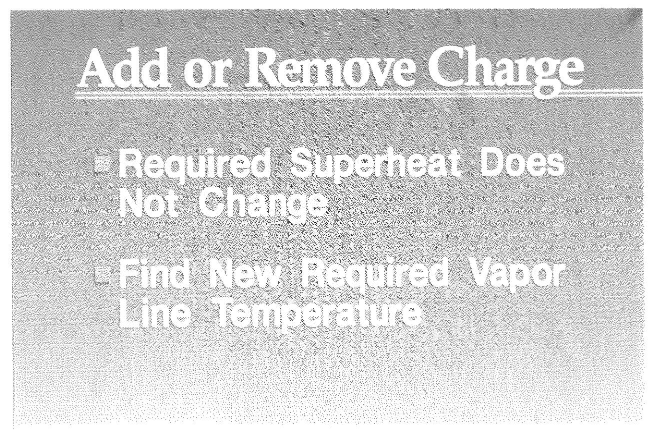
20. Earlier we measured a 59°F vapor line temperature. Since the measured vapor line temperature of 59° and the required vapor line temperature of 59° agree, we know the system is correctly charged. However, there will be times when the required and measured temperatures will not agree. Here is what to do in those cases.



21. First, a tolerance of ±5°F is allowed to compensate for minor inaccuracies in test instruments. That means, in our example, a vapor line temperature as high a 64°F or as low as 54°F would be acceptable.

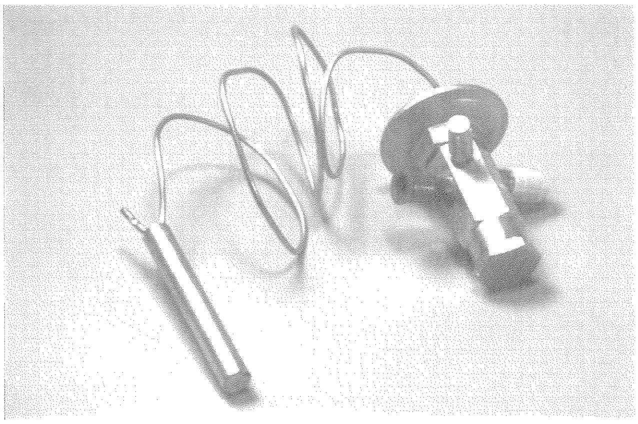
If the vapor line temperature is outside this ±5°F range, charge would have to be added or removed to bring the temperature within range. For example, if the temperature was above 64°F, refrigerant would have to be added while temperatures below 54°F would require removal of some charge.

Since it is no longer permissible to vent refrigerant to the atmosphere, any system overcharge would have to be removed from the system with a recovery device.



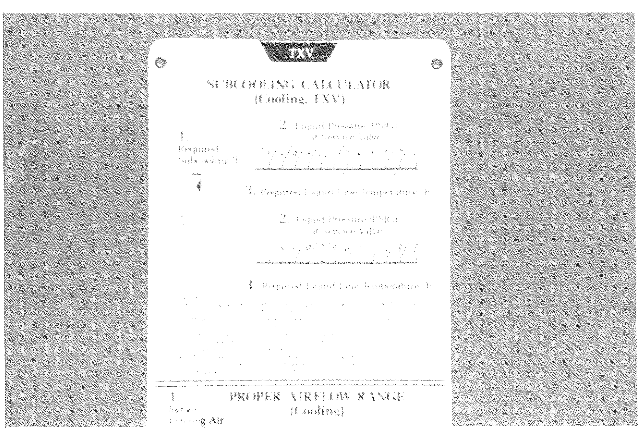
22. Keep this point in mind when adding or removing charge. The temperatures and pressures in the system will change but the **required superheat** value will not change. Because of this, the new values will have to be entered into the calculator to find the new required vapor line temperature.

