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ABSTRACT

This guide provides job relevant tasks, performance objectives, performance guides, resources, learning activitites, evaluation standards, and achievement testing in the occupation of environmental control system installer/servicer (residential air conditioning mechanic). It is designed to be used with any chosen teaching method. The course outline is divided into six duties: (1) brazing, cutting, fitting, soldering, and welding piping and tubing; (2) installing and servicing controls; (3) installing and servicing electrical circuits, components, and motors; (4) installing and servicing compressors, condensers, evaporators, and water towers; (5) installing and servicing refrigeration systems and domestic refrigerators; and (6) installing and servicing residential air conditioning and heating systems. A total of 154 performance objectives are categorized under these duties. The performance objective is defined in terms of task, conditions, standard, and source for standard. These components are provided for each performance objective: performance guide, enabling objectives(s), learning activities, resources, and evaluation (questions and answers). Appendixes include a cross-referenced table of duties, tasks, and performance objectives; tool and equipment list; sources of standards; state-of-the-art literature; a bibliography; and written evaluation questions and answers. (YLB)

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V-TECS GUIDE

FOR

ENVIRONMENTAL CONTROL SYSTEM INSTALLER/SERVICER
(Residential Air Conditioning Mechanic)

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Upon completion of the writing of the Environmental Control System Installer/Servicer V-TEC Guide, six educators were selected to field review the materials for validity and reliability. These educators are to be commended for their thoroughness in providing their expertise in modifying and approving this guide for classroom use. The field reviewers are: Charles Allen (McDuffie High School), Hariel Corley (Allendale Area Vocational Center), William Horne (Wilson Vocational Center), Ray Lawrence (Sumter County Career Center), James Rogers (Fairfield County Career Center), Loran C. Tucker (Daniel Morgan Vocational Center).

The State Office of Vocational Education staff members who assisted the committee were Joe Bunn (Consultant), Dr. Annie Winstead (Sex Equity Consultant), and Jim Lewallen (Word Processing Operator).

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INTRODUCTION

V-TECS guides are an extension or continuation of the V-TECS catalogs. While the V-TECS catalog is a composition of duties, tasks, performance objectives, and performance guides, it deals only with the psychomotor aspect of an occupation. It is a blueprint of an occupation. It deals only with the identification of the "hands on" aspect of the occupation. It does not take into consideration such things as the background information surrounding a task, how to make inferences, generalizations, and decisions from a body of knowledge, nor does it deal with attitudes, job seeking skills, safety, or energy conservation practices. V-TECS guides take these aspects of teaching and learning into consideration.

Experience has shown that the art of learning can also be taught while teaching subject matter. People need to learn how to learn. V-TECS guides take into consideration how students learn and are an efficient way for instructors to assist them to learn.

Psychomotor

Any manipulative skill such as tightening a nut, replacing a hubcap, sharpening a pencil, machining a key slot in a steel shaft, or replacing a SCR in a solid state control panel are examples of manipulative or psychomotor skills. Tasks such as these are identified in V-TECS catalogs. V-TECS catalogs also group tasks by duties and objectives. Each performance objective has a performance standard which must be met to prove student proficiency in the manipulative aspect of the task. The V-TECS catalog, however, does not include any suggestions as to how to learn to do these tasks.

V-TECS guides are developed around psychomotor tasks which are worker-oriented.

Cognitive

To perform psychomotor tasks, students must think. To tighten a nut they must know which way to turn it and when to stop turning it so that they won't strip the threads or shear the bolt off. If replacing a hubcap, there is a certain technique that may vary from one car to another. For example, start the hubcap by placing the cap in a tilted position and tapping it all the way around until it is properly seated. On a different model, it may be necessary to position the hubcap and snap it all at once. At any rate, students must think about what is being done. This is cognition or a mental activity. Cognition is what goes on in the mind about any job being done. V-TECS guides provide both the collateral knowledge and the impetus to apply cognition to psychomotor tasks.

Students gain cognition through both real and vicarious experiences. They may read, view tapes, memorize or practice a process or procedure until they are certain of it. To test their knowledge, students may be required to decide the proper procedure, method, or sequence for performance. This decision-making process or cognitive activity provides the basis for higher thinking skills.

Cognition, then, is that process by which information is stored and used. That voice that warns one of potential dangers is cognition. Anything that goes on in the mind is cognition. Students may become the best workers in their job; but if they fail to think a process through and apply their experience, they may become just one more statistic. It is cognition that tells them to lock and tag out the power supply to an electrical apparatus before starting to repair it. However, cognition does not apply only to safety. Good cognition or thinking can help employees do a job better and quicker. V-TECS guides provide for the cognitive aspects of learning.

Affective

Curriculum writers, supervisors, and instructors often fail to assist students in acquiring a positive attitude toward themselves, their jobs, their school, or their fellow students. V-TECS guides seek to provide assistance to the instructor in achieving this. It is difficult for the instructor to identify little bits and pieces of desirable behavior for every unit and often harder yet to teach them. In this area, students might be judged as to how well they clean up their work area, whether they show up to do the job on time, or whether they must be told several times to do something. Potential employers are interested in student attitude because persons angry at themselves or uncertain of themselves are often poor workers.

A student's ability to succeed on the first job and every job thereafter depends largely on attitude. If, for example, students have the attitude of "let someone else do it," they could be in trouble. Students using V-TECS guides will have activities dealing with how to get along with other students, supervisors, or staff members both in large and small groups.

USE OF V-TECS GUIDE

The guide is designed to provide job-relevant tasks, performance objectives, performance guides, resources, learning activities, evaluation standards, and achievement testing in selected occupations.

A V-TECS guide is designed to be used with any teaching methods you may choose. If a lecture/demonstration method is best for you, you will find sufficient help to meet your needs. If you prefer to use discussions or other methods that require student participation, you will find ample help. Regardless of which method is successful for you, a V-TECS guide can save preparation time and offer innovative methods and procedures. For example, students may work either alone or in teams while in class and learn skills in direct relation to what is actually done on the job. This work also takes into consideration student attitudes, thinking skills, and mathematical reading skills.

The use of small groups in teaching can be helpful in two ways: (1) many students may feel inadequate due to their lack of background information in mechanical things; and (2) some students may feel that they are physically incompetent or lack the necessary background experiences. A successful program (course) can provide students with a sense of security by reinforcing positive attitudes while improving skill and knowledge of the subject. By allowing students to interact on a personal level, this task/learner-centered approach can achieve this. As students gain confidence and discover that they are an essential part of a team engaged in the learning-teaching process, their confidence increases. Too, the student in this setting can learn to work without direct supervision. In addition, use of the small-group method permits the instructor to vary instructional routines away from lecture or other full-class methods to activities for single students, pairs of students, or any number so desired.

You will find suggestions for specific classroom activities. The activities are not meant to restrict you or your students, but only to suggest a variety of learning activities for each task statement. Please do not feel that you must take your students through all the activities. Furthermore, local restrictions may have impact on the teaching of certain lessons. Since V-Tecs is keyed to actual job skills, instructors are encouraged to select those lessons which relate only to the approved local curriculum needs and which can be taught under the approved local regulations.

BRAZING, CUTTING, FITTING, SOLDERING, AND
WELDING PIPING AND TUBING

DUTY: BRAZING, CUTTING, FITTING, SOLDERING, AND WELDING PIPING AND TUBING

PERFORMANCE OBJECTIVE V-TECS 01

TASK: Silver soldering tubing.

CONDITIONS: Basic tool kit, aluminum solder, aluminum solder flux, aluminum tubing, swaging tool, sand cloth, leak detector, 15% silver solder, 45% silver solder and flux, copper tubing, dry nitrogen or refrigerant, steel tubing.

STANDARD: The brazing must be clean, smooth, and leakproof.

SOURCE FOR STANDARD:

V-TECS. **A Catalog of Performance Objectives, Criterion-Referenced Measures and Performance Guides for Plumbing.**

State Department of Education, Alabama, **Air Conditioning and Refrigeration.**

PERFORMANCE GUIDE

1. Cut tubing to proper length.
2. Swage tube.
3. Clean inside and outside of tube.
4. Apply flux to joint.
5. Heat until flux turns to liquid.
6. Apply solder to joint.
7. Clean excess flux.
8. Leak test.

ENABLING OBJECTIVE(S)

Use measuring instruments to measure given lengths.
Use hand tools.

LEARNING ACTIVITIES

1. Instruct student to read text **Modern Refrigeration and Air Conditioning**, pp. 46-47.
2. Define methods of cutting and measuring tubing.
3. Demonstrate the process of making a swage joint.
4. Explain steps necessary in cleaning and applying flux to tubing to be soldered.
5. Demonstrate methods of flame adjustments and heat applied to tubing for soldering.
6. Show how to check solder joint for cleanness and test for leaks.
7. Explain the importance of torch safety.

RESOURCES

Althouse, et al. **Modern Refrigeration and Air Conditioning**, pp. 46-47.

EVALUATION

Questions

1. Does swaging affect the ID of a tubing?
   a. No change
   b. Larger
   c. Only the OD is larger
   d. Smaller
   e. Thickens the tubing wall.
2. If the tubing splits while it is being swaged the tubing is too ____________.
3. When three pieces of tubing are joined with a coupling and a swage joint, ____________ solder joints are made.
4. How far above the swaging block should the tubing extend?
   a. 1/4 inch
   b. 3/8 inch
   c. Length of swaging tool shoulder.
5. When we swage a 3/8 inch tubing a ______________ size tubing will fit inside it.

Answers

1. b
2. Hard
3. 3
4. c
5. 3/8 inch

DUTY: BRAZING, CUTTING, FITTING, SOLDERING, AND WELDING PIPING AND TUBING

PERFORMANCE OBJECTIVE V-TECS 02

TASK: Bend copper tubing.

CONDITIONS: Copper tubing, basic tool kit.

STANDARD: The tubing must not be crimped and there will be no strain on the fitting after it is installed.

SOURCE FOR STANDARD:
State Department of Education, Alabama, **Air Conditioning and Refrigeration.**

PERFORMANCE GUIDE
Bend tubing using bending spring.
1. Place spring over tubing.
2. Bend to desired angle.
3. Remove spring by twisting and pulling off.

Bend tubing using lever type bending tool.
1. Place tool around tubing.
2. Bend to desired angle being careful not to crimp tubing.

Annealing.
1. Heat tubing to a blue color.
2. Allow to cool to room temperature.

ENABLING OBJECTIVE(S)
Use measuring instruments to measure given lengths.
Use hand tools.

LEARNING ACTIVITIES
1. Decribe tools used for bending copper tubing.
2. Demonstrate how to install a spring bender on a given length of tubing, make a 90° bend.
3. Explain the diameter of the bend according to the tubing size.
4. Demonstrate bending a piece of tubing using a lever-type bender.
5. Explain the process of annealing copper tubing.

RESOURCES
Althouse, et al. **Modern Refrigeration and Air Conditioning.**

EVALUATION
Questions
1. What are the two types of tube benders that we use?
2. Why should the diameter of a bend be at least five times the diameter of the tube size?
3. A lever-type bender is a ________________ type bender.
4. How do we anneal copper tubing?
5. When do we use the annealing process on copper tubing?

PERFORMANCE OBJECTIVE V-TECS 02 (Continued)

Answers
1. Spring- and lever-type benders
2. So not to crimp the tubing.
3. Mechanical
4. By applying heat
5. When copper tubing has become hard and brittle.

DUTY: BRAZING, CUTTING, FITTING, SOLDERING, AND WELDING PIPING AND TUBING

PERFORMANCE OBJECTIVE V-TECS 03

TASK: Cut copper tubing/pipe/PVC.

CONDITIONS: Basic tool kit, copper tubing, tape measure, galvanized or black iron pipe, PVC pipe, cutting oil, chalk.

STANDARD: The cut tubing must be smooth, the specified length, and free of kinks.

SOURCE FOR STANDARD:

V-TECS. **A Catalog of Performance Objectives, Criterion-Referenced Measures and Performance Guides for Plumbing.**

State Department of Education, Alabama, **Air Conditioning and Refrigeration.**

PERFORMANCE GUIDE

1. Measure desired length of tubing, pipe, or PVC.
2. Mark point of cut.
3. Place cutter tool on tubing or pipe. (Use hacksaw for PVC).
4. Turn adjusting knob until cutter wheel touches tubing.
5. Rotate cutter in clockwise direction, tightening adjusting knob with each revolution. CAUTION: Do not tighten cutter enough to dent or collapse tubing.
6. Remove burrs from tubing or pipe.
7. Reseal tubing roll after use.

ENABLING OBJECTIVE(S)

Use basic refrigeration hand tools properly.

LEARNING ACTIVITIES

1. Demonstrate arrangement of the various types of tubing groups according to types of materials.
2. Show how to use a measuring tape, measure and mark tubing to given lengths.
3. Explain how to select the proper cutting tool and cut to given lengths, each type of tubing.
4. Demonstrate cleaning and removal of burrs from the ends of tubing.
5. Using recommended methods, reseal tubing rolls after cutting.

RESOURCES

Althouse, et al. **Modern Refrigeration and Air Conditioning.**

PERFORMANCE OBJECTIVE V-TECS 03 (Continued)

EVALUATION

Questions

1. Why is it important that we use the proper cutting tool on a given type of metal?
2. Which direction do we rotate the tubing cutter when cutting a piece of tubing?
3. Why should we not tighten the tubing cutter too tight?
4. Why do we remove the burrs and file the cut ends on the tubing?
5. Why is it important to reseal the end of the tubing after we make a cut from the roll?

Answers

1. For safety.
2. Clockwise
3. So as not to bend or collapse the tubing.
4. To insure a proper fit and a good connection.
5. To keep the tubing dry and clean.

DUTY: BRAZING, CUTTING, FITTING, SOLDERING, AND WELDING PIPING AND TUBING

PERFORMANCE OBJECTIVE V-TECS 04

TASK: Cut mild steel with oxyacetylene torch.

CONDITIONS: Basic tool kit, mild steel, chalk/soap stone, straight edge.

STANDARD: The cut must be smooth, straight, and to dimension.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Measure steel to desired dimensions and mark.
2. Attach cutting tip to hose.
3. Adjust tank regulators according to thickness of metal.
4. Light torch.
5. Adjust flame.
6. Apply heat to metal until red hot.
7. Press cutting tip lever and move cutting tip along marked line.

ENABLING OBJECTIVE(S)
Possess skills for assembly and set-up of oxyacetylene cutting equipment.
Use hand tools.

LEARNING ACTIVITIES
1. Instruct students to read text **Modern Welding**, pp. 85-118, 103-125.
2. Demonstrate assembly of regulators, hose, and torch outfit to cylinders.
3. Show how to check for leaks using soapy water solution.
4. Measure and mark the precise area to be cut.
5. Demonstrate how to adjust regulators, ignite cutting flame, adjust flame, and perform cutting operation smoothly and accurately.
6. Shut down the cutting station, disassemble all related parts, and clean up.

RESOURCES
Althouse, **Modern Welding**, pp. 83-118, 123-125.

EVALUATION
Questions
.. Identify each hose that uses right-handed or left-handed threads.
2. 'Vhat is the recommended working pressure that is to be adjusted on acetylene regulators?
3. How do you determine the working pressure on oxygen regulators?
4. The oxygen lever on the torch has what purpose?
5. How are leaks discovered on the oxyacetylene welding and cutting station?

PERFORMANCE OBJECTIVE V-TECS 04 (Continued)

Answers

1. Right-handed threads — oxygen
   Left-handed threads — actylene
2. From 7-10 lbs. of pressure.
3. The thickness of the metal.
4. To initiate rapid oxidation.
5. Soapy water solution.

DUTY: BRAZING, CUTTING, FITTING, SOLDERING, AND WELDING PIPING AND TUBING

PERFORMANCE OBJECTIVE V-TECS 05

TASK: Dislodge restrictions from tubing.

CONDITIONS: Tubing with restrictions, basic tool kit, leak detector, nitrogen or refrigerant.

STANDARD: All restrictions must be dislodged and the pipe joint leakproof when pressurized.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Attach gauges.
2. Determine location of restriction.
3. Purge system.
4. Cut the pipe at the point of restriction.
5. Remove restriction.
6. Join pipe.
7. Evaluate system.
8. Recharge system.
9. Remove gauges.
10. Leak test.
11. Put system back in operation.

ENABLING OBJECTIVE(S)

Possess skills in assembly and set up procedures with oxyactylene equipment.
Use hand tools.

LEARNING ACTIVITIES

1. Using pressure gauges, show how to check pressure at various points of the system to determine location of restriction.
2. Explain how to purge system and cut pipe at point of restriction and remove restriction.
3. Demonstrate how to rejoin pipe by method of flaring or soldering.
4. Explain the need to check system to insure that the restriction has been properly removed.
5. List the steps in recharging system and remove the gauges.
6. Discuss the importance of testing for leaks and putting the system back in operation.

RESOURCES

Althouse, **Modern Welding**, pp. 83-118, 123-135.

PERFORMANCE OBJECTIVE V-TECS 05 (Continued)

EVALUATION

Questions

1. When testing for a restriction we normally use ______________.
2. In a refrigeration system a restriction is sometimes indicated by a ______________ pattern.
3. How do we normally remove a restriction?
4. How can we check to insure that the restriction has been removed?

Answers

1. Gauges
2. Frost
3. By cutting the lines.
4. Pressurize the system.

DUTY: BRAZING, CUTTING, FITTING, SOLDERING, AND WELDING PIPING AND TUBING

PERFORMANCE OBJECTIVE V-TECS 06

TASK: Flare copper tubing.

CONDITIONS: Basic tool kit, flaring tool kit, copper tubing, flare nuts.

STANDARD: The flare joint will not leak when pressurized.

SOURCE FOR STANDARD:
State Department of Education, Alabama, **Air Conditioning and Refrigeration.**

PERFORMANCE GUIDE

Single Flare

1. Place flare nut on tubing.
2. Place tubing in correct hole of flaring block.
3. Place drop of oil on point of cone.
4. Place flaring cone on block directly about tubing.
5. Turn flaring cone clockwise slowly until flare is formed.

Double Flare Screw-Type Tool

1. Place female flare cone adapter on end of tubing.
2. Place point of flare cone in recess of adapter.
3. Put drop of oil on point of cone.
4. Turn flare cone clockwise until inverted flare is formed.
5. Place flare cone on tubing and turn clockwise until double flare is formed.

Punch-Type Double Flare Tool

1. Clamp tubing in flare block.
2. Place female tool in end of tubing.
3. Drive tool into tubing until inverted flare is formed.
4. Remove female tool and replace with male tool.
5. Drive male tool into tubing until double flare is formed.

ENABLING OBJECTIVE(S)

Use hand tools.

LEARNING ACTIVITIES

1. Using a ruler, measure; demonstrate how to cut two pieces of 1/2" copper tubing to designated length.
2. Show how to place one end of flare nut on tubing end and place end of tubing in desired hole in flaring block.
3. Demonstrate how to center spindle over tubing and turn clockwise slowly until flare is formed.
4. Remove and repeat procedure with second piece of tubing.
5. Using a flare union, show how to screw the flare nuts to the union to make a connection, tightening to insure there are no leaks.
6. Use the same procedure for making a double flare with the exception of using a double flare spindle.

PERFORMANCE OBJECTIVE V-TECS 06 (Continued)

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning,** Chapter 2.

EVALUATION

Questions

1. What is the meaning of ACR as applied to tubing?
   a. It is cold rolled.
   b. It is suitable for air conditioning and refrigeration applications.
   c. It is intended for air cooled applications only.
   d. It is a certain manufacturer's brand symbol.
   e. It is air cooled rolled.
2. When sawing soft copper tubing, how may the chips be prevented from entering the length of tubing to be immediately used?
   a. Apply air pressure on this length of the tube.
   b. Slant the tube so that the chips will not fall into the length being used.
   c. Pinch the tube.
   d. Stuff rags in the tube.
   e. Use a sawing fixture.
3. What type connections should be made when soft copper tubing is being used?
   a. Threaded
   b. Flared or soldered
   c. Welded
   d. Use compression fittings.
   e. Swaged.
4. Why are bending springs used?
   a. To provide a better grip on the tube.
   b. To make a uniform curve.
   c. To keep the tube from kinking.
   d. To keep the outside of the tube clean.
   e. To keep the inside of the tube clean.
5. Why should the end of copper tubing to be flared be filed square?
   a. To keep the tubing bright.
   b. To make the flare equal all around.
   c. To make it easy to attach the flaring tool.
   d. To make the flare of proper thickness.
   e. To keep the flare from splitting.

Answers

1. b
2. b
3. e
4. c
5. b

DUTY: BRAZING, CUTTING, FITTING, SOLDERING, AND WELDING PIPING AND TUBING

PERFORMANCE OBJECTIVE V-TECS 07

TASK: Solder tubing.

CONDITIONS: Basic tool kit, tubing, solder, solder flux, sand cloth, nitrogen or refrigerant, leak detector.

STANDARD: The soldered joint(s) must be clean and not leak when pressurized.

SOURCE FOR STANDARD:
State Department of Education, Alabama, **Air Conditioning and Refrigeration.**

PERFORMANCE GUIDE
1. Clean joint.
2. Apply flux to joint.
3. Light torch.
4. Adjust flame to soft blue outer cone.
5. Apply heat to joint.
6. Heat until flux starts to bubble.
7. Apply solder to joint and flow around joint by moving flame around joint.
8. Allow joint to cool.
9. Clean excess flux from joint.
10. Pressurize and leak test.

ENABLING OBJECTIVE(S)
Use hand tools.

LEARNING ACTIVITIES
1. Using the text book, **Modern Welding,** figure 2-29, show the method of preparing the assembly for the soldering job.
2. Demonstrate making a swage joint to join the tubing together.
3. Using the torch, show how to heat the tubing at the swage joint.
4. After heating the swage joint, show how to apply the wire solder to the shoulder and tubing of the swage joint allowing the heat of tubing to melt and flow the solder.
5. Using a flare connection, demonstrate how to connect the assembly to the compressured air line, and test for leaks at 50 PSI. Place tubing in water to check for air bubbles indicating leaks.

RESOURCES
Althouse, **Modern Welding,** Chapter 2.

PERFORMANCE OBJECTIVE V-TECS 07 (Continued)

EVALUATION

Questions

1. What is the usual composition of soft solder?
   a. Lead and antimony
   b. Lead and tin
   c. Tin and zinc
   d. Zinc and copper
   e. Spelter.
2. What is the base of most silver brazing flux?
   a. Vaseline
   b. Tallow
   c. Zinc chloride
   d. Borax
   e. Sodium chloride
3. What is the advantage of silver brazing over soft soldering?
   a. Cheaper
   b. Quicker
   c. Neater
   d. Stronger
   e. Lighter
4. What is the approximate temperature at which silver brazing allows flow?
   a. 1000° F.
   b. 1050° F.
   c. 1100° F.
   d. 1145° F.
   e. 1200° F.
5. Why must the flux be removed after soldering and brazing?
   a. It is not.
   b. To help one see the quality of the job.
   c. To prevent corrosion.
   d. To polish the joint.
   e. To make the joint stronger.