SUBCOOLING CHARGING METHOD

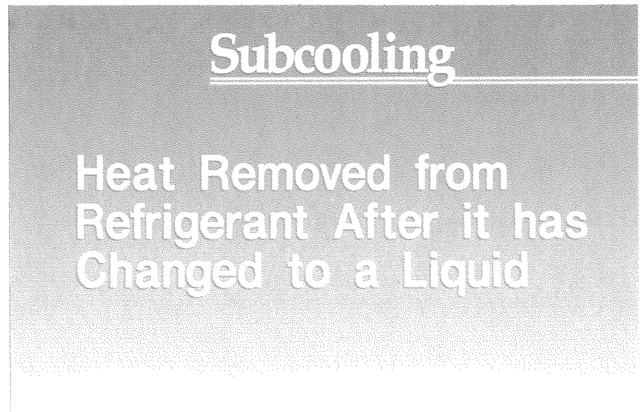


23. That takes care of charging non-TXV systems. But how is a system equipped with a thermostatic expansion valve (commonly called a TXV) charged? A different procedure, known as the subcooling charging method is used.

A TXV controls the flow of refrigerant by a throttling action as the load conditions on the indoor coil vary. In doing this it maintains a constant superheat.

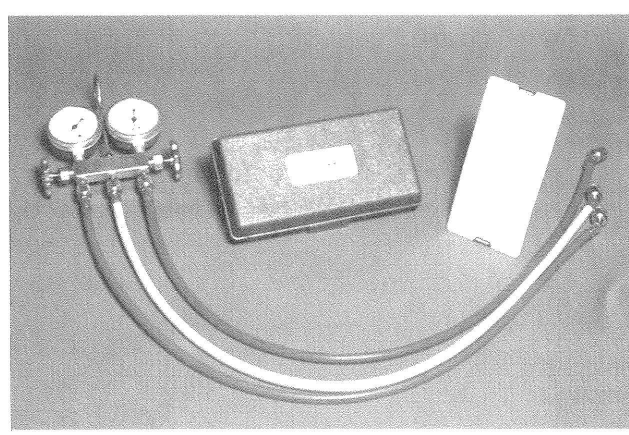


24. Because superheat remains constant over a wide range of operating conditions, we cannot use the superheat calculator to determine if a system is charged correctly. Instead, we use the subcooling calculator on the other side of the calculator.

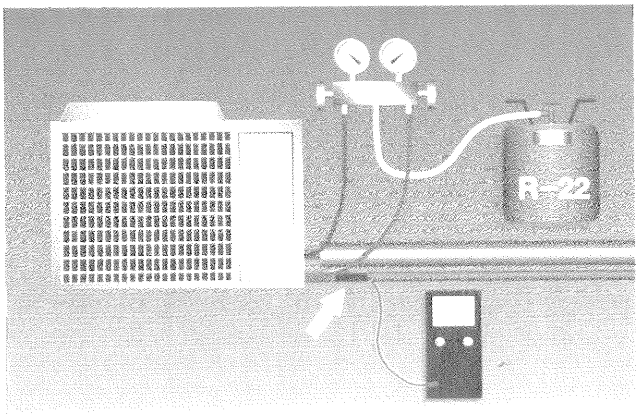


25. Subcooling is the heat removed from refrigerant after it has changed to a liquid. Subcooling lowers the temperature of the liquid but does not change it's state. Modern condensing units are designed to obtain their capacities and efficiencies at a given subcooling value. Any variance from the design subcooling value will cause capacity and efficiency to suffer.

In the past, technicians checked for the presence of liquid refrigerant in a sightglass when charging TXV-equipped systems. This technique is no longer valid because while it tells us that liquid is present, it cannot tell us the liquid's degree of subcooling.

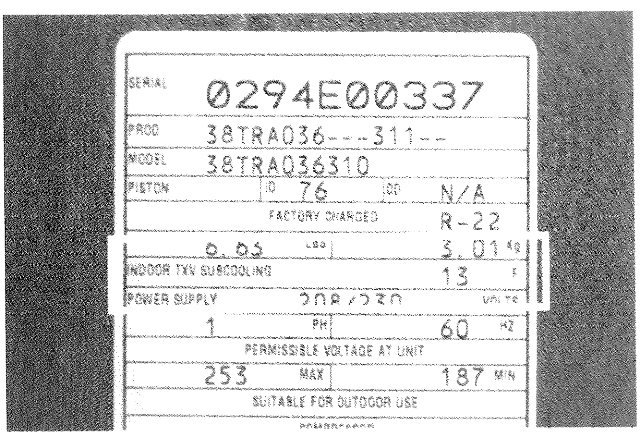


26. The tools necessary to measure and calculate subcooling are the same as used to measure and calculate superheat with one difference, the sling psychrometer is not needed.