Answers

1. b
2. c
3. d
4. d
5. b

DUTY: BRAZING, CUTTING, FITTING, SOLDERING, AND WELDING PIPING AND TUBING

PERFORMANCE OBJECTIVE V-TECS 08

TASK: Solder electrical connections.

CONDITIONS: Soldering iron, 50/50 rosin-core solder, electrical wire (copper), electrical tape, pocket knife.

STANDARD: The solder must flow into the strands of wire and form a tight connection, and the wire must be mechanically secure.

SOURCE FOR STANDARD:
State Department of Education, Alabama, **Air Conditioning and Refrigeration.**

PERFORMANCE GUIDE
CAUTION: Use only rosin-core solder.
1. Remove rubber insulation from wire and carefully clean wire.
2. Twist wires together.
3. Place soldering iron below splice.
4. Apply solder to wire, not to iron.
5. Flow solder into splice.
6. Allow joint to cool.
7. Tape joint tightly with two or more layers of electrical tape insuring that no bare wires are exposed.

ENABLING OBJECTIVE(S)
Use hand tools.

LEARNING ACTIVITIES
1. Show how to carefully cut and remove rubber insulation from wire, being careful not to nick the wire.
2. Explain how to carefully clean exposed wire endings and twist them together.
3. Place the soldering iron on the bottom side of the splice and demonstrate how to apply solder to the wire, not the iron, flowing the solder into the splice.
4. Allow the joint to completely cool, then tape tightly with two or more layers of electrical tape insuring that no bare wires are exposed.
5. Using a test light, explain how to check wiring for continuity. Then test terminals, connections, and wiring with the ohmmeter.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, Chapters 6 and 7.

EVALUATION
Questions
1. How should a solid wire be wrapped around a terminal screw?
   a. Opposite the direction the screw turns as it is tightened.
   b. The same direction the screw is turned as it is tightened.
   c. It should be wrapped twice around the screw.
   d. It should be kept straight.
   e. A terminal should be used.

PERFORMANCE OBJECTIVE V-TECS 08 (Continued)

2. Which of the following is the largest conductor?
   a. No. 8
   b. No. 10
   c. No. 12
   d. No. 14
   e. No. 16
3. What should be heated when soldering a terminal to a stranded wire?
   a. The wire only.
   b. The terminal only.
   c. The solder only.
   d. The flux and solder only.
   e. The wire and terminal only.
4. How should stranded wire be connected to a screw terminal?
   a. Wrap wire clockwise around screw.
   b. Wrap wire counter-clockwise around the screw.
   c. Solder the wire, then wrap around the screw.
   d. Fasten a terminal to wire end.
   e. Separate the strands of wire and wrap around screw in both directions.
5. What should be the resistance across a clean tight terminal?
   a. 0 ohms.
   b. 50 ohms.
   c. 5,000 ohms.
   d. 50,000 ohms.
   e. 100,000 ohms.

Answers

1. b
2. a
3. a
4. d
5. a

DUTY: BRAZING, CUTTING, FITTING, SOLDERING, AND WELDING PIPING AND TUBING

PERFORMANCE OBJECTIVE V-TECS 09

TASK: Weld metal with filler rod.

CONDITIONS: Two pieces of metal, filler rod, basic tool kit, brazing flux, striker, wire brush.

STANDARD: The weld seam will be continuous and without excess flux or metal spatter.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Remove rust and corrosion from area to be welded.
2. Adjust regulators.
3. Clamp metal together.
4. Light torch.
5. Heat seam of metal.
6. Heat filler rod and dip into flux.
7. Apply filler rod to seam when metal is heated to flow point of rod.
8. Work flame in a circular motion while applying rod until length of metal is welded.
9. Allow metal to cool.
10. Clip off loose metal and flux.
11. Clean with wire brush.

ENABLING OBJECTIVE(S)

Possess skills in assembly and setup procedures with oxyacetylene equipment.
Use hand tools.

LEARNING ACTIVITIES

1. Using a grinder, explain how to clean the surfaces of the welding joints.
2. Using C clamps, show how to fasten the metal into place for welding.
3. Demonstrate ability of setting up the oxygen and acetylene regulators and hoses.
4. Using a striker, show how to light the torch and make the proper flame adjustment.
5. Demonstrate proper flame motion, a small circular motion heating the seam of the metal.
6. Using the method of heating the rod, demonstrate how to dip it into the flux and apply the filler rod to the heated metal seam that is at the flow temperature of the filler rod.
7. After the weld is completed, explain the importance of allowing the joint to cool and chipping the loose metal and flux, then, clean with a wire brush.

RESOURCES

Althouse, **Modern Welding.**

PERFORMANCE OBJECTIVE V-TECS 09 (Continued)

EVALUATION

Questions

1. What is the purpose of cleaning the surfaces of the welding joints?
2. What is the standard working pressure adjustment on the acetylene regulators?
3. How is the pressure of the oxygen regulators determined?
4. What is the proper motion in heating the seam of the metal?
5. What finishing steps are taken after the weld is completed?

Answers

1. To insure a proper bond.
2. 7 — 10 lbs.
3. Thickness of the metal.
4. A circular motion.
5. Chip off excess metal and clean with wire brush.

DUTY: BRAZING, CUTTING, FITTING, SOLDERING, AND WELDING PIPING AND TUBING

PERFORMANCE OBJECTIVE V-TECS 10

TASK: Weld metal without filler rod.

CONDITIONS: Two pieces of 26 gauge sheet metal, basic tool kit.

STANDARD: The puddle must be straight, smooth, of uniform width, and carried at least 6 inches.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Clamp two pieces of metal together parallel to each other.
2. Adjust regulators.
3. Light torch.
4. Heat end of seam to above flow point of metal.
5. Work torch in a circular motion, melting metal together along seam.
6. Continue until length of seam is welded.

ENABLING OBJECTIVE(S)

Possess skills in assembly and setup procedures with oxyactylene equipment.
Use hand tools.

LEARNING ACTIVITIES

1. Using safe and proper procedures demonstate how to assemble regulators, hoses, and torch to the cylinders.
2. Explain how to prepare and clean metal pieces, then clamp them together to form the joint.
3. Using the striker, show how to light the torch and adjust the flame.
4. Demonstrate the proper circular motion and heat the metal to temperatures above the flow point along the seam.
5. Show how to use the circular motion to make the flowing melted metal lap and fill the seam and allow the metal to cool.
6. Lecture on how to inspect the welded joint to make sure there aren't any holes and a clean joint has been formed.

RESOURCES

Althouse, **Modern Welding.**

EVALUATION

Questions

1. Identify each hose as to right or left handed threads:
   a. Red hose (acetylene).
   b. Green hose (oxygen).
2. How are leaks detected on the oxyacetylene cutting and welding station?
3. What purpose does the oxygen lever on the torch serve?
4. What is the final step of any welding job?
5. What is the purpose of cleaning the surface of the welding joints?

PERFORMANCE OBJECTIVE V-TECS 10 (Continued)

Answers

1. a. Right-handed threads.
   b. Left-handed threads.
2. With soapy water solution.
3. To initiate rapid oxidation.
4. Cleaning.
5. To insure a proper bond.

INSTALLING AND SERVICING CONTROLS

DUTY: INSTALLING AND SERVICING CONTROLS

PERFORMANCE OBJECTIVE V-TECS 11

TASK: Calibrate temperature controls.

CONDITIONS: Refrigeration system, basic tool kit, flat thermostat wrench, allen wrench set, manufacturer's specifications.

STANDARD: Control will operate in correct temperature range and will not short cycle.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE

Bimetal Control
1. Place thermometer near thermostat to check for equalized temperature.
2. Set control at desired temperature range.

Bellows-Type
1. Determine actual temperature of medium being cooled.
2. Turn range screw clockwise for colder, counterclockwise for warmer.
3. Adjust range screw until correct setting is obtained.

Mercury-Bulb
1. Place thermometer near thermostat to check for equalized temperature.
2. Set heat anticipation pointer to amperage of primary heating control.

ENABLING OBJECTIVE(S)
Read a thermometer.
Use hand tools.

LEARNING ACTIVITIES
1. Explain the importance of checking the electrical circuit and testing the parts.
2. Tell how to manually turn switch on and off and check system cycling.
3. Demonstrate how to place the thermometer next to thermostat and observe cut-in and cut-out of thermostat, adjust range as needed.
4. Show how to reinstall the control device, install the wiring, and test the device.
5. Instruct the students to adjust the thermostat by turning clockwise for increase in temperature or counterclockwise for decrease in temperature.
6. List the steps in operating the system.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning,** Chapter 24.

PERFORMANCE OBJECTIVE V-TECS 11 (Continued)

EVALUATION

Questions

1. What is one type of differential control?
   a. Range
   b. Temperature
   c. Cut-in only
   d. Pressure
   e. Cycling.
2. Where are thermostatic motor control bulbs usually located?
   a. In the brine.
   b. On the top of evaporator.
   c. On the bottom of evaporator.
   d. On the side of evaporator.
   e. At the outlet of the evaporator.
3. How may a thermostat be tested and adjusted?
   a. With a brine bath.
   b. With a pressure pump.
   c. With an electric heating coil.
   d. With a vacuum pump.
   e. With air pressure.
4. With what is the thermostatic element charged?
   a. Alcohol and water.
   b. Sulphur dioxide.
   c. Methyl chloride.
   d. R-12.
   e. A volatile liquid.
5. Why must the thermostat bulb be clamped firmly to the evaporator?
   a. To enable good heat transfer.
   b. To stop rattles.
   c. To prevent leaks.
   d. To make a good electrical ground.
   e. To prevent breakage.

Answers

1. b
2. e
3. a
4. d
5. a

DUTY: INSTALLING AND SERVICING CONTROLS

PERFORMANCE OBJECTIVE V-TECS 12

TASK: Adjust defrost time clock.

CONDITIONS: A self-defrosting refrigeration system, basic tool kit.

STANDARD: The system must defrost at the specified time of day.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE

Commercial

1. Set pointers to the desired defrost cut-in and cut-out time.
2. Manually advance timer to cut-in point.

Residential

1. Turn indicator dial clockwise until a click is heard.
2. Wait until unit comes out of defrost.
3. Turn indicator to the time of day.

ENABLING OBJECTIVE(S)

Operate a timer.
Use hand tools.

LEARNING ACTIVITIES

1. Using the timer pins that come with the timer, show how to screw pointers in at the desired defrost cut-in and cut-out times.
2. After the pins are located, explain how to manually advance the timer to the cut-in point.
3. Demonstrate how to turn the indicator dial clockwise until a click is heard.
4. Wait until the unit comes out of the defrost cycle automatically and show how to check the timing.
5. Direct the students in turning the clock to indicate the time of day, putting the timer back in service.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning,** Chapter 8, p. 271.

EVALUATION

Questions

1. In a defrost timer the pins screwed into the face of the clock determines the ____________ and ______________ of the defrost cycle.
2. What is the purpose of a defrost timer?
3. What is the normal length of time of the average defrost cycle?

Answers

1. Cut-in, cut-out.
2. To prevent ice build-up on the evaporator.
3. 40 to 60 minutes.

DUTY: INSTALLING AND SERVICING CONTROLS

PERFORMANCE OBJECTIVE V-TECS 13

TASK: Calibrate pressure controls.

CONDITIONS: Basic tool kit, operational unit, service valve wrench, manufacturer's specifications.

STANDARD: Pressure controls must be calibrated to manufacturer's recommended setting.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE

1. Locate pressure control and remove cover.
2. Attach gauges and start system.
3. Block airflow over evaporator and note low pressure gauge reading.
4. Turn adjusting screw to cause contact to open when the pressure drops to manufacturer's recommended setting.
5. Remove blockage from evaporator.
6. Block air flow across condenser.
7. Note head pressure gauge reading.
8. Adjust pressure control to trip at manufacturer's recommended pressure.
9. Remove gauges.
10. Reassemble and run unit.

ENABLING OBJECTIVE(S)

Read and understand manufacturer's specifications.
Use hand tools.

LEARNING ACTIVITIES

1. Explain how to examine the control and determine the cut-in and cut-out settings.
2. Demonstrate how to determine the safety control settings using a hydraulic pump and gauge. Have students record the findings.
3. Show how to determine the low-side control settings using a vacuum pump with a compound gauge. Have students record the findings.
4. Tell how to adjust the cut-in and cut-out points.
5. Explain how to install the control in the system.
6. Explain the importance of operating the system for twenty minutes.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning.**

EVALUATION

Questions

1. Why are high-pressure safety motor cut-outs used?
   a. To cycle the unit.
   b. To economize on power consumption.
   c. To protect the motor control.
   d. To protect the unit from high pressures.
   e. To keep the high pressures up to normal.

PERFORMANCE OBJECTIVE V-TECS 13 (Continued)

2. Where should the low-side connection of the pressure motor control be connected into the system?
   a. To the suction line of the warmest evaporator.
   b. To the compressor high side.
   c. To the crankcase.
   d. To the liquid receiver.
   e. Anywhere on the low-pressure side.
3. Where is a high-pressure safety motor cut-out line connected into the system?
   a. At the condenser.
   b. At the compressor head.
   c. To the liquid line.
   d. To the evaporator.
   e. To the suction line.
4. What are the relative pressures in the low-pressure side while the unit is running?
   a. The same throughout.
   b. Higher at the evaporator.
   c. Lower at the evaporator.
   d. Higher at the suction service valve.
   e. Higher as the temperature drops.
5. What is the most common pressure motor control trouble which will cause the system to short cycle?
   a. Lack of refrigerant.
   b. Low-pressure setting too low.
   c. Clogged screen.
   d. Too low a range.
   e. Too low a high-pressure cut-out setting.

Answers
1. d
2. e
3. b
4. b
5. a

DUTY: INSTALLING AND SERVICING CONTROLS

PERFORMANCE OBJECTIVE V-TECS 14

TASK: Adjust superheat setting on expansion valve.

CONDITIONS: Service valve wrench, basic tool kit, operating system with a thermostatic expansion valve, manufacturer's specifications.

STANDARD: The setting must be maintained within specified range.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE
1. Attach gauges.
2. Connect clamp-on thermometer to suction line at evaporator outlet.
3. Record the suction pressure with the unit in operation.
4. Add 2 PSI to the suction pressure (estimated suction line pressure drop).
5. Subtract this number from the reading of the thermometer to determine superheat.
6. Remove tne cap from the superheat valve stem.
7. Place a service valve wrench on the stem and turn in (clockwise) to increase superheat — turn out (counterclockwise) to decrease superheat.

ENABLING OBJECTIVE(S)
Read a passive gauge.
Read and understand manufacturer's specifications.

LEARNING ACTIVITIES
1. Using the pressure gauges, demonstrate how to connect the compound gauge to the low-side of the system and the high pressure gauge to the high side of the system. Then turn the unit on and let it run for a few minutes.
2. Show how to record the suction pressure with the unit in operation. Then tell how to attach a clamp on the thermometer to the evaporator outlet. Allow the unit to run about 15 minutes.
3. Direct the students to measure the suction pressure and record it. Then instruct students to add 2 PSI to the suction pressure, and subtract this number from the reading of the thermometer. This will indicate the superheat.
4. Demonstrate how to remove the cap from the superheat valve system and using a valve wrench on the stem, turn clockwise to increase superheat or counterclockwise to decrease superheat for a 10°F setting.
5. If TEV is faulty, explain the need to adjust the expansion valve by increasing or decreasing the pressure to obtain the proper superheat.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning.**

PERFORMANCE OBJECTIVE V-TECS 14 (Continued)

EVALUATION

Questions

1. Where is the power bulb located when controlling an air-cooling evaporator?
   a. On the evaporator.
   b. On the liquid line.
   c. On the suction line near the evaporator.
   d. On the suction line outside the cabinet.
   e. Anywhere outside the cabinet.
2. What does the thermostatic expansion valve control?
   a. The temperature of the refrigerant in the evaporator.
   b. The quantity of refrigerant in the evaporator.
   c. The pressure in the evaporator.
   d. The temperature of the evaporator.
   e. The high-side pressure.
3. How may needle and seat be tested for leaks?
   a. High pressure air.
   b. Vacuum.
   c. Turning the adjustment all the way out.
   d. Cooling the power bulb and using air pressure.
   e. With water.
4. What will happen to the evaporator if the TEV adjustment screw is turned out?
   a. Starve.
   b. Flood.
   c. Become warmer.
   d. Become colder.
   e. Nothing.
5. What will happen to the evaporator if the power element is located in a warm air steam?
   a. Flood.
   b. Starve.
   c. Nothing.
   d. Unit will not run.
   e. Unit will run constantly.

Answers

1. a
2. b
3. b
4. a
5. a

DUTY: INSTALLING AND SERVICING CONTROLS

PERFORMANCE OBJECTIVE V-TECS 15

TASK: Calibrate air sensitive thermostats.

CONDITIONS: A refrigeration system with air sensitive thermostats, basic tool kit, manufacturer's specifications.

STANDARD: Correct temperature must be maintained at all range settings.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE
1. Take temperature reading in refrigerator.
2. Remove thermostat from mount.
3. Locate adjusting screw.
4. Turn adjusting screw clockwise to decrease temperature.
5. Turn adjusting screw counterclockwise to increase temperature.
6. Reassemble thermostat.
7. Check operation.

ENABLING OBJECTIVE(S)
Use a thermometer.
Read and understand manufacturer's specifications.

LEARNING ACTIVITIES
1. Using a refrigeration thermometer, explain the need to record the temperature reading inside the refrigerator.
2. Show how to remove thermostat from mount.
3. Demonstrate how to locate the adjustment screw and turn clockwise for decrease in temperature or counterclockwise for increase in temperature.
4. Draw a schematic demonstrating how to reassemble thermostat.
5. List the steps in checking the operation.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, Chapter 10.

EVALUATION
Questions
1. What is the voltage of a line voltage thermostat?
   a. 24V.
   b. 120V.
   c. 240V.
   d. 30V.
   e. 6 to 12V.

PERFORMANCE OBJECTIVE V-TECS 15 (Continued)

2. In an electronic combination thermostat, what is the heating and cooling difference?
   a. 0.5°F.
   b. 1°F.
   c. 2°F.
   d. 3°F.
   e. 4°F.
3. How does a low voltage thermostat operate the heating and cooling fan?
   a. A direct line circuit.
   b. Relay.
   c. Stepdown transformer.
   d. Thermostat.
   e. Solenoid.
4. What does the least complicated combination thermostat contain?
   a. Bimetal strip.
   b. Bimetal strip and heat anticipator.
   c. Bimetal strip, heat anticipator, and cold anticipator.
   d. Two separate circuits in sequence.
   e. Two separate mercury tube switches.
5. What does the thermostat control?
   a. Heating.
   b. Cooling.
   c. Humidity and odor.
   d. Cooling and humidity.
   e. Heating and cooling.

Answers
1. b
2. e
3. b
4. c
5. e

DUTY: INSTALLING AND SERVICING CONTROLS

PERFORMANCE OBJECTIVE V-TECS 16

TASK: Align proportional thermostat.

CONDITIONS: A pneumatic control system, temperature proportional control, basic tool kit, manometer, air supply.

STANDARD: When aligned, the thermostat must maintain a constant output voltage.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE

1. Determine thermostat location.
2. Mount device.
3. Connect electrical supply.
4. Connect volt meter to output terminal.
5. Disconnect temperature measuring element from indicator pin.
6. Set "set point" indicator at 50%.
7. Secure pin measuring setting at 50%.
8. Turn reset to longest time.
9. Turn output indicator to DIRECT.
10. Turn proportional adjustment to 100%.
11. Make adjustment to give correct voltage.
12. Move bond adjustment to give correct voltage.
13. Readjust mount mechanism if output changes.
14. Move bond adjustment to maximum.

ENABLING OBJECTIVE(S)

Use a manometer.
Use hand tools.

LEARNING ACTIVITIES

1. Explain how to determine where the thermostat is to be located.
2. Using proper procedure, show how to mount the thermostat and connect the electrical wires.
3. Demonstrate how to connect the manometer to the output terminal to check the output.
4. Explain the purpose of disconnecting the temperature measuring element from the indicator pin, setting "set point" indicator at 50%, and securing the pin measuring setting at 50%.
5. Demonstrate how to turn reset to longest time, turn the output indicator to DIRECT, and turn proportional adjustment to 100%.
6. Using voltage adjustment terminal, discuss how to make an adjustment to give the correct voltage output. Then, show how to adjust the bond terminal to produce a correct voltage.

PERFORMANCE OBJECTIVE V-TECS 16 (Continued)

7. Explain the reason for testing the thermostat to insure the proper output voltage. If the reason for the output voltage changes, also explain readjusting the mount mechanism and moving the bond adjustment to maximum.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning,** Chapter 24, pp. 854-856.

EVALUATION

Questions

1. A proportional thermostat depends on the temperature difference between the thermostat ____________ and ____________ temperature.
2. When the thermostat is controlling a flame it is burning larger when the temperature difference is ________________.
3. The unit starts to flame at what percent of capacity?
4. Basically the proportional thermostat is a ____________ ____________ thermostat.

Answers

1. Setting, room
2. The greatest
3. 50%
4. Solid state

DUTY: INSTALLING AND SERVICING CONTROLS

PERFORMANCE OBJECTIVE V-TECS 17

TASK: Clean thermostat contacts.

CONDITIONS: Thermostat with exposed contacts, basic tool kit.

STANDARD: Contacts must be clean and resistance must measure zero ohms.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE

1. Remove cover.
2. Turn setting until contacts open.
3. Pull a clean piece of paper through the contacts.
4. Test that resistance of contacts measures zero ohms.
5. Replace cover.

ENABLING OBJECTIVE(S)

Use an ohmmeter.

LEARNING ACTIVITIES

1. Show how to remove the cover on the thermostat so the contacts are exposed.
2. Explain the reason for inspecting the contacts to check the condition and testing the contacts with an ohmmeter.
3. Using the proper tools demonstrate how to adjust the contacts to the open position, then show how to pull a clean piece of paper through the contacts to remove the dirt and dust.
4. Using the tool again demonstrate how to close the contact and test the contacts for a ohm reading on the ohmmeter.
5. Use the proper sequence instruct students to adjust the thermostat and put it back in service.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, p. 842.

EVALUATION

Questions

1. What in the thermostat is the moveable contact mounted on?
2. Contacts can be calibrated. (True or False)
3. A regular thermostat senses ____________ ____________.

Answers

1. A bimetal strip
2. True
3. Air temperatures

DUTY: INSTALLING AND SERVICING CONTROLS

PERFORMANCE OBJECTIVE V-TECS 18

TASK: Replace pressure control switch.

CONDITIONS: A refrigeration system equipped with a bulb type pressure control switch, basic tool kit, 10" adjustable wrench, pressure control switch, manufacturer's specifications/wiring schematic.

STANDARD: The pressure control switch must be mechanically secure and all electrical connections made in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Attach gauges.
3. Discharge refrigerant.
4. Remove screws from control mount.
5. Remove electrical wires from control.
6. Remove capillary bulb from high side of system.
7. Mount new control switch.
8. Connect electrical wires.
9. Connect capillary bulb.
10. Evacuate system.
11. Recharge system.
12. Restore power to unit.
13. Leak test.
14. Start system and check operation.
15. Remove gauges.

ENABLING OBJECTIVES

Use hand tools.
Read and understand manufacturer's specifications and wiring schematic.

LEARNING ACTIVITIES

1. Explain how to disconnect power from the unit.
2. Using the pressured gauges show how to check the system gas pressure and remove the wires from the pressure control checking continuity of the switch.
3. Explain that after it is determined the pressure is not working, close the port valve and remove the capillary tube from the system.
4. Using the proper tools demonstrate how to loosen the mounting bolts and remove the pressure control.
5. Tell how to select a proper control and mount it on the unit. Then show how to reconnect the capillary tube to the port valve.
6. Explain how to replace the electrical wiring onto the switch. Then show how to open the port valves and check the connections for leaks.
7. Explain the proper cut-in and cut-out settings. Make necessary adjustments.
8. Explain how to operate the system and check for proper operations.

PERFORMANCE OBJECTIVE V-TECS 18 (Continued)

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning.**

EVALUATION

Questions

1. Why are high-pressure safety motor cut-outs used?
   a. To cycle the unit.
   b. To economize on power consumption.
   c. To protect the motor control.
   d. To protect the unit from high pressure.
   e. To keep the high pressure up to normal.
2. Where should the low-side connection of the pressure motor control be connected into the system?
   a. To the suction line of the warmest evaporator.
   b. To the compressor high side.
   c. To the crankcase.
   d. To the liquid receiver.
   e. Anywhere on the low-pressure side.
3. Where is a high-pressure safety motor cut-out line connected into the system?
   a. At the condenser.
   b. At the compressor head.
   c. To the liquid line.
   d. To the evaporator.
   e. To the suction line.
4. What are the relative pressures in the low-pressure side while the unit is running?
   a. The same throughout.
   b. Higher at the evaporator.
   c. Lower at the evaporator.
   d. Higher at the suction service valve.
   e. Higher as the temperature drops.
5. What is the most common pressure motor control trouble which will cause the system to short cycle?
   a. Lack of refrigerant.
   b. Low-pressure setting too low.
   c. Clogged screen.
   d. Too low a range.
   e. Too low a high-pressure cut-out setting.

Answers

1. d
2. e
3. b
4. b
5. a

DUTY: INSTALLING AND SERVICING CONTROLS

PERFORMANCE OBJECTIVE V-TECS 19

TASK: Replace temperature control.

CONDITIONS: A central heating and cooling system, level, basic tool kit, manufacturer's specifications/wiring schematic.

STANDARD: The temperature control subbase must be mechanically secure and level. All electrical connections must be secure and in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Remove cover from control.
3. Remove mount screws from control.
4. Disconnect electrical wires from control subbase.
5. Remove subbase from wall and discard.
6. Mount new control subbase.
7. Level new control subbase.
8. Connect electrical wires to subbase.
9. Mount new control on subbase.
10. Replace cover.
11. Restore power to unit.
12. Start unit and check operation.

ENABLING OBJECTIVE(S)

Read and understand manufacturer's specification and wiring diagram.

LEARNING ACTIVITIES

1. Explain how to check the 24V. electrical circuit and test the parts; illustrate how to make an electrical wiring diagram.
2. Show how to disconnect the power and remove the old thermostat using proper procedures.
3. Using the proper procedures, demonstrate how to remove all the wiring, remove the control devices, dismantle the control devices, and study their design, construction, and operation.
4. Explain how to reinstall the control devices, install the wiring, and test the circuits.
5. Show how to operate the system.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning,** Chapters 6 and 7.

PERFORMANCE OBJECTIVE V-TECS 19 (Continued)

EVALUATION

Questions

1. Why are high-pressure safety motor cut-outs used?
   a. To cycle the unit.
   b. To economize on power consumption.
   c. To protect the motor control.
   d. To protect the unit from high pressures.
   e. To keep the high pressures up to normal.
2. Where should the low-side connection of the pressure motor control be connected?
   a. To the suction line of the warmest evaporator.
   b. To the compressor high side.
   c. To the crankcase.
   d. To the liquid receiver.
   e. Anywhere on the low-pressure side.
3. Where is a high-pressure safety motor cut-out line connected into the system?
   a. At the condenser.
   b. At the compressor head.
   c. To the liquid line.
   d. To the evaporator.
   e. To the suction line.
4. What are the relative pressures in low-pressure side while the unit is running?
   a. The same throughout.
   b. Higher at the evaporator.
   c. Lower at the evaporator.
   d. Higher at the suction service valve.
   e. Higher as the temperature drops.
5. What is the most common pressure motor control trouble which will cause the system to short cycle?
   a. Lack of refrigerant.
   b. Low-pressure setting too low.
   c. Clogged screen.
   d. Too low a range.
   e. Too low a high-pressure cut-out setting.

Answers

1. d
2. e
3. b
4. b
5. a

DUTY: INSTALLING AND SERVICING CONTROLS

PERFORMANCE OBJECTIVE V-TECS 20

TASK: Replace oil pressure safety control switch.

CONDITIONS: A system with an oil pressure regulator, basic tool kit, service valve wrench, 10" adjustable wrench, manufacturer's specifications/wiring schematic.

STANDARD: The switch must be securely mounted. All line connections must be leakproof and all electrical connections must be secure and in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Attach gauges.
2. Front seat King valve (at receiver outlet).
3. Run system until pumped down.
4. Front seat suction service valve.
5. Shut down system.
6. Front seat discharge service valve.
7. Disconnect electrical supply to system.
8. Disconnect wires from control.
9. Disconnect line from oil pump to control.
10. Disconnect line from compressor crankcase.
11. Disconnect mount screws from control.
12. Shut down system.
13. Front seat discharge service valve.
14. Disconnect electrical supply to system.
15. Disconnect wires from control.
16. Disconnect line from oil pump to control.
17. Disconnect line from compressor crankcase.
18. Disconnect mount screws from control.
19. Reconnect lines to oil pump and crankcase.
20. Reconnect electrical lines.
21. Remount control.
22. Crack flare nut on line from crankcase to control.
23. Back seat King valve.
24. Crack suction service valve.
25. Purge air from crankcase.
26. Tighten flare nut to control.
27. Back seat discharge service valve.
28. Back seat suction service valve.
29. Crack both service valves.
30. Start system and add refrigerant to compensate for purge loss.
31. Remove gauges.

PERFORMANCE OBJECTIVE V-TECS 20 (Continued)

ENABLING OBJECTIVES

Use hand tools.

Read manufacturer's specifications and wiring schematic.

LEARNING ACTIVITIES

1. Explain how to disconnect the power from the unit and check system.
2. Show how to attach the gauge manifold and purge refrigerant from the system until pressures balance.
3. Demonstrate how to remove the oil separator, dismantle, and clean the spilled oil.
4. Direct the students to assemble the separator.
5. Tell how to install the separator and test for leaks.
6. Show how to charge the system and run the unit for 20 minutes.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning.**

EVALUATION

Questions

1. Where is the oil separator located in the system?
   a. Between the condenser and the liquid line.
   b. Between the receiver and the liquid line.
   c. Between the compressor and the condenser.
   d. Between the suction line and the compressor.
   e. Between the liquid line and the evaporator.
2. Why are most oil separators insulated?
   a. To keep the oil warm.
   b. To keep any moisture in the separator from freezing.
   c. To keep the refrigerant from condensing in the separator.
   d. Only hot oil will separate from refrigerant.
   e. To minimize noise.
3. What will happen if the oil separator float collapses?
   a. Nothing.
   b. The valve will stay open.
   c. The valve will stay closed.
   d. The liquid refrigerant will short circuit into the crankcase.
   e. The head pressure will become excessive.
4. What is one advantage of an oil separator?
   a. Keeps the oil in the compressor.
   b. Low cost.
   c. Easy to service.
   d. Traps the moisture.
   e. May be used as a service cylinder.
5. How must an oil separator be mounted?
   a. Any position.
   b. Level.
   c. Suspend from the condenser line.
   d. Below the compressor.
   e. Above the compressor.

PERFORMANCE OBJECTIVE V-TECS 20 (Continued)

Answers

1. c
2. c
3. e
4. a
5. c

DUTY: INSTALLING AND SERVICING CONTROLS

PERFORMANCE OBJECTIVE V-TECS 21

TASK: Replace summer-winter switch-over control.

CONDITIONS: A central heating and cooling system, wall mount summer-winter switch-over control, level.

STANDARD: The control must be level and wired according to color code.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Remove cover plate.
3. Remove mount screws.
4. Disconnect electrical wires.
5. Remove subbase.
6. Mount new subbase.
7. Level subbase.
8. Connect electrical wires.
9. Mount new control on subbase.
10. Replace cover.
11. Connect unit to power source.
12. Start unit.

ENABLING OBJECTIVE(S)
Use hand tools.

LEARNING ACTIVITIES

1. Show how to disconnect power from unit.
2. Demonstrate how to remove the cover plate and mounting screws on the thermostat.
3. Explain how to remove all the wires, check the terminals, and draw a wiring diagram.
4. Using the proper tools, demonstrate removal of the mounting screws for the subbase, obtaining the new subbase, position it, and the reinstalling of the mounting screws, making sure the subbase is level.
5. Using the wiring diagram, show how to reconnect the wires to the subbase, mount the new control on the subbase, and replace the cover.
6. Tell how to connect the power to start the unit and check control operation.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, Chapter 24, pp. 841-842.

PERFORMANCE OBJECTIVE V-TECS 21 (Continued)

EVALUATION

Questions

1. The thermostat controls ________________.
2. How does a low voltage thermostat operate the heating and cooling fan?
3. What is the voltage of a line voltage thermostat?
   a. 240V.
   b. 120V.
   c. 24V.
   d. 6 to 12V.
   e. 30V.
4. What does the least complicated combination thermostat contain?
   a. Bimetal strip.
   b. Two separate mercury tube switches.
   c. Bimetal strip and heat anticipator.
   d. Two separate circuits in sequence.
   e. Bimetal strip, heat anticipator, and cold anticipator.
5. In an electronic combination thermostat, what is the heating and cooling differential?
   a. 4°F.
   b. 2°F.
   c. 0.5°F.
   d. 1°F.
   e. 3°F.

Answers

1. Heating and cooling
2. Using a relay
3. b
4. e
5. a

DUTY: INSTALLING AND SERVICING CONTROLS

PERFORMANCE OBJECTIVE V-TECS 22

TASK: Replace thermostat.

CONDITIONS: A room air conditioner, basic tool kit, thermostat, manufacturer's specifications/wiring schematic.

STANDARD: The electrical connections must be secure and in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Remove control mounting screws.
3. Remove electrical connections.
4. Remove remote bulb from its clamp.
5. Remount new control.
6. Connect electrical wires.
7. Connect remote bulb.
   NOTE: Feeler tube or bulb must not touch evaporator.
8. Connect unit to power source.
9. Start unit and check operation.

ENABLING OBJECTIVE(S)

Read and understand manufacturer's specifications and wiring diagram.

LEARNING ACTIVITIES

1. Demonstrate how to disconnect the power from the unit.
2. Show how to remove the control mounting screws, disconnect the electrical connections, and remove remote bulb from its clamp.
3. Explain how to remount new control.
4. List the steps in reconnecting the electrical wires and connecting remote bulb in its clamp.
5. Direct the students in reconnecting power, starting the unit, and checking the operation.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning,** Chapter 8, pp. 271-273.

EVALUATION

Questions

1. How can a low voltage thermostat operate from a 120V system?
   a. Use a solenoid valve.
   b. Use a transformer.
   c. Use a relay.
   d. Use a sequence control.
   e. Use a resistance.

PERFORMANCE OBJECTIVE V-TECS 22 (Continued)

2. How is a 24V circuit obtained?
   a. From the power company.
   b. Use a solenoid.
   c. Use a thermostat.
   d. Use a step-up transformer.
   e. Use a step-down transformer.
3. Where is a limit control located in the electrical circuits?
   a. In the 24V circuit.
   b. In the 120V circuit.
   c. In the 240V circuit.
   d. In both 24V and 120V circuit.
   e. In either the 24V or 120V circuit.
4. What are the control devices which may be used on the 24V circuit in a domestic gas fueled heating hydronic system?
   a. Thermostat.
   b. Thermostat and relay, safety pilot.
   c. Thermostat, relay, and circulation pump.
   d. Thermostat, relay, gas solenoid, limit control, and safety pilot.
   e. Thermostat, relay, gas solenoid, limit control, safety pilot, and circulation pump.
5. In a low voltage system, what voltage operates the heat anticipator?
   a. 24V
   b. 6V
   c. 120V
   d. 12V
   e. 240V

Answers

1. b
2. e
3. d
4. d
5. a

DUTY: INSTALLING AND SERVICING CONTROLS

PERFORMANCE OBJECTIVE V-TECS 23

TASK: Replace water regulating valve.

CONDITIONS: A water-cooled system, basic tool kit, water regulating valve, 12" adjustable wrench.

STANDARD: The valve must be mechanically secure and all connections must be leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE

1. Shut off unit.
2. Shut off water supply to valve.
3. Disconnect valve water lines.
4. Back seat discharge service valve.
5. Disconnect line from discharge service valve to water valve and reconnect to new valve.
6. Crack discharge service valve.
7. Connect water lines to valve.
8. Turn on water supply and leak test.
9. Leak test refrigerant lines.
10. Start up system and observe water valve.

ENABLING OBJECTIVE(S)

Use hand tools.

LEARNING ACTIVITIES

1. Explain the need to disconnect all power to the unit and close off water supply.
2. Using the proper tools, demonstrate how to remove the water valve making sure to close off the refrigerant to the water valve.
3. Explain the method to disassemble the water valve.
4. Demonstrate ability to remove the old water valve and using the reverse action install the new water valve.
5. Show how to install the gauge manifold, start the unit and after 15 minutes of running, record the inlet and outlet water temperature.
6. Discuss the value of determining if the water will shut off after the unit has stopped.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, Chapter 12.

PERFORMANCE OBJECTIVE V-TECS 23 (Continued)

EVALUATION

Questions

1. What is one main advantage of a pressure-operated water valve?
   a. No cost of operation.
   b. Turns the water on and off.
   c. Easiest to install.
   d. Varies the rate of water flow.
   e. Will operate satifactorily under high water pressure.
2. Where is the refrigerant line to the water valve usually connected into the system?
   a. Suction line
   b. Compressor crankcase
   c. Receiver
   d. Compressor head
   e. Condenser.
3. What is the usual temperature difference between the water outlet and the water inlet?
   a. 0°F
   b. 10°F
   c. 30°F
   d. 40°F
   e. None.
4. What happens to the water flow when the condensing unit stops?
   a. Stops instantly.
   b. Keeps on running.
   c. Continues running but at a lower rate of flow.
   d. Stops quickly.
   e. Increases.
5. What is one of the advantages of an electric water valve?
   a. Easy to install.
   b. Turns the water on and off.
   c. No cost of operation.
   d. Can operate under high pressure.
   e. Varies the rate of water flow.

Answers

1. d
2. d
3. c
4. d
5. d

DUTY: INSTALLING AND SERVICING CONTROLS

PERFORMANCE OBJECTIVE V-TECS 24

TASK: Test thermostat controls.

CONDITIONS: A window air conditioner, thermometer, tape.

STANDARD: The system must start or stop within + 2° of the thermostat control setting.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**
State Department of Education, Alabama. **Air Conditioning and Refrigeration.**

PERFORMANCE GUIDE

1. Attach thermometer to remote bulb with tape.
2. Start unit.
3. Direct discharge air over bulb and observe cut-out temperature on thermometer.
4. Observe cut-in temperature on thermometer.

ENABLING OBJECTIVE(S)

Use a thermometer.

LEARNING ACTIVITIES

1. If the system is nonoperational, explain why the need to check it with motor starting relay tester. Discuss how to determine if thermostat is faulty through the use of a test light, and if it is nonoperational, proceed with the next step.
2. Demonstrate how to remove the motor control from the unit, being careful not to damage the power element.
3. Show how to test the control. Direct the students to determine the cut-in and cut-out temperatures by means of a temperture bath. (Salt, ice, and water may be used for a temperature bath, but a refrigerating temperature bath is better).
4. Demonstrate how to install the control in a circuit in series with a light. Instruct the students to determine the type of range and differential adjustments.
5. Demonstrate how to repair or replace the control, adjusting the cut-in to 25°F and the cut-out to 15°F.
6. Draw a schematic showing how to install the control in the unit to operate the system.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning,** Chapters 6 and 7.

PERFORMANCE OBJECTIVE V-TECS 24 (Continued)

EVALUATION

Questions

1. What is one type of differential control?
    a. Range
    b. Temperature
    c. Cut-in only
    d. Pressure
    e. Cycling.
2. Where are thermostatic motor control bulbs usually located?
    a. In the brine.
    b. On the top of evaporator.
    c. On the bottom of the evaporator.
    d. On the side of the evaporator.
    e. At the outlet of the evaporator.
3. How may a thermostat be tested and adjusted?
    a. With a brine bath.
    b. With a pressure pump.
    c. With an electric heating coil.
    d. With a vacuum pump.
    e. With air pressure.
4. With what is the thermostatic element charged?
    a. Alcohol and water
    b. Sulphur dioxide
    c. Methyl chloride
    d. R-12
    e. A volatile liquid.
5. Why must the thermostatic bulb be clamped firmly to the evaporator?
    a. To enable good heat transfer.
    b. To stop rattles.
    c. To prevent leaks.
    d. To make a good electrical ground.
    e. To prevent breakage.

Answers

1. b
2. e
3. a
4. d
5. a

INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

DUTY: **INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS**

PERFORMANCE OBJECTIVE V-TECS 25

TASK: Align drive pulley.

CONDITIONS: An electric motor connected to a blower, open-end wrenches, straight edges.

STANDARD: Belt must run true without causing vibration.

SOURCE FOR STANDARD:
State Department of Education, Alabama, **Air Conditioning and Refrigeration**.

PERFORMANCE GUIDE
1. Disconnect motor from power source.
2. Remove V-belt.
3. Loosen set screws.
4. Put straight edge in pulley grooves.
5. Align pulleys.
6. Tighten set screws.
7. Connect motor to power source.
8. Start motor and check alignment.

ENABLING OBJECTIVE(S)
Use hand tools.

LEARNING ACTIVITIES
1. Demonstrate how to disconnect power from motor.
2. Show how to remove the V-belt and loosen the set screws on the pulley, sliding the pulley in or out on the shaft.
3. Explain how to put the straight edge in the pulley's grooves and align.
4. Tell how to tighten the loosened set screws and reconnect the power to the motor.
5. Direct the students to start the motor and check the alignment.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning,** Chapter 7, pp. 236-237.

EVALUATION
Questions
1. The A belt is _________ inche(s) in width.
2. To reduce bearing and belt wear, the shafts should be _____________.
3. The most common way to measure the belt length is the _____________.
4. In what direction should a belt rotate?
   a. Clockwise
   b. Counterclockwise
   c. With pull on top section of belt
   d. With pull on bottom section of belt
   e. In any direction.

PERFORMANCE OBJECTIVE V-TECS 25 (Continued)

5. In checking for the correct belt tension, the belt ______________.
   a. Should not slip.
   b. Should not glaze on wearing surfaces.
   c. Should not move 1/2 inch out of line with a 10 lb. force.
   d. Should not move 1/2 inch out of line with a 150 lb. force.
   e. Does not flap.

Answers

1. 1/2
2. Parallel
3. Inside length
4. e
5. c

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 26

TASK: Adjust limit switch.

CONDITIONS: A central heating system, basic tool kit, thermometer, manufacturer's specifications.

STANDARD: The switch must function within + 5° of setting.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE

1. Remove panels covering controls.
2. Reduce air flow across furnace.
3. Check temperature at which limit controls open and close.
4. Check heater cut-out specifications.
5. Adjust limit switch to heater specifications.
6. Recheck temperature rise and adjust if necessary.
7. Replace panels.
8. Reset thermostat to normal setting.

ENABLING OBJECTIVE(S)

Use hand tools.
Use thermometer.
Read and understand manufacturer's specifications.

LEARNING ACTIVITIES

1. Demonstrate how to remove the electrical cover panels and disconnect the blower wires in order to stop the air flow across the combustion chamber.
2. Using a heating thermometer, show how to insert into air stream and record the temperature at the limit control open, then record the temperature at the limit control close once the heat has been removed.
3. Using the manuals for the furnace, explain how to check the cut-out specifications and adjust the limit switch to the manufacturer's specifications.
4. Discuss how to reconnect the blower wires and engage power. Check the temperature rise, making any necessary adjustments.
5. Direct the students in replacing panels and resetting room temperature to normal setting.

RESOURCES

Althouse, et al., **Refrigeration and Air Conditioning,** Chapter 24, p. 863.

PERFORMANCE OBJECTIVE V-TECS 26 (Continued)

EVALUATION

Questions

1. What does a limit control on a heating system using oil or gas test for?
2. If a limit control senses an excessive _________ _________ it will shut the system down.
3. What is the normal differential of a limit switch?
4. On most heating systems the limit switch is installed in the __________ volt circuit.

Answers

1. Air temperatures
2. High temperature
3. 40°F/50°F
4. Line

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 27

TASK: Adjust V-belts tension.

CONDITIONS: An electric motor connected to a blower, open end wrenches, ruler, manufacturer's specifications.

STANDARD: The tension must be adjusted to within + 1/8 inch of manufacturer's recommended tension.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect motor from power source.
2. Loosen pulley set screws.
3. Check deflection at center of greatest free span of belt.
4. Adjust deflection to manufacturer's specifications.
5. Tighten set screws.
6. Connect motor to power source.

ENABLING OBJECTIVE(S)
Use hand tools.
Read and understand manufacturer's specifications.

LEARNING ACTIVITIES
1. Show how to disconnect the power from the motor.
2. Using the correct tools, explain how to loosen pulley set screws.
3. Using your hand, demonstrate how to take hold of the belt and check the deflection at center of greatest free span of belt.
4. With the correct wrench, express how to adjust the belt to manufacturer's specifications.
5. Using the proper tool, review how to tighten the set screws.
6. Direct students in connecting the motor into the power source.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, Chapter 7, pp. 236-237.

EVALUATION
Questions
1. What is the width of an A belt?
   a. 1/4 in.
   b. 3/8 in.
   c. 1/2 in.
   d. 5/8 in.
   e. 3/4 in.

PERFORMANCE OBJECTIVE V-TECS 27 (Continued)

2. What is the most common way to measure the length of a belt?
   a. Inside length.
   b. The length around the complete distance around the belt.
   c. The inside length times two.
   d. The length 1/2 of its depth.
   e. The length 2/3 of its depth.
3. In what direction should a belt rotate?
   a. Clockwise.
   b. Counterclockwise.
   c. With the pull on the top section of the belt.
   d. With the pull on the bottom section of the belt.
   e. In any direction.
4. Why should the shafts be parallel?
   a. To keep the pulley from loosening.
   b. To keep proper tension.
   c. To keep the belt from coming loose.
   d. To reduce vibration.
   e. To reduce bearing and belt wear.
5. What is one way to check for correct belt tension?
   a. There is no evidence of slipping.
   b. There is no glazing of belt wearing surfaces.
   c. The belt does not flap as it revolves.
   d. The belt will move 1/2 inch out of line with a ten lb. force.
   e. The belt will move 1/2 inch out of line with a 150 lb. force.