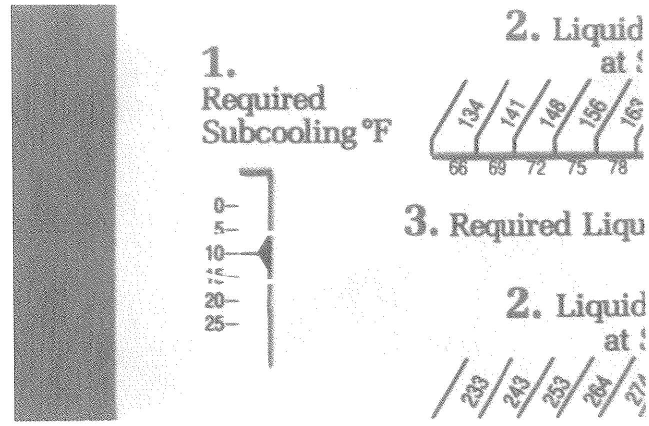


27. With the system off, connect the gauge manifold to the unit's service valves. Then attach the thermometer's sensor to the liquid line near the liquid-line service valve. Insulate it for an accurate reading.

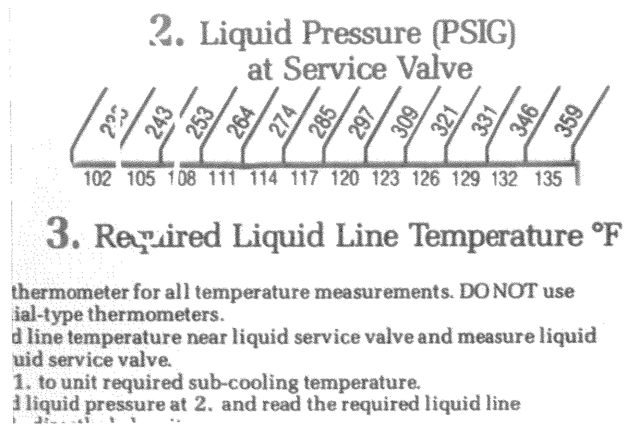
Then turn the system on and let it run at least 15 minutes so that temperatures and pressures can stabilize.



28. For this method to work, the required subcooling value for the unit must be known. This information can be found in the unit's service manual or on the unit's information plate on newer units.

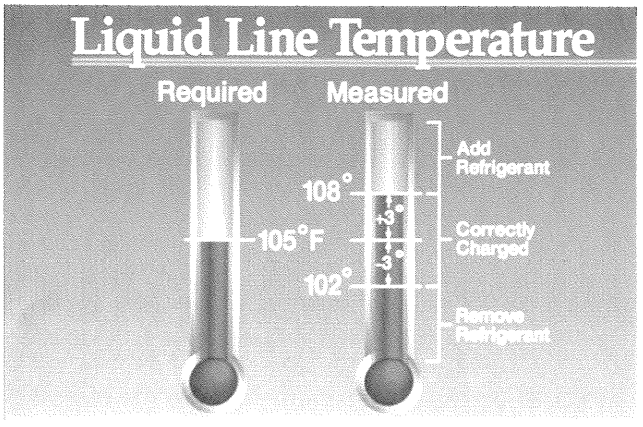


29. Step one requires that the pointer on the left of the subcooling calculator be set at the unit's required subcooling value. For this example we will assume a 10°F subcooling value.



30. Checking the gauge manifold reveals a liquid line pressure of 243 PSI. Step two requires us to find this 243 PSI liquid line pressure on the calculator. In step three, read the required liquid line temperature directly below the liquid line pressure. In this example it is 105°F.

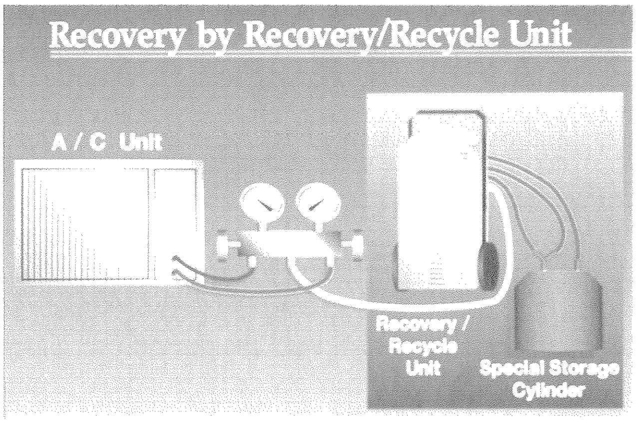
31. Checking the thermometer on the unit's liquid line reveals an actual temperature of 105° F. With the required liquid line temperature and actual liquid line temperature the same, we know the system is correctly charged. As with the superheat method, there will be times when the required and measured temperatures do not agree. Here is what to do in those cases.



32. First, a tolerance of ±3°F is allowed to compensate for inaccuracies in test instruments. That means, in our example, a liquid line temperature as high as 108°F or as low as 102°F would be acceptable.

If the liquid line temperature is outside this ±3°F range, charge would have to be added or removed to bring the temperature within range.

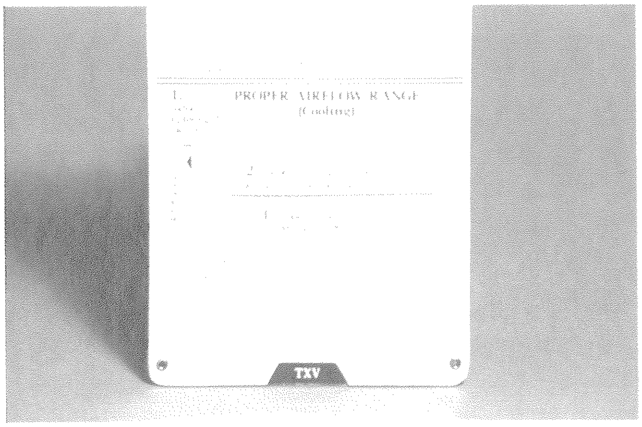
For example, if the temperature was above 108°F, refrigerant would have to be added while temperatures below 102°F would require removal of some charge.



33. Remember, if charge has to be removed, take it out with a recovery machine. **Never** vent refrigerant to the atmosphere.

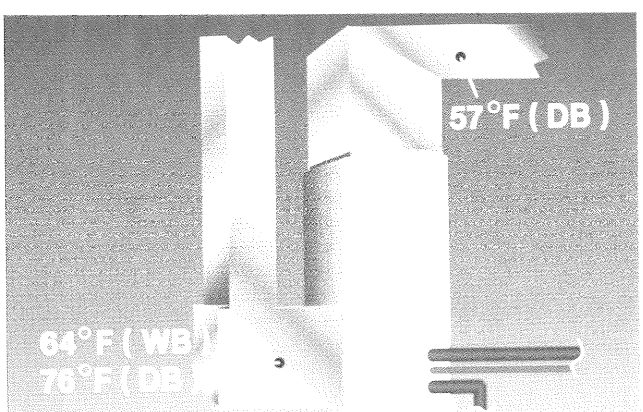
As with the superheat method, adding or removing charge will change system temperatures and pressures. Because of this, enter the new values into the calculator to find the new required liquid line temperature.

PROPER AIRFLOW RANGE



34. The charging procedures just shown are based on the assumption that 400 to 450 cubic feet per-minute of air per-ton of capacity is flowing across the evaporator coil.