Answers
1. c
2. a
3. e
4. e
5. d

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 28

TASK: Clean an electric motor.

CONDITIONS: An electric motor, basic tool kit, open end wrench, small socket wrench set, motor cleaning fluid.

STANDARD: The motor must be free of dirt and grease.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Clean exterior of motor.
2. Remove pulley.
3. Mark end bells.
4. Remove bolts.
5. Tap end bells loose.
6. Remove end bell opposite starting switch.
7. Remove rotor.
8. Clean motor with compressed air.
9. Clean bearings.
10. Replace switch end bell.
11. Check alignment of rotor and starter.
12. Tap end bells in place.
13. Insert bolts.
14. Oil bearings.

ENABLING OBJECTIVE(S)
Use hand tools.

LEARNING ACTIVITIES
1. Discuss the importance of cleaning the exterior of the motor.
2. Using the proper tools, show how to remove the pulley.
3. Demonstrate how to mark the end bells and remove bolts, then tap end bells loose using recommended tools and method.
4. Explain why you remove end bell opposite the starting switch first.
5. Explain how to remove the rotor and clean the motor with compressed air.
6. Express how to clean bearings and replace switch end bell, checking alignment of rotor and starter.
7. Demonstrate how to carefully tap end bells back in place and insert bolts.
8. Instruct students on the value of oiling bearings.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning,** Chapter 7, pp. 235-236.

PERFORMANCE OBJECTIVE V-TECS 28 (Continued)

EVALUATION

Questions

1. What is the main purpose of keeping the exterior of the motor clean?
   a. To keep it from overheating.
   b. To make it run faster.
   c. To improve appearance.
   d. To increase service years.
2. What is the purpose of marking the end bells?
   a. To keep from putting them on the wrong end.
   b. To observe motor polarity.
   c. To insure proper alignment of the bell end.
   d. To keep the motor from running at a lower speed.
3. What should the motor be cleaned with?
   a. Alcohol
   b. Compressed air
   c. Soap and water
   d. Cleaning solvent.
4. When the motor is reassembled, we must check the alignment of the ______________ and ________________.

Answers

1. a
2. c
3. b
4. Rotor, starter

Practical Application

Refer to Checklist Performance Objective 28. Provide proper service and clean the necessary parts.

Method of Evaluation

Use Checklist Performance Objective 28 to evaluate student's performance to determine if the task was completed with at least a 90% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 28 EVALUATION

PERFORMANCE TEST FOR CLEANING AN ELECTRIC MOTOR

Student's Name ______________________ **Date** __________

DIRECTIONS TO STUDENT: Set up the test equipment. Read the instructions. Clean the necessary parts and provide proper service.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completed the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Disconnect power from motor.	______	______
2. Clean the motor of dust and dirt accumulation that might cause overheating by preventing air flow, etc. Clean dust and dirt from fans, etc., that might cause an unbalance on the motor.	______	______
3. Check bearings for excessive end play or wear (horizontal and vertical).	______	______
4. Check shaft for freedom of rotation.	______	______
5. Lubricate the motor according to manufacturer's recommendations, being careful not to over lubricate.	______	______
6. Check for loose, frayed, or bare wiring.	______	______
7. Clean starting switch contacts where applicable. Use correct procedures: every cloth tends to insulate points where fine sandpaper does not.	______	______
8. Check brushes on wound rotor motors.	______	______
9. Clean brushes and commutator where applicable. Fine sandpaper is recommended.	______	______

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 28 EVALUATION (Continued)

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
10. Check drive mechanism: belt for tension and condition and pulleys for alignment.	_____	_____
APPROVED: Yes _____ No _____		

Evaluator's Signature ______________________ Date ______

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 29

TASK: Connect service line to power source.

CONDITIONS: A service line, basic tool kit, cable cutter, crimp connectors, electrical tape, strip tool, National Electric Codes, Local Electric Codes, wire insulation.

STANDARD: All electrical connections must be mechanically secure and in compliance with applicable National and Local Electrical Codes.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
National Electrical Code.

PERFORMANCE GUIDE

CAUTION: This task should be performed by an electrician.

1. Determine size of wire needed.
2. Measure length of wire.
3. Cut wire to measured length.
4. Separate twisted end of Triplex 2 feet.
5. Wrap tape at point where twist begins.
6. Fasten wedge clamp to neutral wire and fasten to house knob.
7. Strip insulation from conductors specified length on both SEC and Triplex.
8. Insert wire into connector and crimp.
9. Repeat for other current carrying wire, neutral wire, and groundwire.
10. Insulate connectors with specified insulation.

ENABLING OBJECTIVE(S)

Read and understand electrical codes.
Use hand tools.

LEARNING ACTIVITIES

1. Using a systematic load calculation, show the students how to determine the total amperage load to the electrical service.
2. Demonstrate the use of the National Electric Code charts and rules by relating the wire size to amperage capacity.
3. Upon determining the total amperes needed, have the students use the wire chart to find the gage wire that is needed, using a triplex twisted wire.
4. Direct the students in measuring the distance from the power source to the service entrance, then cut the wire that length.
5. Demonstrate how to separate the wire by removing the installation one inch from the end of the wire and unwind about two feet and tape to keep the wire from unwinding any further. Do each end like this.
6. Show how to insert the wire into a wedge clamp and connect to the house knob. The utility company will connect to the transformer for power.

RESOURCES

Foley, **Electrical Wiring Fundamentals**, Chapter 11, pp. 176-179.

PERFORMANCE OBJECTIVE V-TECS 29 (Continued)

EVALUATION

Questions

1. When we use a systematic load calculation we are looking for the total ___________ ___________ of the electrical service.
2. What rules do we use to show the relationship of a wire size to its amperage capacity?
3. In the average entrance cable there are normally ___________ cables?
4. When we strip the entrance cable we normally unwind ___________ feet for making connections?

Answers

1. Amperage load
2. National Electric Codes
3. 3
4. 2

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 30

TASK: Install conduit from meter box to circuit breaker/fuse panel.

CONDITIONS: Basic tool kit, conduit benders, fastening devices, National Electric Code, Local Electric Codes.

STANDARD: Installation must meet applicable National and Local Electrical Codes and be securely attached to meter base and circuit breaker/fuse panel.

SOURCE FOR STANDARD:
National Electrical Code.

PERFORMANCE GUIDE

1. Determine location of meter base and circuit breaker panel.
2. Determine path for conduit from meter base to circuit breaker/fuse panel.
3. Measure conduit.
4. Cut and/or bend conduit.
5. Install conduit.
6. Attach conduit to meter base and circuit breaker/fuse panel.

ENABLING OBJECTIVE(S)

Read and understand electrical codes.
Use hand tools.

LEARNING ACTIVITIES

1. Demonstrate how to install the meter base and the breaker panel at the selected location.
2. Explain how to determine the route that the conduit is to go to the circuit breaker and cut any necessary holes for the conduit feed through.
3. Using a measuring instrument, direct students in measuring the length of conduit that will be needed.
4. Using the proper cutting tools, demonstrate how to cut the conduit and make all necessary bends using conduit bending tools or table.
5. Using proper tools and fittings, discuss how to start at the meter base attaching conduit with locknut.
6. Use L bends or 90° bends, couplings, direct students in assembling of the conduit, working it to the breaker panel and connecting the conduit to the breaker panel.
7. After the conduit is assembled, show how to clean the work area and put the tools and extra materials up.

RESOURCES

Foley, **Electrical Wiring Fundamentals,** Chapter 11, pp. 182-184.

EVALUATION

Questions

1. What determines the location of the meter base?
2. Using conduit, the size is indicated by the ___________ of the wire.
3. What do we normally cut conduit with?
4. What is the purpose of using conduit?

PERFORMANCE OBJECTIVE V-TECS 30 (Continued)

Answers

1. Available power
2. Gauge or size
3. A tubing cutter
4. For electrical safety

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 31

TASK: Install "hard start kit" (potential relay and start capacitor).

CONDITIONS: A refrigeration system, potential relay, start capacitor, wire, electrical connectors, basic tool kit, manufacturer's specification/wiring schematic.

STANDARD: The potential relay and start capacitor must be securely attached and wired according to manufacturer's specifications and/or wiring diagram.

SOURCE FOR STANDARD:

Writing Team, State of Alabama.

Weaver and Kirkpatrick, **Environmental Control.**

Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Mount relay and capacitor.
3. Connect wires according to wiring schematic.
4. Restore power to unit.
5. Test amperage draw with ammeter.

ENABLING OBJECTIVE(S)

Use hand tools.

Read and understand manufacturer's specifications and wiring schematic.

LEARNING ACTIVITIES

1. Explain how to check the complete system and operate if possible.
2. If system will not operate, show how to shut off power and remove the starting relay and overload protector from the motor compressor.
3. Instruct the students to test the motor for open circuit, grounds, and shorts using test light and ohmmeter.
4. Demonstrate how to test the capacitor with capacitor tester for open circuit, shorts, grounds, and capacity. If faulty, replace with exact duplicate.
5. Interpret the process of connecting motor test cord with good capacitor to motor terminals and starting motor compressor.
6. If operational, tell how to replace wiring and operate system.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning,** Chapters 6 and 7.

EVALUATION

Questions

1. Which ohmmeter test of the three motor terminals has the highest resistance?
   a. Start to common.
   b. Run to common.
   c. Start to run.
   d. All are the same.
   e. The resistance is 0 for each test.

2. If one lead of an ohmmeter is on a terminal, where must the other one be to check for grounds?
   a. On one other terminal.
   b. On two other leads.
   c. Neither of the leads on the terminal.
   d. On the hermetic housing.
   e. On the overload protector terminal.
3. What happens when one installs an under-capacity capacitor?
   a. No change.
   b. Motor will overheat.
   c. Motor will run too fast.
   d. Capacitor will overheat.
   e. Motor will run too slowly.
4. What is the best way to test for a shorted winding?
   a. Test light.
   b. Ammeter.
   c. Volt meter.
   d. Ohmmeter.
   e. Thermometer.

Answers
1. c
2. d
3. b
4. d

Practical Application
Refer to Checklist Performance Objective 31. Wire, replace, and install "hard start kit," (potential relay and start capacitor).

Method of Evaluation
Use Checklist Performance Objective 31 to evaluate student's performance to determine if the task was completed with at least 90% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 31 EVALUATION

PERFORMANCE TEST FOR INSTALLING A "HARD START KIT"

Student's Name ______________________ Date __________

DIRECTIONS TO STUDENT: Set up test equipment. Read the instructions. Wire, replace, and install, "Hard Start Kit."

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completed the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Disconnect power, remove service panel.	______	______
2. Remove wire leads from contactor relay (if unit is being replaced).	______	______
3. Remove contactor relay.	______	______
4. Replace contactor relay with one of same electrical specifications.	______	______
5. Rewire contactor relay.	______	______
6. Connect power.	______	______
7. Start unit.	______	______
8. Test amperage draw, observe operation.	______	______
9. Stop unit.	______	______
10. Replace service panel.	______	______

APPROVED: Yes ______ No ______

Evaluator's Signature ______________________ Date __________

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 32

TASK: Install lockout relay.

CONDITIONS: Lockout relay, basic tool kit, manufacturer's specifications/wiring schematic.

STANDARD: The lockout relay must be securely attached and wired according to wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Disconnect wires.
3. Remove old lockout relay.
4. Mount new lockout relay.
5. Connect wires according to wiring schematic.
6. Restore power to unit.
7. Trip pressure control to test lockout relay.
8. Reset thermostat to put unit back into operation.

ENABLING OBJECTIVE(S)
Use hand tools.
Read and understand manufacturer's specifications and wiring schematic.

LEARNING ACTIVITIES
1. Show how to disconnect the power from the unit.
2. Using a screwdriver, demonstrate how to disconnect the wires of the lockout relay.
3. Discuss how to remove the old lockout relay and mount a new one in its place.
4. Using a screwdriver, tell how to reconnect the wires according to the wiring schematic.
5. Direct the students in restoring the power to the unit.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, Chapter 12.

EVALUATION
Questions
1. What does a lockout relay check for?
2. What voltage does a lockout relay normally operate in?
3. Is the lockout relay adjustable?
4. How can we correct a problem in a lockout relay?

PERFORMANCE OBJECTIVE V-TECS 32 (Continued)

Answers

1. A circuit failure
2. 120V
3. No
4. Replace it.

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 33

TASK: Install single-phase service entrance (3 wire).

CONDITIONS: Basic tool kit, holesaw, rigid conduit, service wire, ground rod, ground wire, ground clamp, pipe wrench, roof flashing, weather head, fastening devices, National Electric Code, Local Electric Codes.

STANDARD: A single-phase service entrance must be installed in accordance with applicable National and Local Electrical Codes. The conduit and electrical connections must be mechanically secure and grounded.

SOURCE FOR STANDARD:
National Electrical Code.

PERFORMANCE GUIDE

CAUTION: This task should be performed by an electrician.

1. Locate meter base.
2. Locate point on eve directly above meter base.
3. Saw hold in eve and roof.
4. Place conduit through hole in roof and eve and mount in meter base.
5. Tighten conduit to form a leak-proof joint in meter base.
6. Install leak- proof flashing at roof line.
7. Pull service and bare ground wire through conduit.
8. Drive ground rod.
9. Fasten bare ground wire to ground rod.
10. Connect conductors to terminals in meter base.
11. Fasten base of weather head to conduit.
12. Install wire divider in weather head.
13. Place cover on weather head.

ENABLING OBJECTIVE(S)

Use hand tools.
Read and understand electrical codes.

LEARNING ACTIVITIES

1. Using a measuring device, direct the students to measure from the ground up to approximately 5 feet or eye level. Then mount the meter base to the wall.
2. Using a rod, demonstrate how to find the location on the wall above the meter. The minimum distance from the ground to the service entrance or weather head is 10 feet. Show how to make a hole for mast or conduit according to its diameter in the eve of the roof.
3. Show how to install the mast through the hole in the eve then mount the mast into the threaded hole in the meter base. Once this is done, tighten the mast to meter base to make a watertight fit.
4. Explain how to install a flashing over the mast and attach to the roof sealing against leaks.
5. Tell how to fasten the proper amperage wires together with electrical connections. Feed them from the top down the mast until there is about 6 inches of wire in the meter base.

PERFORMANCE OBJECTIVE V-TECS 33 (Continued)

6. Demonstrate how to measure two feet of wire from the weatherhead and cut the wire off. Feed the wire into the insert for the weather head. Fasten into place, connecting hood on the weather head and securing the conduit about three feet below the service entrance, and each one foot if necessary.
7. Direct the students in installing the wires in the meter base into the lugs. The ground wire will be connected to the ground terminal and a wire extended down to a ground rod that is eight feet long and driven into the ground.
8. Lecture on the importance of testing wires to ensure the hot wires are connected to meter terminals. If the ground wire is not bare, explain how to mark it with white tape at the service entrance.

RESOURCES

Foley, **Electrical Wiring Fundamentals**, Chapter 11, pp. 179-181.

EVALUATION

Questions

1. When installing a meter base, the distance from the ground to the meter base is ________ ________.
2. When installing a service entrance, what is the minimum distance between the ground and the weather head.
3. The conduit that extends from the meter base to the weather head is called the ____________.
4. A straping that secures the conduit is located __________ feet below the weather head?
5. After connecting all wires we always check for a __________ condition.

Answers

1. Five feet
2. Ten feet
3. Mast
4. Three feet
5. Shorted

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 34

TASK: Install weather head.

CONDITIONS: Basic tool kit, weather head, ladder, National Electric Code, Local Electric Codes, service entrance.

STANDARD: The weather head must be mechanically secure and meet applicable National and Local Electrical Code standards.

SOURCE FOR STANDARD:
National Electrical Code.

PERFORMANCE GUIDE

CAUTION: This task should be performed by an electrician.

1. Locate service entrances.
2. Disassemble weather head.
3. Mount base of weather head on conduit.
4. Install divider into base of weather head.
5. Insert wires into divider.
6. Install weather hood on base of weather head.

ENABLING OBJECTIVE(S)

Read and understand electrical codes.

LEARNING ACTIVITIES

1. After the service entrance has been located, direct the student to obtain the weather head and necessary tools.
2. Using the tools, explain how to disassemble the weather head, knocking the filler plugs out of the wire separator.
3. Using the necessary tool, demonstrate how to connect the base of the weather head to the mast ensuring the mask is supported about 12 inches below the weather head.
4. Describe how to separate the wires and install the wire divider and secure it in place.
5. Using the necessary tools, show how to bend the wire down and install the service cap.

RESOURCES

Foley, **Electrical Wiring Fundamentals,** Chapter 11, pp. 182-184.

EVALUATION

Questions

1. The weather head is mounted at the top of the ____________.
2. What is the purpose of the weather head?
3. What are the three parts of a weather head?

Answers

1. Mast
2. To prevent water leaks
3. The head, the wire divider, and the base

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 35

TASK: Make RPM test on electric motor.

CONDITIONS: Tachometer, blowers, basic tool kit, manufacturer's specifications, electric motor with rated RPM.

STANDARD: Deviation greater than 100 RPM of rated RPM must be noted.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

CAUTION: Wear protective hair covering and properly fitted clothing around moving machinery.

1. Remove panel for access to motor and blower shafts.
2. Connect tachometer to shaft for required test.
3. Record test and make comparison to rated RPM.
4. Replace panel.

ENABLING OBJECTIVE(S)

Use a tachometer.
Use hand tools.
Read and understand manufacturer's specifications.

LEARNING ACTIVITIES

1. Demonstrate how to remove panel to obtain access to the motor and blower shafts.
2. Show how to remove the blower from the shaft.
3. Explain how to connect the tachometer to the motor shaft and engage power.
4. Using the designated RPM rate for the motor, direct the students in testing with the tachometer. Have the students record findings and make a comparison to rated RPM.
5. Direct students to replace the panel and clean up the work area.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning,** Chapter 7.

EVALUATION

Questions

1. What is the purpose of checking the RPM?
2. In checking the motor speed, where do we attach the tachometer?
3. Using the recorded RPM, we check this recording with the ________________ ____________ to make a comparison of the motor speed.
4. We can also reduce the motor speed by adding _____________ in the motor circuit.

PERFORMANCE OBJECTIVE V-TECS 35 (Continued)

Answers
1. To determine the motor speed
2. To the motor shaft
3. Manufacturer's rating
4. Resistance

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 36

TASK: Mount circuit breaker panel and install circuit breaker.

CONDITIONS: Basic tool kit, screws, bolts, etc., circuit breaker panel, circuit breaker.

STANDARD: The circuit breaker panel must be securely mounted at the specified location and level. The circuit breaker(s) must be rated to load specified by circuit.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

CAUTION: This task should be performed by an electrician.

1. Determine location of breaker box.
2. Fasten breaker box to wall.
3. Remove cover from electrical distribution panel.
4. Mount circuit breaker to bus bar.
5. Connect wires to breaker.
6. Connect electricity to bus bar.
7. Turn breakers on.
8. Test voltage at wire connections.
9. Install panel cover.

ENABLING OBJECTIVE(S)

Use hand tools.

LEARNING ACTIVITIES

1. Discuss the need to select the location where the breaker panel is to be mounted and have a student remove the panel cover.
2. Using the proper fastening devices, demonstrate how to mount the breaker panel to the wall and install the main breaker.
3. Show how to install the service cable through the top of the breaker panel and connect the black wire to one side of the main breaker and the red wire to the other terminal of the main breaker.
4. Tell how to install the ground wire to the ground terminal.
5. Discuss how to install the required breakers, if 240 volts are needed use a double pole breaker. This distributes the power load equally between the two main bus terminals. If 120 volts are required use a single pole breaker. This connects to only one bus terminal.
6. After the breakers are installed, review how to connect each branch circuit to its prospective breaker and the ground wires to the ground or neutral bus.
7. Using an ohmmeter, show the students how to check the circuits for any grounded condition. Explain that if there are no shorts then the power should be turned on and voltage checked at the wire connections. Direct the student to install the panel cover and clean the area.

PERFORMANCE OBJECTIVE V-TECS 36 (Continued)

RESOURCES

Foley, **Electrical Wiring Fundamentals**, Chapter 11, pp. 182-183.

EVALUATION

Questions

1. In a breaker panel the two hot bus bars are referred to as the ____________ bus and the ____________ bus.
2. How many bus bars does a single pole breaker connect?
3. How many volts can we use from the breaker panel using a single pole breaker?
4. A double pole breaker is connected to ____________ bus of the breaker panel.
5. What item of test equipment do we use to check for a shorted condition?

Questions

1. Black bus, red bus
2. One
3. 120 volts
4. Two or both
5. An ohmmeter

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 37

TASK: Mount meter base and meter.

CONDITIONS: Basic tool kit, 6 ft. ruler, a meter base and meter.

STANDARD: The meter base must be mounted at the specified height and be level. The meter must be firmly attached, protected by a protective cover and locking bank, and be sealed.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

CAUTION: This task should be performed by an electrician.

1. Locate meter base installation site.
2. Mount center of meter base 5½ feet from ground level.
3. Level meter base and mark fastening holes.
4. Drill holes in wall where marked.
5. Fasten base.
6. Recheck level of meter base.
7. Remove protective cover and locking band from meter base.
8. Align meter plug terminals (male) with meter base terminals (female).
9. Push meter in socket until a tight fit is obtained.
10. Replace meter protective cover and locking band.
11. Install seal.

ENABLING OBJECTIVE(S)

Use hand tools.
Read a ruler.

LEARNING ACTIVITIES

1. Observing the position of the structure and the location of the power lines, discuss the requirement to select the installation site for the meter base.
2. Using the rule of thumb in electricity the meter base should be at eye level or between 4 to 6 feet above the ground. For this installation, instruct students to locate the meter base 5½ feet from the ground.
3. Explain the value of selecting the proper drill bits for the structure materials and demonstrate how to drill the holes to mount the meter base. When mounting the meter base the socket jaws should be truly vertical.
4. After the meter socket is mounted, show how to insert the meter into the socket firmly and replace meter cover and the locking band.
5. Direct the students in installing the protective seal and cleaning work area.

RESOURCES

Foley, **Electrical Wiring Fundamentals**, Chapter 11, pp. 181-182.

PERFORMANCE OBJECTIVE V-TECS 37 (Continued)

EVALUATION

Questions

1. The position of the structure and the location of the power lines determine the location of the __________ __________.
2. What is the distance between the meter base and the ground?
3. When mounting the meter base, why must we make sure the socket jaws are truly vertical?
4. A meter base is made of materials that are __________ __________.

Answers

1. Meter base
2. Eye level or five feet
3. To make sure the meter does not drag.
4. Water proof

DUTY: INSTALLILNG AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 38

TASK: Replace air pressure switch.

CONDITIONS: Air pressure switch, basic tool kit, manufacturer's specifications/wiring schematic, a refrigeration system.

STANDARD: The air pressure switch must be mechanically secure and all electrical connections must be in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Locate air pressure switch.
3. Disconnect wires.
4. Remove old air pressure switch.
5. Mount replacement air pressure switch.
6. Reconnect wires.
7. Restore power to unit.
8. Start system and check operation.