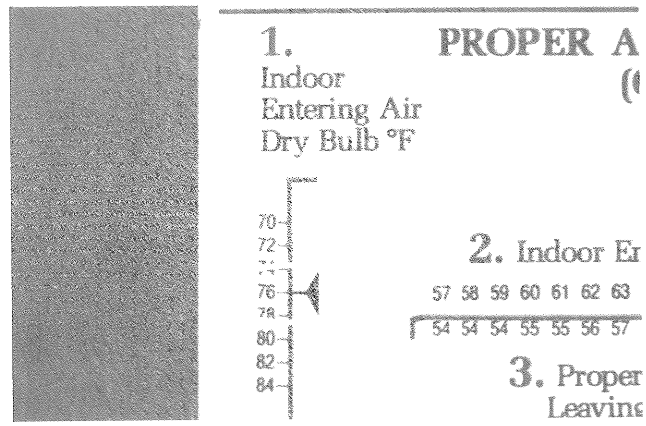
The calculator is designed to provide a quick check to see if air flow is within these limits through the use of the required airflow range calculator located directly below the subcooling calculator.



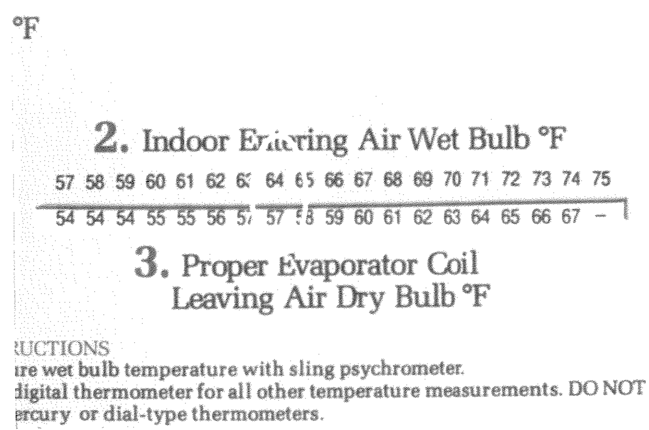
35. All that is required to check air flow is a measurement of the wet and dry-bulb temperatures of the air-entering the evaporator and the dry-bulb temperature of the air leaving the evaporator.

Before performing this procedure, make sure the air filter is clean and all supply and return registers are open and unrestricted.

For this example we will assume an evaporator entering-air wet-bulb temperature of 64°F and an entering-air dry-bulb temperature of 76°F. A 57°F dry-bulb temperature is measured in the air leaving the evaporator.

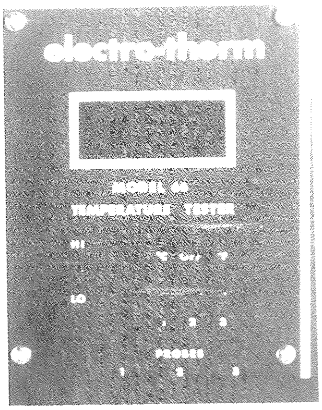


36. Step one requires that the arrow on the calculator be set opposite the evaporator entering-air dry-bulb temperature of 76°F.

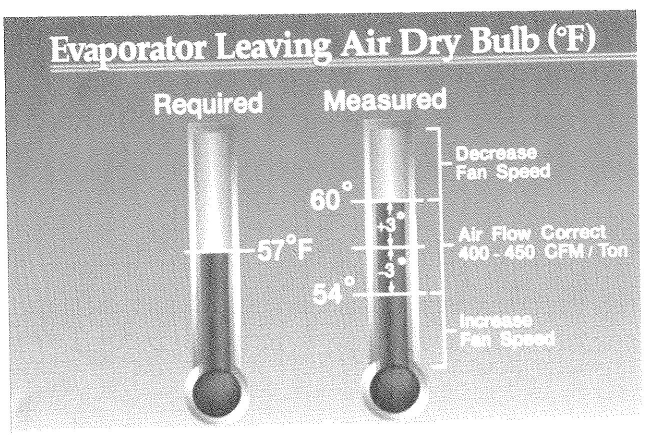


37. Step two requires that the evaporator entering-air wet-bulb temperature of 64°F be found.

The third and final step is to read the proper evaporator leaving-air dry-bulb temperature of 57°F directly below.



38. Earlier we measured a 57°F leaving-air dry-bulb temperature. Since this measured temperature agrees with the required temperature we know the airflow is within the 400 to 450 cubic feet per-minute per-ton range. Here is what to do if the measured and required temperatures do not agree.



39. A ±3°F tolerance is allowed for test instrument inaccuracies. That means in this example, that an evaporator leaving-air dry-bulb temperature as high as 60°F and as low as 54°F would be acceptable.

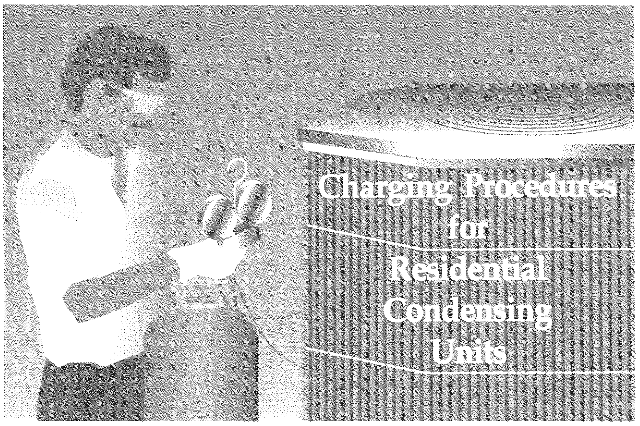
If the air temperature is outside this ±3°F range, fan speed changes would be needed. For example, if the temperature was above 60°F, fan speed would have to be decreased. If the temperature was below 54°F, fan speed would have to be increased.

The preceding procedure assumes the unit is charged correctly. After any fan speed adjustments are made, check the system charge again using either the superheat or subcooling method. Adjust the charge if required.

REVIEW & CONCLUSION

40. Now, let's review what we have just learned about charging residential condensing units.

- Observe all safety precautions when working on air conditioning systems.
- The superheat method is used to charge non-TXV evaporators. These include capillary tube coils and coils that contain metering pistons.
- The superheat calculator is designed for accurate system charging with this method.
- The subcooling method is used to charge systems equipped with TXVs.
- The subcooling calculator is designed for accurate system charging with this method.
- System airflow can be checked using the proper airflow range calculator.



41. That completes the program on charging procedures for residential condensing units. With this information, you will be able to accurately charge all residential condensing units so they will deliver peak performance and efficiency.

NOTES

QUIZ

1. Name two types of fixed-orifice metering devices. ________________ ________________

2. True or False? Only superheated gas should return to an operating compressor.

3. A sling psychrometer is used to measure ________________ ________________ ________________.

4. A dash mark (-) appears on the charging calculator for a required superheat value. It indicates:

    a. the unit can be charged.
    b. the unit cannot be charged.
    c. more information is needed.
    d. charge is low in the system.

5. A required vapor line temperature of 62°F is needed for a correct charge. An actual vapor line temperature of 55°F is measured. What step must the service technician take?

    a. remove refrigerant
    b. add refrigerant
    c. nothing, charge is correct
    d. add 6 oz. of R-22

6. True or False? Units equipped with TXV metering devices can be charged using the superheat method.

7. Name two locations where the required subcooling value for a condensing unit can be found. ____ ____

8. An actual liquid line temperature of 110°F is measured. The required liquid line temperature is 108°F. What step must the service technician take?

    a. add refrigerant
    b. remove refrigerant
    c. nothing, charge is correct
    d. remove 6 oz. of R-22

9. True or False? For correct system operation, airflow across the evaporator coil should be in the 400-450 cubic feet per minute per ton of capacity range.

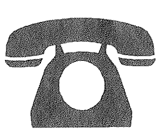
10. A leaving-air dry-bulb temperature of 55°F is measured. The required leaving-air dry-bulb temperature is 60°F. What step must the service technician take?

    a. nothing, the unit is correctly charged
    b. add refrigerant
    c. decrease fan speed
    d. increase fan speed

APPENDIX

For additional information on related subjects or to prepare supplementary training sessions, use this list.