ENABLING OBJECTIVE(S)
Use hand tools.
Read and understand manufacturer's specifications and wiring schematic.

LEARNING ACTIVITIES
1. Explain the importance of measuring the duct size.
2. Tell how to determine the type of airflow control, damper control, or fire damper used, and its size.
3. Demonstate how to operate the system and measure the air velocities and calculate the air volumes and temperatures.
4. The instructor should assign the air volumes desired at each opening.
5. Show how to operate the system and adjust the damper controls or airflow controls to the desired volumes.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning.**

EVALUATION
Questions
1. Which of the following will cause an airflow control to react?
   a. If the air temperature in the room is too high or too low.
   b. If the air temperature to the room is too high or too low.
   c. If the temperature in the fresh air is too high or too low.
   d. If the temperature in the exhaust air is too high or too low.
   e. All of the above.

PERFORMANCE OBJECTIVE V-TECS 38 (Continued)

2. What usually causes a fire damper to close?
   a. The heating of a fusible leak.
   b. The lack of airflow in the ducts.
   c. A pressure stat in the room indicating overheating.
   d. The recycling of the air conditioner.
   e. All of the above.

3. What is the air fed into a fan called?
   a. Forced draft.
   b. Induced draft.
   c. Inertia.
   d. Axial flow.
   e. Radial flow.

Answers

1. e
2. a
3. a

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 39

TASK: Replace belts.

CONDITIONS: Basic tool kit, belt length gauge, belt tension gauge, belt, manufacturer's specifications, a refrigeration system.

STANDARD: The belt must be the correct size, tension must be adjusted to within + 1/8 inch of manufacturer's recommended tension, and the belt must stay on track.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect motor from power source.
2. Remove service panel.
3. Loosen belt adjustment.
4. Remove belt.
5. Inspect the belt pulleys and flywheel.
6. Install new belt.
7. Adjust belt tension.
8. Restore power to unit.
9. Start motor, check belt tension and amp draw.
10. Shut off motor.
11. Replace service panel.

ENABLING OBJECTIVE(S)
Use hand tools.
Read and understand manufacturer's specifications.

LEARNING ACTIVITIES
1. Measure the outside lengths of three V-belts.
2. Identify a belt adjusting and aligning tool.
3. Identify a belt tension gauge.
4. Explain motor shaft, compressor shaft and alignment.
5. Explain pulley groove, fly wheel, groove alignment.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 236-237, 909.
Smith, **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 159-161.

EVALUATION
Questions
1. What is the most popular way to drive the open compressor and large fans?
2. A poorly aligned belt will do what to the life of the motor?
3. How far should one be able to depress a properly tensioned belt when applying a 10 pound force?
4. Where is the belt adjusting and aligning tool applied to tension the belt?
5. What is the three standard widths that most belts fall into?

PERFORMANCE OBJECTIVE V-TECS 39 (Continued)

Answers

1. V-belts
2. Shorten
3. 1/2 inch
4. Between the pulley and the flywheel.
5. A. 1/2 inch
   B. 5/8 inch
   C. 15/16 inch

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 40

TASK: Replace electric motor.

CONDITIONS: Basic tool kit, wire nuts, electrical tape, manufacturer's specifications/wiring schematic, a refrigeration system, parts.

STANDARD: The motor must be mechanically secure. All electrical connections must be secure and in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
State Department of Education, Alabama. **Air Conditioning and Refrigeration.**

PERFORMANCE GUIDE
1. Disconnect motor from power source.
2. Disconnect all electrical wiring to motor.
3. Unbolt motor from base mount and remove fan, coupling, or pulley from motor.
4. Remove motor.
5. Install new motor with same electrical specifications.
6. Install fan, coupling, or pulley.
7. Reconnect all wires.
8. Connect motor to power source.
9. Start motor.
10. Check for proper rotation and amperage draw.

ENABLING OBJECTIVE(S)
1. Read schematic diagram.
2. Use tools such as wrenches.
3. Fuse a clamp around amp meter.

LEARNING ACTIVITIES
1. Instruct students to read **Modern Refrigeration and Air Conditioning,** pp. 227-233, 234-236, 238.
2. Demonstrate how to locate and identify electric motor nameplate-dataplate.
3. List locked rotor amps shown on the motor nameplate.
4. List RPMs shown on the motor nameplate.
5. Record the electric motor nameplate voltage.
6. Identify the type of electric motor being used.
7. Show how to lubricate electric motor bearings.
8. Record full load amperage shown on the motor nameplate.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning,** pp. 237-732, 234-236, 238.

Phase 1(s) **Fundamentals of Residential Heating and Cooling,** Lennox Industries, Inc., pp. 12, 13, 18, 20, 22-27.

PERFORMANCE OBJECTIVE V-TECS 40 (Continued)

EVALUATION

Questions

1. Which two motor "drives" are used to connect the motor to the load?
2. Which color wire lead (speed tap) coming from a four speed motor is normally used for low speed?
3. Which color wire lead (speed tap) coming from a four speed motor is normally used for high speed?
4. How many setscrews does an adjustable motor pulley have?

Answers

1. Belt drive and direct drive
2. Red
3. Black
4. Two

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS.

PERFORMANCE OBJECTIVE V-TECS 41

TASK: Replace contactor relay.

CONDITIONS: Contactor relay, basic tool kit, manufacturer's specifications/wiring schematic, a refrigeration unit, tools, equipment and materials.

STANDARD: The contactor relay must be mechanically secure and be wired in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Remove service panels.
3. Remove wires from contactor relay.
4. Remove contactor relay.
5. Replace contactor relay with one of same electrical specifications.
6. Rewire contactor relay.
7. Connect unit to power source.
8. Start unit.
9. Test amperage draw.
10. Stop unit.
11. Replace service panel.

ENABLING OBJECTIVE(S)

Read schematic diagram.
Use hand tools to include screwdrivers, nutdrivers, long round nosepliers.

LEARNING ACTIVITIES

1. Instruct students to read **Electricity for Refrigeration, Heating, and Air Conditioning**, pp. 166-172 and **Refrigeration and Air Conditioning**, pp. 298-299.
2. Locate and identify the contactor used in an air conditioning or refrigeration unit.
3. List the electrical specifications (voltage, cycles, amperage) shown on the contactor relay.
4. Show how to draw the electrical symbol for a contactor relay having a coil and the sets of normally open contacts.
5. Demonstrate how to check a contactor coil with an ohmmeter to test for opens and shorts.
6. Explain how to pick out the stationary contacts in the contactor relay.

RESOURCES

Langley, **Refrigeration and Air Conditioning**, pp. 298-299.
Smith, **Electricity for Refrigeration, Heating, and Air Conditioning**, pp. 166-172.

PERFORMANCE OBJECTIVE V-TECS 41 (Continued)

EVALUATION

Questions

1. Other than the contacts, name the portion of a contactor that moves.
2. When the coil of a contactor is energized, what is created around the laminated core within the coil?
3. Contactor contacts are normally made of which two types of metal?
4. What resistance will be shown on the ohmmeter if the contactor coil is shorted?
5. The ohmmeter reading will show what resistance if the contactor coil is open?

Answers

1. Armature
2. Magnetic field
3. Silver and cadmium
4. Zero
5. Infinity

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 42

TASK: Replace current relay.

CONDITIONS: Current relay, basic tool kit, manufacturer's specifications/wiring schematic, a refrigeration system, tools, equipment and material.

STANDARD: The current relay must be mechanically secure and be wired in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Remove compressor terminal cover.
3. Remove relay from terminals.
4. Remove wires from relay.
5. Push replacement relay on compressor terminals.
6. Wire replacement relay.
7. Connect unit to power source.
8. Start unit.
9. Test amperage draw.
10. Stop unit.

ENABLING OBJECTIVE(S)

Use wiring diagram.
Use hand tools such as screwdrivers, nutdrivers and long round nose pliers.

LEARNING ACTIVITIES

1. Instruct students to read **Modern Refrigeration and Air Conditioning,** pp. 260-261 and **Electricity for Refrigeration, Heating, and Air Conditioning,** pp. 150-152.
2. Explain the operation of a current relay.
3. Describe the construction of a current relay.
4. Demonstate how to draw the electrical symbol of a current relay.
5. Test the current relay contacts with an ohmmeter.
6. Show how to check the current relay coil with an ohmmeter.
7. Identify "L, M & S" terminals on the current relay.

RESOURCES

Smith, **Electricity for Refrigeration, Heating and Air Conditioning,** pp. 150-152.
Althouse, et al., **Modern Refrigeration and Air Conditioning,** pp. 260-261.

PERFORMANCE OBJECTIVE V-TECS 42 (Continued)

EVALUATION

Questions

1. Which terminal of the current relay is the "hot" power supply hooked up to?
2. Terminal "M" of the current relay is electrically connected to which compressor motor terminal?
3. Is the coil of the current relay constructed of large wire or small wire?
4. Within the current relay, what is located and connected between terminals "L" and "M"?

Answers

1. "L"
2. Run
3. Large
4. The coil

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 43

TASK: Replace defrost heater.

CONDITIONS: Replacement heater, basic tool kit, ohmmeter, manufacturer's specifications/wiring schematic, a refrigeration system with a defrost heater.

STANDARD: The defrost heater must be mechanically secure and be wired in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Remove breaker strips to locate heater.
3. Isolate and check circuit with ohmmeter.
4. Locate defrost heater and remove.
5. Identify and tag wires.
6. Install replacement defrost heater.
7. Connect unit to power source.
8. Start unit.
9. Place unit in defrost and check amperage draw.
10. Stop unit.
11. Replace breaker strips.
12. Reinstall cabinet parts.

ENABLING OBJECTIVE(S)

Use wiring diagram.
Use knowledge of disassembly of the domestic refrigerator.

LEARNING ACTIVITIES

1. Instruct students to read **Modern Refrigeration and Air Conditioning**, pp. 309-313, 318, 321-323, 348 and **Refrigeration and Air Conditioning**, pp. 296, 310-312.
2. Describe the operation of the defrost heater circuit while reading a schematic diagram.
3. Demonstrate how to check defrost heater with an ohmmeter.
4. Draw a diagram of a domestic refrigerator defrost heater circuit.
5. Explain the operation of a defrost timer.
6. Tell how the defrost limiter switch functions.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 309-313, 318, 321-323, 348.
Langley, **Refrigeration and Air Conditioning**, pp. 296, 310-312.

PERFORMANCE OBJECTIVE V-TECS 43 (Continued)

EVALUATION

Questions

1. The defrost limiter switch (defrost termination thermostat) normally opens at approximately what temperature?
2. Most defrost heaters are attached to which refrigeration component?
3. What ohmmeter reading indicates an open defrost heater?
4. Is the defrost heater wired in series or parallel with the defrost termination thermostat?

Answers

1. 50°F or 10°C.
2. The evaporator
3. Infinity
4. Series

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 44

TASK: Replace defrost thermostat.

CONDITIONS: Defrost thermostat, basic tool kit, manufacturer's specifications/wiring schematic, a refrigeration system, tools, equipment and material.

STANDARD: The defrost thermostrat must be mechanically secure and be wired in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Remove breaker strip to locate defrost thermostat.
3. Isolate and check circuit with ohmmeter.
4. Locate thermostat and remove.
5. Identify and tag wires.
6. Install replacement defrost thermostat.
7. Connect unit to power source.
8. Start unit.
9. Place unit in defrost and watch for defrost termination.
10. Stop unit.
11. Replace breaker strip.

ENABLING OBJECTIVE(S)
Use wiring diagram.
Use knowledge of disassembly of a domestic refrigerator.

LEARNING ACTIVITIES
1. Instruct student to read **Modern Refrigeration and Air Conditioning**, pp. 311-329 and **Refrigeration and Air Conditioning**, pp. 310-312.
2. Draw the electrical symbol for a defrost thermostat.
3. Explain the operation of a defrost thermostat in the defrost circuit.
4. Identify a defrost thermostat.
5. Show how to check a defrost thermostat with an ohmmeter.
6. Demonstrate how to draw a schematic diagram of a defrost circuit showing the location of the defrost thermostat within the circuit.
7. List the approximate opening and closing temperatures of defrost thermostats.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 311-329.
Langley, **Refrigeration and Air Conditioning**, pp. 310-312.

PERFORMANCE OBJECTIVE V-TECS 44 (Continued)

EVALUATION

Questions

1. Is the defrost thermostat electrically wired in parallel or in series with the defrost heater?
2. What ohmmeter reading indicates that the defrost thermostat contacts are closed?
3. At what approximate temperature does the defrost thermostat contacts close?
4. Is the defrost thermostat a manual reset or automatic reset switch?

Answers

1. Series
2. Zero
3. 30°F or -1.1°C.
4. Automatic reset.

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 45

TASK: Replace defrost timer.

CONDITIONS: Defrost timer, basic tool kit, manufacturer's specifications/wiring schematic, a refrigeration system, tools and equipment.

STANDARD: The defrost timer must be mechanically secure and be wired in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Locate timer.
3. Remove wires from timer and tag for identification.
4. Remove timer.
5. Install new defrost timer.
6. Wire new timer according to wiring diagram.
7. Connect unit to power source.
8. Test operation with volt meter while turning timer manually.

ENABLING OBJECTIVE(S)
Use wiring diagrams.
Use knowledge of the disassembly of a domestic refrigerator.

LEARNING ACTIVITIES
1. Instruct students to read **Modern Refrigeration and Air Conditioning**, pp. 311-329, and **Refrigeration and Air Conditioning**, pp. 310-312.
2. Draw the electrical symbol for a defrost timer.
3. Discuss in writing the operation of a defrost timer.
4. Show how to identify a defrost timer.
5. Demonstrate how to identify a defrost timer motor.
6. Test a defrost timer motor with an ohmmeter.
7. Test a defrost timer open contacts with an ohmmeter.
8. Test a defrost timer closed contacts with an ohmmeter.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 311-329.
Langley, **Refrigeration and Air Conditioning**, pp. 310-312.

EVALUATION
Questions
1. Domestic refrigerator defrost timer motors normally use __________ volts for their operation.
   a. 24
   b. 115
   c. 230
   d. 440

PERFORMANCE OBJECTIVE V-TECS 45 (Continued)

2. Are defrost timer defrost contacts electrically wired in series or in parallel with the defrost thermostat?
3. Are defrost timer defrost contacts electrically wired in series or in parallel with the defrost heater?
4. Name a circuit that the defrost timer will complete (energize) after completion of the defrost cycle.
5. The defrost timer is located on the evaporator coil. (True or False)

Answers

1. 115
2. Series
3. Series
4. Compressor motor or freezer blower motor.
5. False

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 46

TASK: Replace drive pulley.

CONDITIONS: Wheel puller, basic tool kit, allen wrenches, straight edge, 6" steel ruler, a motor with a pulley, tools and equipment.

STANDARD: The new drive pulley must be in position, mechanically secure and aligned.

SOURCE FOR STANDARD:
State Department of Education, Alabama, **Air Conditioning and Refrigeration.**

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Remove belts or fans.
3. Loosen set screws.
4. Attach wheel pulley, if necessary.
5. Clean and oil shaft.
6. Heat may be applied to wheel hub if needed.
7. Remove fly wheel.
8. Clean and oil shaft again.
9. Install replacement pulley, (alignment key, if used).
10. Position pulley correctly on shaft.
11. Tighten set screw.
12. Replace fan or belts.
13. Start unit and check for mechanical security and alignment.

ENABLING OBJECTIVE(S)
Use hand tools.

LEARNING ACTIVITIES
1. Instruct students to read **Modern Refrigeration and Air Conditioning**, pp. 236-237.
2. Identify an adjustable "V" pulley with one "V" groove.
3. Identify an adjustable "V" pulley with two "V" grooves.
4. Identify a wheel puller.
5. Explain the correct use of a wheel puller.
6. State the method used to insure that the pulley and flywheel are in line with each other.
7. List two types of pulleys.
8. List two types of construction (metals) used in the construction of pulleys.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 236-237.
Lennox Industries, Inc., Phase 1 (s) **Residential Heating and Cooling**, (Fundamentals and Maintenance), pp. 23-27.

PERFORMANCE OBJECTIVE V-TECS 46 (Continued)

EVALUATION

Questions

1. Does the "A" width pulley fit belts 1/2 in. to 11/16 in. wide or belts up to 17/32 inch in width?
2. When using a variable pitch pulley, how much may the speed of the driven unit be varied?
3. What device may be used to adapt (reduce) a pulley with a 3/4 inch bore to a 1/2 inch bore?
4. Do pulley set screws usually have a "national fine" thread or a "national course" thread?

Answers

1. Belts up to 17/32 inches in width
2. As much as 30 percent
3. A bushing
4. National course threads

Practical Application

Refer to Checklist Performance Objective 46. Performance Test for Replacing Drive Pulley.

Method of Evaluation

Use Checklist Performance Objective 46 to determine if the assignment was completed with at least 90% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 46 EVALUATION

PERFORMANCE TEST FOR REPLACING DRIVE PULLEY

Student's Name _______________________________ Date

DIRECTIONS TO STUDENT: Remove and replace a drive pulley on a motor shaft using the basic tool kit, wheel puller, 6" steel ruler, allen wrenches and a straight edge.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Give the student reasonable time to compiete the job. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Power disconnected from unit.	______	______
2. Belts or fans removed.	______	______
3. Check and record position of pulley.	______	______
4. Set screws loosened.	______	______
5. Shaft cleaned and oiled.	______	______
6. Wheel puller properly used.	______	______
7. Shaft cleaned and oiled.	______	______
8. Pulley installed in correct position on shaft.	______	______
9. Was alignment checked.	______	______
10. Set screw tightened.	______	______
11. Fan or belt checked prior to installing.	______	______
12. Was unit started, operation, mechanical security and alignment of pulley checked?	______	______
13. Work station cleaned.	______	______
14. Tools cleaned and put away.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature _______________________________ Date

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 47

TASK: Replace electric actuating valve.

CONDITIONS: Basic tool kit, manufacturer's specifications/wiring diagram, a refrigeration system with an electric actuating valve, tools, equipment and materials.

STANDARD: The actuating valve must be mechanically secure, wired in accordance with wiring diagram and/or manufacturer's specifications, and be calibrated.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Remove wires.
3. Remove linkage.
4. Remove hold-down bolts.
5. Remove actuating valve.
6. Position new actuating valve.
7. Replace hold-down bolts.
8. Connect wires according to wiring diagram.
9. Calibrate.
10. Connect unit to power source.
11. Check system operation.

ENABLING OBJECTIVE(S)
Use knowledge of wiring diagrams.
Use knowledge of electrical safety.

LEARNING ACTIVITIES
1. Read and discuss **Electric Controls for Refrigeration and Air Conditioning,** pp. 103-107 and **Electricity for Refrigeration, Heating, and Air Conditioning,** pp. 270-276.
2. Identify an electric actuating valve.
3. Describe orally the purpose and operation of an electric actuating valve.
4. Demonstrate how to test the actuating valve motor with an ohmmeter.
5. Show how to check the electrical power supply for the actuating valve with a volt meter.
6. List the steps in cleaning and lubricating linkage of an electric actuating valve.

RESOURCES
Langley, **Electric Controls for Refrigeration and Air Conditioning,** pp. 103-107.
Smith, **Electricity for Refrigeration, Heating and Air Conditioning,** pp. 270-276.

PERFORMANCE OBJECTIVE V-TECS 47 (Continued)

EVALUATION

Questions

1. Which test meter should be used to check an electric actuating valve's motor windings?
2. Which testing meter should be used to check the electrical power supply to the actuating valve?
3. After installing a new actuating valve, the valve must be calibrated. (True or False)

Answers

1. Ohmmeter
2. Voltmeter
3. True

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 48

TASK: Replace fan blade.

CONDITIONS: Fan blade, basic tool kit, fan blade puller, a fan, tools, equipment and material.

STANDARD: The fan blade must be mechanically secure, turn in direction of arrow indicator, and have clearance from surrounding case or shroud.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Loosen set screw on fan blade.
3. Remove fan blade.
4. Position new fan blade.
5. Tighten set screw.
6. Connect unit to power source.
7. Start unit.
8. Check rotation and clearance.

ENABLING OBJECTIVE(S)
Use hand tools.

LEARNING ACTIVITIES

1. Instruct students to read **Modern Refrigeration and Air Conditioning**, pp. 789-791.
2. Show how to identify an axial flow (propeller) type fan.
3. Tell how to identify a radial flow (squirrel cage) type fan.
4. Discuss in writing the difference between induced draft and forced draft.
5. Explain the correct method of cleaning a fan.
6. Show how to oil a fan motor.
7. Demonstrate how to clean an axial flow fan.
8. Determine if a propeller type fan blades are bent and will possibly cause excessive vibration and noise.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 789-791.

EVALUATION
Questions

1. Name two particles which collect on a fan and reduce its efficiency.
2. How often should dust be removed from a fan?
3. Name two types of drive for a radial flow fan.
4. The fan speed can be changed by using an adjustable (variable pitch) pulley. (True or False)
5. Does a propeller fan move by radial flow or axial flow?

PERFORMANCE OBJECTIVE V-TECS 48 (Continued)

Answers

1. Lint and dirt.
2. Every six months.
3. Direct drive and belt drive.
4. True
5. Axial flow.

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 49

TASK: Replace fan control switch (speed control relay).

CONDITIONS: Fan control switch, basic tool kit, manufacturer's specifications/wiring schematic, a fan, tools, equipment and materials.

STANDARD: The switch must be mechanically secure and wired in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Remove service panel.
3. Disconnect wires.
4. Remove control switch.
5. Position replacement control switch.
6. Make electrical connections in accordance with wiring diagram.
7. Connect unit to power source.
8. Start unit.
9. Test operation.
10. Replace service panel.

ENABLING OBJECTIVE(S)
Use wiring diagram.
Use hand tools.
Read and understand manufacturer's specifications and schematic.

LEARNING ACTIVITIES
1. Demonstrate how to identify a fan control relay switch.
2. Explain how to check the normally closed contacts with an ohmmeter.
3. Show how to check the normally closed contacts with an ohmmeter.
4. Illustrate how to check the coil for opens or shorts with an ohmmeter.
5. Describe the operation of the relay for high speed fan operation.
6. Describe the operation of the relay for low speed fan operation.
7. Draw the electrical symbol for a fan control relay switch.

RESOURCES
Atlhouse, et al. **Modern Refrigeration and Air Conditioning**, pp. 789-791.

EVALUATION
Questions
1. How many sets of contacts are normally located within a fan control relay switch?
2. Is a fan control relay switch coil normally energized for high speed fan operation or low speed fan operation?
3. Are the normally closed relay contacts used for high fan speed or low fan speed?

PERFORMANCE OBJECTIVE V-TECS 49 (Continued)

4. The normally open contacts are wired in series with the fan motor low speed winding tap. (True or False)
5. Is the relay coil energized for heating or cooling when using a gas furnace and air conditioning unit?

Answers

1. Two
2. High
3. Low
4. False
5. Cooling

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 50

TASK: Replace fuse.

CONDITIONS: Basic tool kit, cartridge fuse, National Electric Codes, Local Electric Codes.

STANDARD: The fuse must be mechanically secure and meet applicable National and Local Electrical Code standards.

SOURCE FOR STANDARD:
National Electrical Code.

PERFORMANCE GUIDE
1. Disconnect power to fuse box.
2. Locate and remove old fuse.
3. Check fuse receptacle.
4. Insert new fuse.
5. Connect power to fuse box.

ENABLING OBJECTIVE(S)
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES
1. Instruct student to read **Modern Refrigeration and Air Conditioning**, p. 206, **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 58-59, 107-111, **Principles of Refrigeration**, pp. 281-182.
2. Illustrate how to draw the electrical symbol for a fuse.
3. Show how to check a fuse in a circuit with a voltmeter.
4. Test a fuse with an ohmmeter.
5. Demonstrate how to identify a plug fuse.
6. Demonstrate how to identify a cartridge fuse.
7. Differentiate the difference between a renewable fuse and a non-renewable fuse.
8. Explain how to "short" circuit blows a fuse.
9. Describe the operation of a time delay fuse in a motor circuit.

RESOURCES
Lennox Industries Inc., **Residential Heating and Cooling**, (Fundamentals and Maintenance) Phase 1 (s), pp. 14-17.
Althouse, **Modern Refrigeration and Air Conditioning**, p. 206.
Smith, **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 58-59, 107-111.
Marsh, **Principles of Refrigeration**, pp. 281-282.

PERFORMANCE OBJECTIVE V-TECS 50 (Continued)

EVALUATION

Questions

1. Are fuses rated in amperage or ohms?
2. Which type fuse allows for temporary overloads in motor circuits?
3. Which type of cartridge fuse is constructed so that the fuse element may be replaced, instead of the complete fuse?
4. What electrical test meter may be used to check a fuse in the circuit with the circuit power on?
5. When checking a fuse that is good, what reading will an ohmmeter indicate?

Answers

1. Amperage
2. Dual element -- time delay.
3. Renewable
4. Voltmeter
5. Zero

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 51

TASK: Replace hermetic compressor overload protector.

CONDITIONS: Basic tool kit, hermetic compressor overload protector, manufacturer's specifications/wiring schematic, an air conditioner, tools and equipment.

STANDARD: The overload protector must be mechanically secure and wired in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Remove wire from defective overload protector.
3. Remove overload protector from mount.
4. Mount replacement overload protector.
5. Wire replacement overload protector.
6. Restore power to unit.
7. Attach ammeter to common side of overload protector.
8. Start compressor.
9. Record amperage reading and compare to manufacturer's specifications.
10. Remove ammeter.

ENABLING OBJECIVE(S)
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES
1. Instruct students to read **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 177-185; **Modern Refrigeration and Air Conditioning**, pp. 224-226.
2. Show how to identify hermetic compressor motor external overload protector.
3. Illustrate how to draw an overload protector electrical symbol.
4. Illustrate how to draw a compressor motor electrical circuit with an external overload protector.
5. Show how to check an overload protector with an ohmmeter.
6. Explain the operation of an overload protector.

RESOURCES
Smith, **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 177-185.
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 224-226.

Questions

1. Which compressor motor terminal is the simple bimetal overload protector wired to?
2. What causes the overload protector bimetal disc to snap open the contacts?
3. When checking an overload protector with an ohmmeter, the meter will read __________ if the overload is open.
   a. Infinity
   b. 115 volts
   c. Zero
   d. 230 volts
4. Some overload protectors have heaters within the overload. (True or False)

Answers

1. C Terminal.
2. Excessive heat.
3. Infinity
4. True

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 52

TASK: Replace hot-wire relay.

CONDITIONS: Hot wire relay, basic tool kit, manufacturer's specifications/wiring schematic, a refrigeration unit, tools, equipment and material.

STANDARD: The hot-wire relay must be mechanically secure and wired in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Locate relay.
3. Remove wires from relay.
4. Remove relay.
5. Position new relay.
6. Make electrical connections.
7. Connect unit to power source.
8. Start unit.
9. Test amperage draw.

ENABLING OBJECTIVE(S)
Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES
1. Read **Modern Refrigeration and Air Conditioning**, pp. 263-265.
2. Show how to identify a hot wire relay.
3. Illustrate how to draw the electrical symbol for a hot wire relay.
4. Tell how to check the relay contacts with an ohmmeter.
5. Describe in writing the operation of a hot wire relay.
6. Demonstrate how to identify the terminals of a hot wire relay.
7. Describe the safety cut-out feature of a hot wire relay.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 263-265.
Smith, **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 154-155.

EVALUATION
Questions
1. What does "current draw" cause the "hot wire" in a hot wire relay to do when heated?
2. When the hot wire relay "hot wire" is cold what position are the relay contacts in?
3. Which set of hot wire contacts acts as an overload contacts?
4. How soon does the hot wire relay starting winding contacts open?

PERFORMANCE OBJECTIVE V-TECS 52 (Continued)

Answers

1. Stretch
2. Closed
3. Run winding contacts.
4. Soon as the motor reaches its operating speed.

Practical Application

Refer to Checklist Performance Objective 52. Performance Test to remove and replace a hot-wire relay.

Method of Evaluation

Use Checklist Performance Objective 52 to determine if the assignment was completed with at least 90% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 52 EVALUATION

PERFORMANCE TEST FOR REPLACING HOT-WIRE RELAY

Student's Name ______________________ Date ________

DIRECTIONS TO STUDENT: Remove and replace a hot-wire relay using the basic tool kit, wiring schematic diagram and manufacturer's specifications.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to electrical safety procedures and correct wiring of the relay. Give the student reasonable time to complete the job. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Unit disconnected from power source.	______	______
2. Wires identified and removed from relay.	______	______
3. Checked specifications of new relay.	______	______
4. New relay checked with an ohmmeter was installed.	______	______
5. Wires correctly connected to proper relay terminals.	______	______
6. Unit started and current draw checked.	______	______
7. Safety procedures used by student.	______	______
8. Work area cleaned.	______	______
9. Tools cleaned and put away.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________ Date ________

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 53

TASK: Replace fan relay.

CONDITIONS: Basic tool kit, fan relay, manufacturer's specifications/wiring schematic, a fan with a defective fan relay, tools, equipment.

STANDARD: The fan relay must be mechanically secure and wired in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Locate relay.
3. Remove wires from relay.
4. Remove relay.
5. Position replacement relay.
6. Connect wires to relay according to manufacturer's schematic.
7. Connect unit to power sources.
8. Start unit.
9. Check relay for proper operation.

ENABLING OBJECTIVE(S)
Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES
1. Read **Electricity For Refrigeration, Heating, and Air Conditioning**, pp. 173-177.
2. Tell how to identify a fan relay.
3. Demonstrate how to draw the electrical symbol for a SPDT fan relay.
4. Show how to use an ohmmeter to check the fan relay low speed contacts.
5. Illustrate how to use an ohmmeter to check the fan relay high speed contacts.
6. Show how to use an ohmmeter to check the fan relay coil.
7. Describe orally the purpose and operation of a SPDT fan relay for heating and for cooling.

RESOURCES
Smith, **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 173-177.
Lennox, **Residential Heating and Cooling (Service and Procedures)**, Phase II (s), pp. 25-31.

PERFORMANCE OBJECTIVE V-TECS 53 (Continued)

EVALUATION

Questions

1. Is the SPDT fan relay energized for heating or cooling?
2. Are the normally open or normally closed contacts wired in series with the high speed tap of the fan motor?
3. If the thermostat fan switch is set for continuous fan operation which contacts are being used in the SPDT fan relay?
4. All fan relays have two sets of contacts. (True or False)

Answers

1. Cooling
2. Normally open
3. Normally open
4. False

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 54

TASK: Replace limit control switch.

CONDITIONS: Limit control switch, basic tool kit, manufacturer's specifications/wiring schematic, gas furnace and equipment.

STANDARD: The limit control switch must be mechanically secure and wired according to wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Remove service cover.
3. Locate limit switch.
4. Remove wires from defective switch.
5. Remove switch from mount.
6. Secure replacement switch.
7. Install wires on new control.
8. Connect unit to power source.
9. Test control.
10. Replace service cover.

ENABLING OBJECTIVE(S)
Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES
1. Read **Modern Refrigeration and Air Conditioning**, pp. 863, 880.
2. Show how to identify a limit control switch for a gas furnace.
3. Demonstrate how to identify a combination fan and limit switch for a gas furnace.
4. Describe orally the purpose of a gas furnace limit switch.
5. Show how to draw the electrical symbol for a limit switch.
6. Explain how to check a gas furnace limit switch contacts with an ohmmeter.
7. Describe orally the operation of a gas furnace limit switch.

RESOURCES
Althouse, et al., Modern Refrigeration and Air Conditioning, pp. 850, 863.
Lennox, Residential Heating and Cooling, (Fundamentals and Maintenance), Phase 1 (s).

EVALUATION

Questions

1. If the limit switch opens (breaks the circuit), does the furnace start-up or stop?
2. Are furnace limit switch contacts normally open or normally closed?
3. What causes the limit switch contacts to open?
4. Limit switches are sometimes wired in the 115 volts circuit. (True or False)
5. Limit switches are sometimes wired in the 24 volts circuit. (True or False)

Answers

1. Stop
2. Normally closed.
3. Excessive heat.
4. True
5. True

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 55

TASK: Replace magnetic coil.

CONDITIONS: Magnetic coil, basic tool kit, manufacturer's specifications/wiring schematic, a refrigeration system, tools and equipment.

STANDARD: The magnetic coil must be mechanically secure, wired according to wiring diagram and/or manufacturer's specifications, and open/close the contacts when voltage is removed/applied.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Locate magnetic coil.
3. Remove wires from coil.
4. Remove coil.
5. Position new coil.
6. Connect wires to coil.
7. Connect unit to power source.
8. Start system.
9. Test coil function.

ENABLING OBJECTIVE(S)
Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES
1. Read **Electricity for Refrigeration, Heating and Air Conditioning,** pp. 166-172.
2. Demonstrate how to identify the coil in a contactor.
3. Read the specifications and state the voltage to be used for the coil.
4. Describe orally the purpose (operation) of the coil in the contactor.
5. Sketch the electrical symbol for a contactor with three normally open contacts and a coil.
6. Show how to check a coil with an ohmmeter.
7. Explain orally the purpose of the laminated iron core that the coil is wound around.

RESOURCES
Smith, **Electricity for Refrigeration, Heating and Air Conditioning,** pp. 166-172.
Lennox, **Residential Heating and Cooling (Service and Procedures),** Phase II (s), pp. 18-26.

PERFORMANCE OBJECTIVE V-TECS 55 (Continued)

EVALUATION

Questions

1. Does the coil create a magnetic field when it is energized or de-energized?
2. Are contactor coils rated in amperage or voltage?
3. The voltage applied to a coil is always the same as the voltage applied to the contacts. (True or False)
4. If a coil is shorted, should the ohmmeter read zero or infinity?
5. A measurable resistance on the ohmmeter usually indicates an open coil. (True or False)

Answers

1. Energized
2. Voltage
3. False
4. Zero
5. False

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 56

TASK: Replace magnetic starter.

CONDITIONS: Basic tool kit, manufacturer's specifications/wiring schematic, a refrigeration unit with a magnetic starter.

STANDARD: The magnetic starter must be mechanically secure, wired according to wiring diagram and/or manufacturer's specifications, not bind on start, and the armature must move freely.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Remove service panel.
3. Disconnect wires.
4. Remove magnetic starter.
5. Position new magnetic starter.
6. Rewire new magnetic starter.
7. Connect unit to power source.
8. Start system.
9. Check amp draw.
10. Stop system.
11. Replace service panel.

ENABLING OBJECTIVE(S)

Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES

1. Read **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 53, 160-163 and **Modern Refrigeration and Air Conditioning**, pp. 437-438.
2. Show how to identify a magnetic starter.
3. Explain how to locate the coil in a magnetic starter.
4. Point out the contacts in a magnetic starter.
5. Orally discuss the differences between a magnetic starter and a magnetic contactor.
6. Demonstrate how to check a magnetic starter coil and contacts with an ohmmeter.
7. Point out the overloads in a magnetic starter.
8. Illustrate how to draw the electrical symbol for a magnetic starter.
9. Explain how to conduct a visual inspection of the magnetic starter contacts, checking for pitted contacts.

PERFORMANCE OBJECTIVE V-TECS 56 (Continued)

RESOURCES

Smith, **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 53, 160-163.

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 437-438.

EVALUATION

Questions

1. Magnetic starter overloads are sometimes called heaters. (True or False)
2. How many general classes of overloads are used in magnetic starters?
3. Name two general classes of overloads that are used in magnetic starters.
4. Do magnetic starters have mechanical linkage?
5. Are magnetic starters used more on single phase equipment or three phase equipment?

Answers

1. True
2. Three
3. Bimetal relay and thermal relay or molten alloy relay.
4. Yes
5. Three phase equipment.

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 57

TASK: Replace potential relay.

CONDITIONS: Potential relay, basic tool kit, wire terminals, manufacturer's specifications/wiring schematic, a motor with potential relay, tools, equipment and material.

STANDARD: The potential relay must be mechanically secure, wired according to wiring diagram and/or manufacturer's specifications, and drop the start winding and/or start capacitor from the motor circuit.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Weaver and Kirkpatrick, **Environmental Control**.
Langley, **Electric Controls for Refrigeration and Air Conditioning**.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Locate relay.
3. Disconnect wires from relay terminals.
4. Remove mount screw and relay.
5. Mount new relay.
6. Connect electrical wires.
7. Restore power to unit.
8. Start unit.
9. Check relay operation.

ENABLING OBJECTIVE(S)
Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES
1. Read **Modern Refrigeration and Air Conditioning**, pp. 261-265 and **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 173-176.
2. Demonstrate how to identify a potential relay.
3. Draw the electrical symbol for a potential relay.
4. Check the potential relay contacts with an ohmmeter.
5. Describe in writing the operation of a potential relay.
6. Draw a diagram showing a potential relay wired to a start capacitor, run capacitor, and compressor motor.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 261-265.
Smith, **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 173-176.

PERFORMANCE OBJECTIVE V-TECS 57 (Continued)

EVALUATION

Questions

1. Which causes the potential relay to work properly, an increase in current or an increase in voltage (back EMF)?
2. When the unit is "off" are the relay contacts open or closed?
3. As the thermostat closes and starts the refrigeration unit, is there any arcing of the potential relay contacts?
4. Are the contacts located between terminals 1 & 2, or terminals 2-5?

Answers

1. Increase in voltage.
2. Closed.
3. There is no arcing.
4. Terminals 2-5.

Practical Application

Refer to Checklist Performance Objective 57. Replace potential relay.

Method of Evaluation

Use Checklist Performance Objective 57 to evaluate student's performance to determine if the task was completed with at least a 90% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 57 EVALUATION

PERFORMANCE TEST FOR REPLACING POTENTIAL RELAY

Student's Name ______________________________ Date ____________

DIRECTIONS TO STUDENT: Remove and replace a potential relay, using the basic tool kit, wiring diagram, and manufacturer's specifications.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to electrical safety procedures and correct wiring of the relay. Give the student reasonable time to complete the job. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Unit disconnected from power source.	______	______
2. Wires identified and removed from relay.	______	______
3. Checked specifications of new relay.	______	______
4. New relay checked with an ohmmeter prior to installation.	______	______
5. Wires correctly connected to proper relay terminals.	______	______
6. Unit started and relay checked.	______	______
7. Safety procedures used by student.	______	______
8. Work area cleaned.	______	______
9. Tools cleaned and put away.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________________ Date ____________

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 58

TASK: Replace time delay relay.

CONDITIONS: New time delay relay, basic tool kit, manufacturer's specifications/wiring schematic, a unit with a defective time delay relay, tools, equipment.

STANDARD: The time delay relay must be mechanically secure and wired according to wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control**.

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Remove service cover.
3. Locate relay.
4. Remove wires from relay.
5. Remove relay.
6. Mount new relay.
7. Install wires on new relay according to wiring schematic.
8. Connect unit to power source.
9. Start machine.
10. Test relay.
11. Stop machine.
12. Replace service cover.

ENABLING OBJECTIVE(S)

Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES

1. Read **Electricity for Refrigeration, Heating and Air Conditioning**, p. 212 and **Modern Refrigeration and Air Conditioning**, p. 851.
2. Describe in writing one purpose (use) of a time delay relay.
3. Show a time delay relay.
4. Tell how a time delay relay operates.
5. Demonstrate how to check a time delay relay contacts with an ohmmeter.
6. Demonstrate how to check a time delay relay heater with an ohmmeter.

RESOURCES

Smith, **Electricity for Refrigeration, Heating and Air Conditioning**, p. 212.
Althouse, et al., **Modern Refrigeration and Air Conditioning**, p. 851.

PERFORMANCE OBJECTIVE V-TECS 58 (Continued)

EVALUATION

Questions

1. All time delay relays have the same delay period. (True or False)
2. List two voltages that are used with time delay relay heaters.
3. What type of relay is used to delay the starting of a load for a designated period of time?
4. Time delay relays have bimetal elements. (True or False)

Answers

1. False
2. 24 volts, 115 volts or 230 volts.
3. Time delay relay.
4. True

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 59

TASK: Replace transformer.

CONDITIONS: Transformer, ohmmeter, basic tool kit, manufacturer's specifications/wiring schematic, a refrigeration unit using a 24 volt transformer.

STANDARD: The transformer must be mechanically secure and wired according to wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Locate transformer.
3. Remove wires from transformer.
4. Remove transformer.
5. Mount new transformer.
6. Connect wires to transformer.
7. Connect unit to power source.
8. Start unit.
9. Check transformer operation.

ENABLING OBJECTIVE(S)
Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES
1. Read **Electricity for Refrigeration and Air Conditioning**, pp. 60-61, 207-210.
2. Sketch the electrical symbol for a step-down transformer on the bound on overhead.
3. Demonstrate how to use a voltmeter to check the 24 volt output of a transformer.
4. Show how to check the primary winding of a transformer with an ohmmeter.
5. Illustrate how to check the secondary winding of a transformer with an ohmmeter.
6. Read the electrical specifications printed on a transformer.

RESOURCES
Smith, **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 60-61, 207-210.
Residential Heating and Cooling (Fundamentals and Maintenance), Lennox, Phase I (s), pp. 26-28.

EVALUATION
Questions
1. What is used to check the 24 volt output of a transformer?
2. Show the schematic symbol for a transformer.

PERFORMANCE OBJECTIVE V-TECS 59 (Continued)

Answers

1. A voltmeter
2. 

Practical Application

Refer to Checklist Performance Objective 59. Replace transformer.

Method of Evaluation

Use Checklist Performance Objective 59 to evaluate student's performance to determine if the task was completed with at least 90% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 59 EVALUATION

PERFORMANCE TEST FOR REPLACING TRANSFORMER

Student's Name ______________________ Date ______________________

DIRECTIONS TO STUDENT: Remove and replace a transformer, using a multimeter, basic tool kit, wiring diagram and manufacturer's specification.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to electrical safety procedures, use of the multimeter and correct wiring of the transformer. Give the student reasonable time to complete the job. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Unit disconnected from power source.	______	______
2. Transformer wires identified and disconnected.	______	______
3. New transformer checked with ohmmeter.	______	______
4. Transformer replaced and wires connected correctly.	______	______
5. Power on and transformer output checked.	______	______
6. Work performed safely.	______	______
7. Work area cleaned.	______	______
8. Tools cleaned and put away.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________ Date ______________________

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 60

TASK: Reverse the rotation of an electric motor.

CONDITIONS: A three phase electric motor, voltmeter and basic tool kit.

STANDARD: All electrical connections must be secure and the motor must rotate in the opposite direction.

SOURCE FOR STANDARD:
Langley, **Electric Controls for** Refrigeration and Air Conditioning.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Open power disconnect.
3. Remove wire from L1.
4. Remove wire from L2 and connect to L1.
5. Connect wire from L1 to L2.
6. Close power disconnect.
7. Start motor.

ENABLING OBJECTIVE(S)
Use knowledge of motors and wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING OBJECTIVE(S)
1. Read **Electricity for Refrigeration, Heating** and **Air Conditioning**, pp. 141-144 and **Modern Refrigeration and Air Conditioning**, pp. 219-221.
2. Explain how to identify a three-phase motor.
3. Illustrate how to draw a schematic diagram of a three-phase motor star winding.
4. Illustrate how to draw a diagram of a three-phase motor delta winding.
5. Show how to disassemble a three-phase motor and name the parts.
6. Demonstate how to assemble a three-phase motor.
7. Tell how to check the windings of a three-phase motor with an ohmmeter.

RESOURCES
Smith, **Electricity for Refrigeration, Heating** and **Air Conditioning**, pp. 141-144.
Althouse, **Modern Refrigeration and Air Conditioning**, pp. 219-221.

EVALUATION
Questions
1. What is the most common type of three-phase motor used in heating, cooling and refrigeration?
2. Three-phase motors use motor starting relays. (True or False)
3. Which part of the motor is the rotating magnetic field produced in?
4. A dual voltage three-phase motor can be obtained. (True or False)
5. Which test meter should be used to check the three-phase motor windings for shorts or opens?

Answers

1. Squirrel cage induction type.
2. False
3. Stator
4. True
5. Ohmmeter

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 61

TASK: Start a seized hermetic compressor motor.

CONDITIONS: Test cord, capacitors, basic tool kit, manufacturer's specifications, a refrigeration system with a seized hermetic compressor motor, tools and equipment.

STANDARD: The capacitors must be discharged before handling; the electrical terminals must be clean, electrically insulated, and leakproof; the motor must drive the compressor directly.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Disconnect wires to compressor terminals.
3. Put start capacitor in series with run terminal using test cord.
4. Connect unit to power source.
5. Energize unit for no more than a second or two.
6. Attempt operating normally if compressor reverses.
7. Check for excessive current draw after unit has warmed up.
8. Repair or replace compressor if compressor remains stuck after several tries.

ENABLING OBJECTIVE(S)
Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES
1. Read **Modern Refrigeration and Air Conditioning**, p. 349.
2. Show how to use an ohmmeter to ohm out a compressor motor for shorts and opens.
3. Identify the compressor motor start, run and common terminals by using an ohmmeter.
4. Demonstrate how to check a compressor motor external overload with an ohmmeter.
5. Demonstrate how to check a start capacitor with an ohmmeter.
6. Show how to check a run capacitor with a capacitor tester.
7. Explain how to draw a wiring diagram of the electrical hook-up to start a stuck hermetic compressor motor using a test cord and start capacitor in series with the run winding.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, p. 349.

PERFORMANCE OBJECTIVE V-TECS 61 (Continued)

EVALUATION

Questions

1. Stuck 115 volt compressor motors can sometimes be started by using 230 volts for just a second. (True or False)
2. How long should the capacitor be energized in the circuit when trying to release a stuck compressor motor?
3. Is the start capacitor connected in series or in parallel with the run winding when trying to free a seized compressor motor?
4. How many methods may be used to free a stuck compressor motor, one, two or three?

Answers

1. True
2. One or two seconds
3. Series
4. Three

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 62

TASK: Test defrost thermostat.

CONDITIONS: Basic tool kit, ohmmeter, manufacturer's specifications, a frost free refrigerator or freezer, tools and equipment.