Title	Format	Form No.	Catalog No.
Charging, Recovery, Recycling and Reclamation	Video/Slides/Book	GTAC2-5	022-108
	Book	GTAC2-105	020-109
Air Measurement	Video/Slides/Book	SK19-02	020-068
	Book	SK19-01	020-067
Evacuation and Charging	Video/Slides/Book	SK18-02	020-066
	Book	SK18-01	020-065
Troubleshooting Residential Cooling Systems	Video/Slides/Book	SK22-02	020-108
	Book	SK22-01	020-107



Important - We have dozens of other product, theory and skills training programs to select from. For a free Service Training Materials (STM) Catalog, call 1 (800) 962-9212.

REQUIRED SUPERHEAT CALCULATOR
(Cooling, NON-TXV)

1. Indoor Entering Air Wet Bulb °F

50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76

2. Condenser Entering Air Dry Bulb °F

55	60	65	70	75	80	85	90	95	100	105	110	115
23	21	19	16	12	8	–	–	–	–	–	–	–

3. Required Superheat °F

INSTRUCTIONS

- Measure wet bulb temperature with a sling psychrometer.
- Use a digital thermometer for all other temperature measurements. DO NOT use mercury or dial-type thermometers.

1. Measure the indoor entering air wet bulb temperature and the condenser entering air dry bulb temperature.
2. Set the pointer at 1. to the indoor entering air wet bulb temperature. Find the condenser entering air dry bulb temperature at 2. and read and record the required superheat 3. directly below it.
3. Measure the vapor line temperature near the vapor service valve and measure vapor pressure at vapor service valve.
4. Set pointer at 4. to measured vapor pressure.
5. Find required superheat at 5. and read the required vapor line temperature 6. directly below it.
6. If the measured vapor line temperature does not agree with the required vapor line temperature, *add* refrigerant to *lower* temperature or *remove* refrigerant to *raise* temperature. (Allow tolerance of ± 5°F.)
7. To prevent slugging do not attempt to adjust charge at conditions in table that are indicated with a dash (-).

4. Vapor Pressure (PSIG)

61, 64, 67, 70, 73, 76, 79, 82, 86

5. Required Superheat °F

0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	75	77	79	81	83	85

6. Required Vapor Line Temperature °F

GT24-01
020-434

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REV 9/89

NON-TXV

SUBCOOLING CALCULATOR (Cooling, TXV)

1. Required Subcooling °F

0 – 5 – 10 – 15 – 20 – 25

2. Liquid Pressure (PSIG) at Service Valve

3. Required Liquid Line Temperature °F

2. Liquid Pressure (PSIG)	134	141	148	156	163	171	179	187	196	205	214	223
3. Required Liquid Line Temperature °F	51	54	57	60	63	66	69	72	75	78	81	84

2. Liquid Pressure (PSIG)	233	243	253	264	274	285	297	309	321	331	346	359
3. Required Liquid Line Temperature °F	87	90	93	96	99	102	105	108	111	114	117	120

INSTRUCTIONS

- Use a digital thermometer for all temperature measurements. DO NOT use mercury or dial-type thermometers.

1. Measure liquid line temperature near liquid service valve and measure liquid pressure at liquid service valve.
2. Set pointer at **1.** to unit required sub-cooling temperature.
3. Find measured liquid pressure at **2.** and read the required liquid line temperature **3.** directly below it.
4. If the measured liquid line temperature does not agree with the required liquid line temperature, *add* refrigerant to *lower* temperature or *remove* refrigerant to *raise* temperature. (Allow tolerance of ± 3°F.)

PROPER AIRFLOW RANGE (Cooling)

1. Indoor Entering Air Dry Bulb °F

70 – 72 – 74 – 76 – 78 – 80 – 82 – 84

2. Indoor Entering Air Wet Bulb °F

3. Proper Evaporator Coil Leaving Air Dry Bulb °F

2. Wet Bulb °F	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
3. Leaving Air Dry Bulb °F	56	56	56	56	57	58	58	59	60	61	62	63	64	65	66	67	68	69	69

INSTRUCTIONS

- Measure wet bulb temperature with sling psychrometer.
- Use a digital thermometer for all other temperature measurements. DO NOT use mercury or dial-type thermometers.