STANDARD: The thermostat must close and open at manufacturer's specified temperatures.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Locate defrost thermostat.
3. Remove evaporator cover.
4. Remove screws from thermostat.
5. Disconnect thermostat wires.
6. Place thermostat in deep freeze and leave wires outside lid.
7. Attach ohmmeter. When thermostat reaches manufacturer's specified low temperature the contact should close and zero ohms resistance should be indicated on the ohmmeter.
8. Remove thermostat from freezer.
9. Measure resistance again. When thermostat reaches manufacturer's specified high temperature the contacts should open and infinite resistance indicated on the ohmmeter.
10. Remove ohmmeter.
11. Remount or replace thermostat.
12. Connect thermostat wires.
13. Replace evaporator cover.
14. Connect unit to power source.
15. Start unit and turn to defrost cycle.
16. Check operation. (Allow time for the unit to cool to manufacturer's specified temperature).

ENABLING OBJECTIVE(S)

Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES

1. Read **Modern Refrigeration and Air Conditioning,** pp. 311-320.
2. Identify a defrost thermostat.
3. Explain in writing the function (purpose) of a defrost thermostat in the defrost circuit.
4. Draw an electrical defrost circuit with the defrost heater and defrost thermostat.
5. While reading a schematic diagram, explain the operation of the defrost circuit electrical devices.

PERFORMANCE OBJECTIVE V-TECS 62 (Continued)

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 311-320.

EVALUATION

Questions

1. With the evaporator coated with frost and ice, will the defrost thermostat contacts usually be opened or closed?
2. It is possible that a defrost thermostat can stop the defrost cycle. (True or False)
3. With the electrical power turned off, what electrical testing device would ususally be used to check the defrost thermostat contacts position?
4. If the defrost thermostat temperature is 90°F, would the contacts normally be opened or closed?

Answers

1. Closed
2. True
3. Ohmmeter
4. Opened

Practical Application

Refer to Checklist Performance Objective 62. Test a defrost thermostat.

Method of Evaluation

Use Checklist Performance Objective 62 to evaluate student's performance to determine if the task was completed with a 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 62 EVALUATION

PERFORMANCE TEST FOR TESTING DEFROST THERMOSTAT

Student's Name ______________________ **Date** __________

DIRECTIONS TO STUDENT: Remove and test a defrost thermostat, using the basic tool kit, an ohmmeter, wiring diagram, manufacturer's specifications and a deep freezer.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to electrical safety procedures, use of the ohmmeter and correct wiring of the thermostat. Give the student reasonable time to complete the job. A score of 100% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Unit disconnected from power source.	______	______
2. Thermostat wires identified and disconnected.	______	______
3. Manufacturer's specifications checked.	______	______
4. Ohmmeter used correctly.	______	______
5. Thermostat replaced correctly.	______	______
6. Thermostat wires correctly connected.	______	______
7. Unit started and operation checked.	______	______
8. Work area cleaned.	______	______
9. Tools cleaned and put away.	______	______
10. Work performed safely.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________ **Date** __________

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 63

TASK: Test defrost timer.

CONDITIONS: Ohmmeter, basic tool kit, manufacturer's specifications/wiring schematic, a refrigerator with a defrost timer, tools, equipment and material.

STANDARD: The defrost timer must be mechanically secure, wired according to wiring diagram and/or manufacturer's specifications, and open or close the contacts at specified times during the defrost cycles.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Locate defrost timer.
3. Disconnect wires from defrost timer.
4. Remove timer.
5. Place timer in cooling position (any place but defrost).
6. Test for zero ohms across # 3 and # 4 terminals.
7. Test for zero ohms across # 3 and # 2 terminals.
8. Turn timer into defrost cycle (around 2 o'clock mark).
9. Test for zero ohms across # 3 and # 4 terminals.
10. Test for zero ohms across # 3 and # 2 terminals.
11. Connect wires to timer.
12. Reinstall timer.

ENABLING OBJECTIVES
Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES
1. Read **Modern Refrigeration and Air Conditioning,** pp. 313-316, 441-443.
2. Demonstrate how to check a defrost timer motor with an ohmmeter.
3. Demonstrate how to check a defrost timer's closed contacts with a voltmeter.
4. Explain how to use a voltmeter to check a defrost timer's open contacts.
5. Show how to draw the electrical schematic diagram of a defrost timer.
6. Explain orally the purpose and operation of a defrost timer.
7. Identify a domestic refrigerator defrost timer.
8. Identify a commercial refrigerator defrost timer.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning,** pp. 313-316, 441-443.

PERFORMANCE OBJECTIVE V-TECS 63 (Continued)

EVALUATION

Questions

1. Are defrost timers used for hot gas defrost systems or electrical defrost systems?
2. The defrost timer normally cuts off the compressor motor during electric defrosting of the evaporator. (True or False)
3. Defrost timers cut off the compressor motor during hot gas defrosting of the evaporator. (True or False)
4. During electric defrost, should the evaporator fan motor be on or off?

Answers

1. Both hot gas and electrical defrost.
2. True
3. False
4. Off

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 64

TASK: Test hermetic compressor overload protectors.

CONDITIONS: Manual start cord, basic tool kit, a refrigeration unit with an overload protector, tools, equipment and material.

STANDARD: The overload protector must open if there is excessive current draw, excessive temperature, c both.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Althouse, et al., **Modern Refrigeration** and **Air Conditioning**, p. 226.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Remove compressor terminal cover plate.
3. Locate overload protector.
4. Remove compressor wires.
5. Connect test cord to compressor series with overload.
6. Connect ammeter.
7. Start and hold in locked rotor about 5 seconds. (Overload protector should trip).
8. Remove ammeter.
9. Remove test cord.
10. Connect compressor wires.
11. Replace compressor terminal cover plate.
12. Restore power to unit.
13. Test run.

ENABLING OBJECTIVE(S)
Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES
1. Read **Electricity for Refrigeration, Heating** and **Air Conditioning**, pp. 59-60, 177-184 and **Modern Refrigeration and Air Conditioning**, pp. 224-226.
2. Demonstrate how to draw the electrical symbol for a two wire bimetal overload.
3. Illustrate how to draw the electrical symbol for a three wire bimetal overload.
4. Show how to draw the electrical symbol for a magnetic overload.
5. Explain how to check a bimetal overload with an ohmmeter.
6. Discuss orally, the operation of a bimetal overload.

RESOURCES
Smith, **Electricity for Refrigeration, Heating** and **Air Conditioning**, pp. 59-60, 177-184.
Althouse, et al., **Modern Refrigeration** and **Air Conditioning**, pp. 224-226.

PERFORMANCE OBJECTIVE V-TECS 64 (Continued)

EVALUATION

Questions

1. Which will open quicker, a bimetal overload with a heater or a bimetal overload without a heater?
2. What does the bimetal do to open the circuit when the bimetal gets warm (hot)?
3. Most domestic refrigerators use magnetic overload relays. (True or False)

Answers

1. Bimetal overload with a heater.
2. The bimetal warps.
3. False

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 65

TASK: Test high-voltage transformer.

CONDITIONS: High voltage transformer, ohmmeter, basic tool kit, a unit with a high-voltage transformer.

STANDARD: When the high-voltage transformer is tested the primary and secondary windings must show measurable resistance.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Locate transformer.
3. Remove wires from transformer.
4. Measure resistance of primary winding.
5. Measure resistance of secondary winding.
6. Connect wires to transformer.
7. Restore power to unit.
8. Check unit operation.

ENABLING OBJECTIVE(S)
Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES
1. Read **Electricity for Refrigeration, Heating, and Air Conditioning**, pp. 60-61, 207-210.
2. Show how to draw the electrical schematic symbol for a transformer.
3. Discuss in writing the difference between a step-down transformer and a step-up transformer.
4. Describe in writing the construction of a transformer.
5. Demonstrate how to identify the primary winding of a step-down transformer.
6. Illustrate how to identify the secondary winding of a step-down transformer.

RESOURCES
Residential Heating and Cooling Fundamentals and Maintenance, Lennox, Phase 1 (s), pp. 26-28.
Smith, **Electricity for Refrigeration, Heating, and Air Conditioning**, pp. 60-61, 207-210.

PERFORMANCE OBJECTIVE V-TECS 65 (Continued)

EVALUATION

Questions

1. What determines if the secondary winding puts out more or less voltage than the primary winding voltage?
2. If the primary winding is 120 volts and the secondary winding has 1/5 the number of windings as the primary winding, what is the secondary winding output voltage?
3. A direct current power source can be used for a transformer. (True or False)

Answers

1. The number of windings compared to the primary winding.
2. 24 volts
3. False

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 66

TASK: Test hot-wire relay.

CONDITIONS: Ohmmeter, motor test cord, basic tool kit, a domestic refrigerator with a hot-wire relay.

STANDARD: The hot-wire relay when tested must remove the start winding from the circuit at 75% to 80% of full motor running speed.

SOURCE FOR STANDARD:
Langley, **Electric Controls** for **Refrigeration** and **Air Conditioning.**

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Locate relay.
3. Remove wires from relay.
4. Test for zero ohms resistance across L to M terminal.
5. Connect wires to relay.
6. Restore power to unit.
7. Test run.

ENABLING OBJECTIVE(S)

Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES

1. Read and discuss **Electric Controls for Refrigeration and Air Conditioning,** p. 27 and **Modern Refrigeration and Air Conditioning,** pp. 263-265.
2. Draw the electrical symbol for a hot wire relay.
3. Identify terminals "L, M and S" on a hot wire relay.
4. State the purpose of the "L-S" contacts in the relay.
5. State the purpose of the relay "L-M" contacts.
6. Explain orally the operation of the hot wire relay.

RESOURCES

Langley, **Electric Controls for Refrigeration and Air Conditioning,** p. 27.
Althouse, et al., **Modern Refrigeration and Air Conditioning,** pp. 263-265.

EVALUATION

Questions

1. Is the hot wire relay resistance heater located between "L-S" terminals or "L-M" terminals?
2. Do the "L-M" contacts or the "L-S" contacts act as overload contacts in the hot wire relay?
3. With the compressor motor running at full speed, should the hot wire relay "L-S" contacts be open or closed?
4. With the refrigeration unit "off" should the hot wire relay "L-S" contacts be open or closed?

PERFORMANCE OBJECTIVE V-TECS 66 (Continued)

Answers

1. "L-M" terminals
2. "L-M" contacts
3. Open
4. Closed

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 67

TASK: Test magnetic contactor.

CONDITIONS: Ohmmeter, test cord, basic tool kit, a refrigerator system with a magnetic contactor, equipment.

STANDARD: When the coil is energized the ohmmeter should measure zero ohms on normally open contacts and infinite on normally closed contacts. Any deviation from this performance must be detected.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Locate magnetic contactor.
3. Disconnect contactor wires.
4. Test voltage to coil.
5. Reconnect contactor wires.
6. Restore power to unit.
7. Start unit.

ENABLING OBJECTIVE(S)
Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES
1. Read and discuss **Electric Controls for Refrigeration and Air Conditioning**, pp. 15-18 and **Modern Refrigeration and Air Conditioning**, p. 850.
2. Define a contactor in writing.
3. Draw the schematic electrical symbol for a contactor.
4. Identify the circuits and loads controlled by a contactor in a schematic wiring diagram.
5. Demonstrate how to check contactor contacts with an ohmmeter.
6. Show how to remove a movable contact from a contactor.
7. Illustrate how to assemble a contactor.
8. Tell how to assemble a contactor.
9. Identify the contactor armature.

RESOURCES
Langley, **Electric Controls for Refrigeration and Air Conditioning**, pp. 15-18.
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 850.

PERFORMANCE OBJECTIVE V-TECS 67 (Continued)

EVALUATION

Questions

1. Is the contactor armature a stationary part or a moving part?
2. Which device usually has built-in overloads, the contactor or the motor starter?
3. Name a type of alloy used in the manufacture of contactor contacts.
4. How many movable contacts are in a three-pole contactor?

Answers

1. Moving part
2. Motor starter
3. Silver cadmium alloy
4. Three

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 68

TASK: Test potential relay.

CONDITIONS: Ammeter, test cord, manufacturer's specifications/wiring diagram, basic tool kit, a refrigeration system with a potential relay.

STANDARD: Resistance of the contact points to voltage must be sufficiently high to prevent the points from opening before the motor reaches 80% to 90% of its full speed and low enough to positively open the points and remove the starting winding from the circuit. Any deviation from this specified performance must be detected.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Check wiring diagram of start capacitor with a potential relay.
2. Clamp ammeter around a start capacitor wire.
3. Connect electrical power.
4. Start refrigeration system.
5. Check length of time for starting circuit to disengage. (NOTE: If starting circuit does not disengage immediately, disconnect electrical power).
6. Check full load amperage.
7. Remove ammeter.
8. Stop refrigeration system.

ENABLING OBJECTIVE(S)

Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES

1. Read and discuss **Electric Controls for Refrigeration and Air Conditioning**, p. 25 and **Modern Refrigeration and Air Conditioning**, pp. 261-265.
2. Identify a potential relay.
3. Show how to check the electrical wiring hook-up of a potential relay.
4. Draw the schematic symbol of a potential relay.
5. Demonstrate how to test a potential relay with an ohmmeter.
6. Describe orally the operation of a potential relay.

RESOURCES

Langley, **Electric Controls for Refrigeration and Air Conditioning**, p. 25.
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 261-265.

PERFORMANCE OBJECTIVE V-TECS 68 (Continued)

EVALUATION

Questions

1. Which compressor motor terminal is potential relay terminal 2 connected, "C", "S", or "R"?
2. Are the potential relay contacts normally closed or normally open?
3. What is another name for a potential relay?
4. Which potential relay terminal is the "Common Terminal"?
5. The coil is located between which potential relay terminals?

Answers

1. "S"
2. Normally closed.
3. Voltage relay.
4. Terminal 5.
5. Terminals 2 and 5.

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 69

TASK: Wire current relay (coil-type).

CONDITIONS: Current relay, basic tool kit, manufacturer's specifications/wiring schematic, an operative refrigeration system, tools and equipment.

STANDARD: The relay must be mechanically secure and wired according to wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Discharge start capacitor.
3. Remove relay from motor terminals.
4. Identify each wire.
5. Mount relay in proper position.
6. Connect live voltage to wire "L" on the relay.
7. Connect wire from "S" on relay to start terminal.
8. Connect a wire from "M" on the relay to run terminal on compressor motor.
9. Connect other side to compressor motor external overload.
10. Restore power to unit.
11. Check operation.

ENABLING OBJECTIVE(S)

Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES

1. Read and discuss **Electric Controls for Refrigeration and Air Conditioning**, pp. 26-28 and **Modern Refrigeration and Air Conditioning**, pp. 260-265.
2. Draw the schematic symbol for a current relay.
3. Describe orally the operation of a current relay.
4. Show how to test a current relay contacts with an ohmmeter.
5. Demonstrate how to check a current relay coil with an ohmmeter.
6. Identify the top and bottom of a current relay.
7. Explain orally, why the current relay must be installed in the correct position.

RESOURCES

Langley, **Electric Controls for Refrigeration and Air Conditioning**, pp. 26-28.
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 260-265.

PERFORMANCE OBJECTIVE V-TECS 69 (Continued)

EVALUATION

Questions

1. Are current relay contacts normally open or normally closed?
2. Should current relay terminal "M" be connected to compressor motor terminal ___________, "C", "S", or "R"?
3. Should current relay terminal "S" be connected to compressor motor terminal "C", "S", or "R"?
4. The current relay coil is usually located between which terminals in the relay?

Answers

1. Normally open.
2. Terminal "R".
3. Terminal "S".
4. Terminals "L" and "M".

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 70

TASK: Wire fan relay.

CONDITIONS: Fan relay, manufacturer's specifications/wiring schematic, basic tool kit, a blower unit with a 24 volt AC control.

STANDARD: The fan relay must be mechanically secure and wired according to wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Place relay line voltage contacts in series with "hot" wire according to wiring schematic.
3. Connect one side of relay coil to secondary common of the 24 voit AC transformer.
4. Connect other side of relay coil to control switch.
5. Restore power to unit.
6. Start fan.
7. Check operation.

ENABLING OBJECTIVE(S)
Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES
1. Read and discuss **Electric Controls for Refrigeration and Air Conditioning**, p. 23 and **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 251-255.
2. Draw the schematic symbol for a fan relay with one set of contacts.
3. Draw the schematic symbol for a fan relay with two sets of contacts.
4. Show how to check a fan relay coil with an ohmmeter.
5. Demonstrate how to check a fan relay contact with an ohmmeter.
6. Describe orally, the operation of a one contact fan relay.
7. Describe orally the operation of a fan relay having two sets of contacts.

RESOURCES
Langley, **Electric Controls for Refrigeration and Air Conditioning**, p. 23.
Smith, **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 251-255.

EVALUATION
Questions
1. The fan relay coil normally has the same voltage power supply as the fan relay contacts. (True or False)
2. A fan relay has a 230 volt contact and a 24 volt coil. (True or False)
3. A fan relay has a 115 volt contact and a 24 volt coil. (True or False)
4. The fan relay can be purchased with a stepdown transformer attached "fan center." (True or False)

PERFORMANCE OBJECTIVE V-TECS 70 (Continued)

Answers

1. False
2. True
3. True
4. True

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 71

TASK: Wire heat pump controls.

CONDITIONS: Ohmmeter, basic tool kit, wire terminal kit, manufacturer's specifications/wiring schematic, a heat pump, tools, equipment and materials.

STANDARD: The heat pump controls must be mechanically secure and wired according to wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Wire according to wiring schematic starting at service entrance.
3. Recheck each wire to ensure compliance with schematic.
4. Restore power to the unit.
5. Test run unit on both heating and cooling cycles.

ENABLING OBJECTIVE(S)
Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES
1. Read and discuss **Modern Refrigeration and Air Conditioning,** pp. 800-815, 837, 867 and **Electricity for Refrigeration, Heating and Air Conditioning,** pp. 232-283.
2. Identify a heat pump schematic diagram.
3. Read and explain orally a heat pump schematic diagram.
4. Explain how to identify a heat pump wiring diagram.
5. Identify the electrical controls and devices on a heat pump.
6. Demonstrate how to check the relays on a heat pump with an ohmmeter.
7. Explain orally the cycles of a heat pump to include: cooling, 1st stage heating, 2nd stage heating, and defrosting.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning,** pp. 800-815, 837-867.
Smith, **Electricity for Refrigeration, Heating and Air Conditioning,** pp. 232-283.

EVALUATION
Questions
1. When twisting electrical wires to be placed in a wire nut, should the wire splice "pig tail" be twisted clockwise or counterclockwise?
2. Does the heat pump reversing valve use a solenoid or a heater as the activator for position changing?
3. What color equipment grounding wire is usually used on heat pumps?
4. What electrical power supply is used for most residential heat pumps?

PERFORMANCE OBJECTIVE V-TECS 71 (Continued)

Answers

1. Clockwise
2. Solenoid
3. Green
4. 230 volts, 1, 60 cycle power.

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 72

TASK: Wire mercury bulb thermostat.

CONDITIONS: Wall thermostat, thermostat wire, basic tool kit, pocket knife, manufacturer's specifications/wiring schematic.

STANDARD: The thermostat subbase must be securely mounted and level. The thermostat must be wired according to wiring diagram and/or manufacturer's specifications and securely mounted to the subbase.

SOURCE FOR STANDARD:
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE
1. Select location fci thermostat.
2. Turn off power.
3. Pull wire through hole in wall.
4. Place subbase over wire and secure to wall.
5. Level subbase.
6. Remove insulation from wires.
7. Connect wires to terminals according to wiring diagram.
8. Secure thermostat to subbase and tighten.
9. Restore power to unit.
10. Start unit.
11. Check operation.

ENABLING OBJECTIVE(S)
Use knowledge of wiring diagrams.
Use hand tools.

LEARNING ACTIVITIES
1. Read and discuss **Electric Controls for Refrigeration and Air Conditioning**, pp. 45-56 and **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 55-57, 67, 187-202, 225-229.
2. Identify a mercury bulb thermostat.
3. Draw a SPST mercury bulb switch.
4. Draw a SPDT mercury bulb switch.
5. Identify the mercury bulb thermostat electrical terminals located on the subbase.
6. Identify the thermostat heating anticipator and cooling anticipator.
7. Explain orally how a mercury bulb thermostat operates for heating and cooling.
8. Draw an electrical schematic of a thermostat electrical hook-up for an air conditioning(cooling and heating) system.

RESOURCES
Langley, **Electric Controls for Refrigeration a·d Air Conditioning**, pp. 45-56.
Smith, **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 55-57, 67, 187-212, 225-229.

PERFORMANCE OBJECTIVE V-TECS 72 (Continued)

EVALUATION

Questions

1. What voltage is used with most home heating and cooling thermostats?
2. On a multi-stage thermostat subbase, which terminal is usually used for first stage heating?
3. Which thermostat subbase terminal is normally wired to the fan relay coil?
4. Name the two positions that the thermostat fan switch may be set in.

Answers

1. 24 volts
2. "Y1" terminal
3. "G" terminal
4. "On" and "auto"

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 73

TASK: Wire a split-phase, dual-voltage motor to a 208/240 VAC supply.

CONDITIONS: Basic tool kit, wiring schematic/manufacturer's specifications, a split-phase, dual-voltage motor and a 208/240 VAC supply.

STANDARD: All electrical connections must be secure and in accordance with wiring schematic and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect electrical power to unit.
2. Connect leads according to wiring schematic.
3. Turn on electrical power.
4. Start motor.
5. Test supply voltage and amperage and compare with specifications.
6. Stop motor.

ENABLING OBJECTIVE(S)
Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES
1. Read and discuss **Modern Refrigeration and Air Conditioning**, pp. 210-219. and **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 129-132.
2. Identify a split-phase, 208/240 volt motor.
3. Copy all information from the motor data plate.
4. Explain orally the data plate information.
5. Draw a split-phase motor schematic diagram.
6. Show how to use an ohmmeter to check the split-phase motor main winding.
7. Describe orally, the operation of the centrifugal switch in the split-phase motor start winding circuit.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 210-219.
Smith, **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 129-132.

EVALUATION
Questions
1. Name two windings located in a split-phase motor.
2. Which winding in a split phase motor is constructed of the larger diameter wire?
3. How many hot wires are wired to a 208 volt split-phase, single phase motor?
4. A split-phase motor should be grounded for safety. (True or False)

PERFORMANCE OBJECTIVE V-TECS 73 (Continued)

Answers

1. Start winding and main winding.
2. Main or run winding.
3. Two hot wires.
4. True

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 74

TASK: Wire a start capacitor with a current or hot-wire.

CONDITIONS: Current relay, start capacitor, wire, basic tool kit, manufacturer's specifications/wiring schematic.

STANDARD: All electrical connections must be secure and in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Remove panel cover.
3. Remove wires from start capacitor.
4. Test capacitor.
5. Remove old capacitor, if defective.
6. Install new capacitor.
7. Place wire from "S" terminal on relay to one terminal of start capacitor.
8. Place wire from "S" terminal on compressor to remaining terminal on start capacitor.
9. Restore power to unit.
10. Start unit.
11. Check to see if compressor starts when capacitor is energized.
12. Replace panel cover.