1. Measure the wet bulb and dry bulb temperature for indoor entering air and dry bulb temperature for evaporator coil leaving air.
2. Set the pointer at **1.** to measured indoor entering air dry bulb temperature.
3. Find the measured indoor entering air wet bulb temperature at **2.** and read the proper evaporator coil leaving air dry bulb temperature at **3.** directly below it.
4. If the measured leaving air dry bulb temperature is 3°F or more *lower* than the proper leaving air temperature, *increase* evaporator fan speed. If the measured leaving air dry bulb temperature is 3°F or more *higher* than the proper leaving air temperature, *decrease* evaporator fan speed.

TXV

NOTES

NOTES

QUIZ KEY

Answer	Paragraph No.	Page No.
1. capillary tubes, piston-type	4	1
2. True	5	2
3. wet-bulb temperature	10	3
4. b	17	5
5. a	20 & 21	6
6. False	23	7
7. service manual, information plate	28	8
8. c	32	9
9. True	34	9
10. d	38 & 39	11

RESIDENTIAL SPLIT SYSTEM COOLING INSTALLATION & START-UP CHECKLIST

LOAD CALCULATION AND EQUIPMENT SELECTION

- ☐ Heat gain ____________ BTU/H @ _____ °F design temp.
- ☐ Condensing unit selected Model#__________________
- ☐ Evaporator coil selected Model #__________________
- ☐ Refrigerant lines sized per installation instructions liquid _________ suction _________ length _________
- ☐ HACR circuit breaker size _________ amps
- ☐ Branch circuit wire size _____________ AWG

OUTDOOR UNIT INSTALLATION

- ☐ Unit secured to pad with correct clearance for airflow and service
- ☐ Raintight disconnect installed within sight of unit
- ☐ Wiring done in accordance to wiring diagram and all applicable codes
- ☐ Refrigerant lines properly trapped, insulated, secured and connected to service valves
- ☐ Shipping brackets/compressor bolts removed and/or loosened per instructions
- ☐ Optional and field-supplied accessories such as filter drier properly installed

INDOOR UNIT INSTALLATION

- ☐ "A" coil installed in furnace plenum for proper airflow and condensate drainage
- ☐ Fan coil securely mounted with provisions for vibration isolation
- ☐ Secondary drain pan installed under above-ceiling fan coils
- ☐ Correctly sized metering device installed (TXV or metering piston)
- ☐ Refrigerant lines properly connected
- ☐ Condensate drain installed with trap
- ☐ All accessories/options correctly installed
- ☐ Air filters clean and in place

AIR DISTRIBUTION SYSTEM

- ☐ Ductwork sized to handle 400-500 CFM/ton of capacity
- ☐ Branch runs at least 6" diameter with balancing damper installed
- ☐ Ductwork insulated and equipped with vapor barrier (if applicable)
- ☐ Flexible connectors provided in return and supply duct at furnace or air handler
- ☐ All supply and return air grilles open and unrestricted

OUTDOOR UNIT START-UP

- ☐ Refrigerant lines and indoor coil evacuated to at least 500 microns
- ☐ Service valves opened
- ☐ All field-made refrigerant line connections checked for leaks
- ☐ Crankcase heater (if used) energized 24 hrs prior to start-up
- ☐ Compressor and Outdoor Fan run on call for cooling
- ☐ Refrigerant charge correct. Use superheat method for fixed restrictor metering devices or subcooling method for TXV equipped cooling coils.
  _________°F measured superheat
  _________°F measured subcooling

INDOOR UNIT START-UP

- ☐ Condensate flows freely from drain
- ☐ No air leaks in system ductwork
- ☐ Air flows freely from all supply registers
- ☐ Airflow adequate (use airflow range calculator, Cat. # 020-434)

GENERAL

- ☐ All thermostat functions operate correctly (heat, cool, fan)
- ☐ All accessory items operating correctly
- ☐ Outdoor unit/air handler/refrigerant lines checked for vibration
- ☐ Balancing dampers adjusted for correct air flow to each branch run
- ☐ All work areas cleaned up
- ☐ System operation reviewed with customer and Owner's Manual presented

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