ENABLING OBJECTIVE(S)

Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES

1. Read and discuss **Modern Refrigeration and Air Conditioning**, pp. 217, 259-265, and **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 150-155.
2. Identify a current relay.
3. Identify a start capacitor.
4. Draw the schematic symbol for a current relay.
5. Draw the schematic symbol for a start capacitor.
6. Explain orally how to test a start capacitor with an ohmmeter.
7. Show how to test a start capacitor with an ohmmeter.
8. Explain orally the purpose of a bleed resistor on a start capacitor.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 217, 259-265.
Smith, **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 150-155.

PERFORMANCE OBJECTIVE V-TECS 74 (Continued)

EVALUATION

Questions

1. Is the start capacitor wired in series or in parallel with the start winding of the motor?
2. Should the start capacitor be wired to "S" or "M" terminal of the current relay?
3. It is possible for a start capacitor to store an electrical charge. (True or False)
4. Is the start capacitor wired in series with the current relay coil or in parallel with the coil?

Answers

1. Series
2. "S" Terminal
3. True
4. Parallel

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 75

TASK: Wire a start capacitor with a potential relay.

CONDITIONS: Start capacitor, capacitor tester, manufacturer's specifications/wiring diagram, basic tool kit, a refrigerator system with a potential relay and the necessary tools and equipment.

STANDARD: All electrical connections must be secure and in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Remove panel cover.
3. Remove wires from start capacitor.
4. Test capacitor.
5. Remove old capacitor, if defective.
6. Install new capacitor.
7. Connect wires according to wiring schematic.
8. Restore power to unit.
9. Start unit.
10. Test amperes.
11. Replace panel cover.

ENABLING OBJECTIVES
Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES
1. Read and discuss **Modern Refrigeration and Air Conditioning**, pp. 218-219, 261-265 and **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 152-153.
2. Draw a schematic diagram of a potential relay.
3. Explain orally how a potential relay operates.
4. Use a resistor to bleed a start capacitor's charge.
5. Copy the data from a start capacitor data plate.
6. Draw an electrical diagram of a potential relay and start capacitor wired to a compressor motor.
7. Discuss orally the action of a start capacitor in the motor circuit.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 218-219, 261-265.
Smith, **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 152-153.

PERFORMANCE OBJECTIVE V-TECS 75 (Continued)

EVALUATION

Questions

1. When testing a start capacitor with an ohmmeter, the meter reading is zero - what does this indicate?
2. Are the potential relay contacts normally open or normally closed?
3. The start capacitor is connected to which terminal of the potential relay?
4. A start capacitor has an open circuit. (True or False)

Answers

1. Shorted capacitor.
2. Normally closed.
3. Terminal One.
4. True

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 76

TASK: Wire a run capacitor with a P.S.C. compressor motor.

CONDITIONS: P.S.C. compressor motor, run capacitor, basic tool kit, manufacturer's specifications/wiring schematic.

STANDARD: The capacitor must be mechanically secure with all electrical connections securely attached and in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Locate capacitor mounting space.
3. Mount capacitor.
4. Place one wire with spade connector to one side of capacitor.
5. Connect other end of same wire to run terminal of compressor.
6. Place another wire to other side of capacitor.
7. Connect other end of same wire to start terminal of compressor.
8. Connect unit to power source.
9. Start compressor.
10. Test amperage draw.

ENABI ING OBJECTIVE(S)
Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES
1. Read and discuss **Modern Refrigeration and Air Conditioning**, pp. 216-219 and **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 135-137.
2. Identify a permanent split capacitor motor.
3. Draw the schematic for a PSC motor.
4. Show how to check a run capacitor with an ohmmeter.
5. Demonstrate how to locate and identify the run capacitor identified terminal.
6. Draw a wiring diagram showing with the hot and neutral wires connected to the PSC compressor motor.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 216-219.
Smith, **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 135-137.

PERFORMANCE OBJECTIVE V-TECS 76 (Continued)

EVALUATION

Questions

1. Does a PSC motor use a start capacitor or a run capacitor?
2. Is the run capacitor identified terminal wired to the motor "R" terminal or "S" terminal?
3. It is possible for a disconnected run capacitor to shock the mechanic. (True or False)
4. Which terminals on the compressor motor are the run capacitor wires electrically wired to?

Answers

1. Run capacitor
2. "R" terminal
3. True
4. "R" and "S" terminals

DUTY: INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS, AND MOTORS

PERFORMANCE OBJECTIVE V-TECS 77

TASK: Wire a run capacitor with a C.R.S. compressor motor.

CONDITIONS: Run capacitor, basic tool kit, capacitor tester, manufacturer's specifications/wiring schematic, a refrigeration unit with a capacitor run-capacitor start (C.R.S.) motor.

STANDARD: The capacitor must be mechanically secure with all electrical connections securely attached in accordance with the wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Remove panel cover.
3. Disconnect wires from run capacitor.
4. Test capacitor.
5. Remove old capacitor, if faulty.
6. Install new capacitor.
7. Connect wires to new capacitor according to wiring schematic.
8. Restore power to unit.
9. Start unit.
10. Test amperage draw.
11. Replace panel cover.

ENABLING OBJECTIVE(S)

Use knowledge of wiring diagrams.
Use knowledge of electrical safety.
Use hand tools.

LEARNING ACTIVITIES

1. Read and discuss **Modern Refrigeration and Air Conditioning**, pp. 218-219, and **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 140-141.
2. Identify a capacitor start, capacitor run compressor motor.
3. Draw the electrical schematic symbol for a CSR compressor motor.
4. Draw the electrical hook-up for a potential relay and start and run capacitors with a CSR motor.
5. Describe orally the purpose of a run capacitor being used with an electric motor.
6. State, orally, the purpose of the hot wire being connected to the run capacitor identified terminal.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 218-219.
Smith, **Electricity for Refrigeration, Heating and Air Conditioning**, pp. 140-141.

PERFORMANCE OBJECTIVE V-TECS 77 (Continued)

EVALUATION

Questions

1. When the CSR compressor motor reaches running speed, is the run capacitor or the start capacitor electrically removed from the circuit?
2. When the refrigeration unit is "off," receiving no power, are the potential relay contacts open or closed?
3. What setting should be selected on the ohmmeter for use in testing a run capacitor?
4. Does a CSR motor use a start capacitor or a run capacitor?

Answers

1. Start capacitor.
2. Closed
3. R x 10,000 ohms
4. Both are used, the start capacitor and the run capacitor.

INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 78

TASK: Add oil.

CONDITIONS: Basic tool kit, 1/4" hose, oil pump, refrigerant oil, flashlight, a refrigeration system.

STANDARD: The oil level must be raised to the center of the sight glass.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Lang, **Principles of Air Conditioning.**
Weaver and Kirkpatrick. **Environmental Control.**
State Department of Education, Alabama, **Air Conditioning and Refrigeration.**

PERFORMANCE GUIDE
1. Start compressor.
2. Observe oil level in oil sight glass.
3. Install 1/4" hose to compressor.
4. Connect 1/4" hose to oil pump.
5. Open valve.
6. Add oil to raise its level to center of sight glass.
7. Close valve.
8. Allow oil level to balance.
9. Remove 1/4" hose, drain, and seal ends.

ENABLING OBJECTIVE(S)
Use pressure gauges.
Identify and describe the high pressure side and the low pressure side of refrigerant system.
Read manufacturer's oil specifications.

LEARNING ACTIVITIES
1. Read **Modern Refrigeration and Air Conditioning**, pp. 367, 540, 929 and **Principles of Refrigeration**, pp. 209, 211, 214.
2. Emphasize the importance of proper care and use of tools.
3. Explain why it is important to use only the oil recommended by the compression manufacturer.
4. Demonstrate by adding an amount of oil stipulated by the instructor.
5. Demonstrate by vapor charging hermetic unit and test for leaks.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 367, 540, 929.
Marsh, et al., **Principles of Refrigeration,** pp. 209, 211, 214.

PERFORMANCE OBJECTIVE V-TECS 78 (Continued)

EVALUATION

Questions

1. How do you add oil to the system if the system cannot be made to produce a vacuum?
2. What safety steps must be taken when adding oil to a system which has service valves and the vacuum method is used?
3. The primary purpose of oil in a refrigeration system is ________________.
4. One of the chief properties required of a good refrigerant oil is ____________.
5. The meaning of "pour point" of oil is ________________.

Answers

1. Build up a pressure in an oil charged cylinder.
2. Always keep the end of the hose submerged in oil.
3. Cooling and lubricating.
4. It should flow at low temperatures.
5. The lowest temperature at which the oil will flow.

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 79

TASK: Add refrigerant.

CONDITIONS: Basic tool kit, refrigerant, a refrigeration system that is low in refrigerant, and manifold gauge set.

STANDARD: When refrigerant is added to the system, the sight glass must be clear.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**
State Department of Education, Alabama, **Air Conditioning and Refrigeration.**

PERFORMANCE GUIDE

1. Attach gauges to both high and low side.
2. Start machine and allow time for system pressures to stabilize.
3. Check refrigerant sight glass.
4. Add refrigerant to fill sight glass to where it is clear. NOTE: Add only gas to low side. If liquid is added to low side compressor will lock up and may be damaged.
5. Allow pressures to reach normal operating range.
6. Remove gauges.
7. Tighten caps and covers on service valves.

ENABLING OBJECTIVE(S)

Use pressure gauges and listing.
Describe the high pressure side and the low pressure side of a refrigerant system.
Read manufacturer's refrigerant specifications.

LEARNING ACTIVITIES

1. Discuss reading assignment **Modern Refrigeration and Air Conditioning**, pp. 300, 364-367. Study and review reference materials **Principles of Refrigeration**, pp. 263-265.
2. Demonstrate by starting the system and allow it to run for at least 15 minutes and check for frost line in the evaporator.
3. Discuss the safety precautions used with the materials, supplies and equipment.
4. Demonstrate by installing the service valve attachment or clamp-on valve on the suction line.
5. Emphasize the importance of proper care and use of tools.
6. Check the system by running the unit and by testing for leaks.
7. Demonstrate the proper method of closing valves and removing refrigerant gauge.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 300, 364-367.
Marsh, et al., **Principles of Refrigeration**, pp. 263-265.

PERFORMANCE OBJECTIVE V-TECS 79 (Continued)

EVALUATION

Questions

1. The most common indication of a shortage of refrigerant in a hermetic system is ______________.
2. The most important thing to do if a shortage of refrigerant is discovered is ______________.
3. The best way to heat a service cylinder is ____________.
4. One may determine when the unit has been charged with the correct amount of refrigerant __________________.
5. The best leak testing method is __________________.

Answers

1. Lowering of frost line on evaporator.
2. Find the leak.
3. Use hot water.
4. By the frost line on the evaporator.
5. Electronic sniffer.

Practical Application

Refer to Checklist Performance Objective 79. Add refrigerant.

Method of Evaluation

Use Checklist Performance Objective 79 to evaluate student's performance to determine if the task was completed with at least a 90% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 79 EVALUATION

PERFORMANCE TEST FOR ADDING REFRIGERANT

Student's Name ______________________________ Date __________

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completed the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Vapor charge a refrigerant system.	______	______
2. Liquid charge a refrigerant system.	______	______
3. Install refrigerant gauges and knowledge of operation of service valves.	______	______
4. Charge system with the exact amount of refrigerant.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________________ Date __________

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 80

TASK: Adjust evaporator pressure regulating valve.

CONDITIONS: Basic tool kit, pressure/temperature chart, flashlight, soap solution, a refrigeration system.

STANDARD: Adjustment must maintain evaporator pressure at control setting specified by the manufacturer.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**

PERFORMANCE GUIDE

1. Locate evaporator pressure regulating valve.
2. Determine type of valve.
3. Install gauges and observe pressure.
4. Remove cover on adjustment stem.
5. Adjust valve slowly to obtain specified temperature.
6. Record evaporator temperature.
7. Allow time for evaporator to change temperature.
8. Repeat steps 5, 6, and 7, as necessary.
9. Replace adjustment cover.
10. Remove gauges.
11. Leak test.

ENABLING OBJECTIVE(S)

Use pressure gauges.
Read manufacturer's evaporator pressure regulating valve specifications.
Use pressure temperature chart.

LEARNING ACTIVITIES

1. Discuss the hermetic system assigned and study the reference materials **Trane Reciprocating Refrigeration Manual,** pp. 49-50.
2. Demonstrate installing the refrigerants of gauges, start the unit, and after 15 minutes of running, record the evaporator pressure.
3. Discuss safety precautions used with the use of tools and equipment.
4. Emphasize the care of tools and equipment.
5. Determine the pressure change in the evaporator by one complete turn of the adjustment.
6. Demonstrate by using temperature pressure chart to determine if manufacturer recommended temperatures are correct.

RESOURCES

Trane Reciprocating Refrigeration Manual, The Trane Company, pp. 49-50.

EVALUATION

Questions

1. When the load on a refrigeration system decreases, how does this effect the suction pressure?
   a. Stays the same.
   b. It drops.
   c. It increases.
2. The evaporator pressure regulator valve is installed in which refrigerant line?
   a. Liquid line.
   b. Hot gas line.
   c. Suction line .
3. Until the suction pressure is pumped down to the setting of the valve, how does the system operate?
   a. As though the valve didn't exist.
   b. With high suction pressure.
   c. With low suction pressure.

Answers

1. b
2. c
3. a

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 81

TASK: Adjust pressure (automatic expansion valve).

CONDITIONS: Basic tool kit, manufacturer's specifications, a refrigeration system.

STANDARD: The pressure must be adjusted to manufacturer's specifications.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control**.

PERFORMANCE GUIDE

1. Attach gauges on both high and low side.
2. Start machine and allow time for pressure to stabilize.
3. Remove cover on automative expansion valve adjustment.
4. Turn adjustment clockwise to increase flow, counterclockwise to decrease flow.
5. Set to manufacturer's specifications.
6. Test evaporator temperature.
7. Replace adjustment cover.
8. Remove gauges.
9. Replace caps on gauge parts.
10. Leak test.

ENABLING OBJECTIVE(S)

Identify and describe the high pressure side and the low pressure side of a refrigerant system.
Read manufacturer's automatic expansion valve operating specifications.

LEARNING ACTIVITIES

1. Discuss reading assignment **Modern Air Conditioning and Refrigeration**, pp. 78, 110, and 141. Study and review reference materials **Principles of Refrigeration**, p. 224.
2. Demonstrate the correct method of pumping down a system into a receiver or condenser receiver if a system does not have hand valves for the isolation of various parts.
3. Disassemble an old expansion valve, noting the relationship of the parts to the entire valve. Use the valve to show how the parts work.
4. Demonstrate the correct method of installing refrigerant gauges.
5. Adjust valve by turning it all the way in and record outlet pressure.
6. Adjust valve by turning it all the way out and record outlet pressures.
7. Explain the variation in head pressure that you recorded.
8. Emphasize the proper care and use of tools and equipment.

RESOURCES

Marsh, et al., **Principles of Refrigeration**, p. 224.
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 78, 110 and 141.

PERFORMANCE OBJECTIVE V-TECS 81 (Continued)

EVALUATION

Questions

1. Before attempting to start the unit, the service valves should be in which position:
   a. Mid position
   b. Back seated
   c. Front seated.
2. When the valve is adjusted to the correct setting, where will the frost line be?
   a. Almost covering the evaporator
   b. The first 10% of the evaporator
   c. Half way across the evaporator.
3. When service valves are in the back seated position and the unit is started, what may result?
   a. Damage to the compressor.
   b. Nothing
   c. Evaporator frosting.

Answers

1. b
2. a
3. a

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 82

TASK: Adjust unloaders.

CONDITIONS: Basic tool kit, manufacturer's specifications, a refrigeration system with unloaders.

STANDARD: Adjustments must increase or decrease unloading to manufacturer's specifications.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control**.

PERFORMANCE GUIDE
1. Attach gauges.
2. Operate system.
3. Remove cover of adjustment screw on compressor head.
4. Turn adjustment clockwise to increase unloading counterclockwise to decrease unloading.
5. Watch gauges and room temperature to reach requirements.
6. Remove gauges.
7. Replace adjustment screw cover.
8. Set thermostat to normal setting.

ENABLING OBJECTIVE(S)
Locate pressure differential adjustments.
Use pressure gauges.
Read manufacturer's unloader pressure specifications.

LEARNING ACTIVITIES
1. Discuss reading assignments **Trane Reciprocating Refrigeration Manual**, pp. 17-19. Study and review reference materials **Modern Refrigeration and Air Conditioning**, p. 138.
2. Show how to install the refrigerant gauge on the suction and discharge side of the compressor.
3. Emphasize the proper care and use of tools and equipment.
4. Show how to adjust cylinder load point to manufacturer's specifications.
5. Demonstrate how to adjust pressure differential on unloader to unload cylinder to manufacturer's specifications.
6. Demonstrate the proper method of closing valves and removing gauges.

RESOURCES
Trane Reciprocating Refrigeration Manual, The Trane Company, pp. 17-19.
Althouse, et al., **Modern Refrigeration and Air Conditioning**, p. 138.

PERFORMANCE OBJECTIVE V-TECS 82 (Continued)

EVALUATION

Questions

1. Reciprocating compressors with unloaders generally start at which size below?
   a. 3 HP.
   b. 5 HP.
   c. 10 HP.
2. What is one advantage of cylinder unloading?
   a. Prevents frequent starting and stopping.
   b. Keeps compressors cool.
   c. Prevents oil foaming.
3. It is estimated that compressor wear occurs most during start up. What percent of wear below would be correct?
   a. 10%
   b. 60%
   c. 90%

Answers

1. c
2. a
3. c

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 83

TASK: Balance evaporator.

CONDITIONS: Basic tool kit, air velocity indicator, manufacturer's specifications, a split central air conditioner with air-over evaporator.

STANDARD: The evaporator must operate within air volume and evaporator temperature tolerances.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control**.

PERFORMANCE GUIDE
1. Attach gauges.
2. Measure air flow through ducts.
3. Measure current draw of evaporator fan motor.
4. Determine that system is fully charged.
5. Adjust fan motor speed to maximum efficiency (minimum current draw) while remaining within the tolerances of air volume and evaporator temperature.

ENABLING OBJECTIVE(S)
Use air velocity meter.
Read manufacturer's specifications.
Record velocity reading.

LEARNING ACTIVITIES
1. Discuss reading assignment **Modern Refrigeration and Air Conditioning**, pp. 241-246, 250-254, 289-298. Study and review reference materials **Principles of Air Conditioning**, pp. 164-166. **Trane Reciprocating Refrigeration Manual**, pp. 8-9.
2. Demonstrate how to connect refrigerant gauges to low pressure side and high pressure side of refrigerant system.
3. Show how to measure air velocity and record.
4. Illustrate how to adjust air velocity to manufacturer's specifications by adjusting evaporator fan speed without exceeding motor manufacturer's recommended current draw.
5. Emphasize safety in the handling of tools and equipment.
6. Explain how to install all access panels securely.

RESOURCES
Harris, **Modern Air Conditioning Practice**, pp. 241-246, 250-254, 289-298.
Lang, **Principles of Air Conditioning**, pp. 164-166.
Reciprocating Refrigeration Manual, The Trane Company, pp. 8-9.

EVALUATION
Questions
1. What does an anemometer measure?
   a. Feet
   b. Cubic feet
   c. Temperature

PERFORMANCE OBJECTIVE V-TECS 83 (Continued)

2. What is wrong if the anemometer registers backwards?
   a. Nothing
   b. The air flow is too slow.
   c. The anemometer is facing the wrong way.
3. How is the anemometer held in reference to the air stream?
   a. At an angle.
   b. Square to the air stream.
   c. At a 45^{o} angle.

Answers
1. a
2. c
3. b

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 84

TASK: Bleed air from system.

CONDITIONS: Pressure/temperature chart, manufacturer's specifications, an operating refrigeration system.

STANDARD: The system must be purged until no more than .01% of the air remains in the system.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Althouse, et al., **Modern Refrigeration and Air Conditioning**, p. 384.

PERFORMANCE GUIDE
1. Attach gauges.
2. Start system.
3. Turn system off.
4. Purge or bleed air by opening high side valve.
5. Restart unit, observe pressures. (Pressures should correspond to formula for finding correct head pressure. If still too high, turn unit off and purge again).
6. Remove gauges.

ENABLING OBJECTIVE(S)
Use temperature-pressure chart.
Use pressure gauges.
Read manufacturer's head pressure chart.

LEARNING ACTIVITIES
1. Discuss reading assignment **Modern Refrigeration and Air Conditioning**, p. 582. Study and review reference materials **Trane Reciprocating Refrigeration Manual**, pp. 134 and 138.
2. Show how to install refrigerant gauges to the high pressure side and the low pressure side of the refrigerant system.
3. Tell how to start system and run for 15 minutes. Record pressure on low and high side of system. Turn system off.
4. Show how to open high side service valve and bleed air from system.
5. Demonstrate how to start system and observe pressures. Use manufacturer's head pressure chart for finding correct head pressure. If head pressure is still too high, repeat activities 3, 4 and 5.
6. Emphasize the importance of safety and proper use and care of tools and equipment.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, p. 582.
Trane Reciprocating Refrigeration Manual, The Trane Company, pp. 134 and 138.

PERFORMANCE OBJECTIVE V-TECS 84 (Continued)

EVALUATION

Questions

1. Where will noncondensable gas move toward and collect?
   a. Evaporator
   b. Condenser
   c. Compressor.
2. How can noncondensable gases effect head pressure?
   a. Lower it.
   b. Raise it.
   c. They have no effect.
3. Which of the following is a noncondensable gas?
   a. Freon 22.
   b. Air.
   c. Freon 12.

Answers

1. b
2. b
3. b

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 85

TASK: Clean evaporative condenser.

CONDITIONS: Basic tool kit, cleaning solvent, manufacturer's specifications, a system with an evaporative condenser.

STANDARD: The condenser must be free of all foreign matter and corrosion.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Turn water off and drain system.
3. Pour or spray cleaning solvent on surfaces, allow time for solvent to react.
4. Rinse and repeat step 3, as necessary, until all growth or corrosion is removed.
5. Replace drain plugs.
6. Turn water on.
7. Restore power to unit.
8. Start unit and check for normal operation.

ENABLING OBJECTIVE(S)
Use cleaning materials.
Read manufacturer's evaporative condenser specifications.
Read manufacturer's cleaning solvent directions.

LEARNING ACTIVITIES
1. Read **Principles of Refrigeration**, pp. 161-163.
2. Explain how to turn make-up water valve off.
3. Show how to drain water from evaporative condenser.
4. Explain how to spray cleaning solvent on surfaces of evaporative condenser. Read manufacturer's cleaning solvent directions. Allow time for solvent to react.
5. Show how to rinse all surfaces of evaporative condenser with water.
6. Demonstrate how to install drain plugs or close drain valves.
7. Turn make-up water valve on to evaporative condenser.
8. Demonstrate how to start system and check operation.

RESOURCES
Marsh, et al., **Principles of Refrigeration**, pp. 161-163.
Trane Reciprocating Refrigeration Manual, The Trane Company, pp. 30-32.

PERFORMANCE OBJECTIVE V-TECS 85 (Continued)

EVALUATION

Questions

1. How are the coils cooled in an evaporative condenser?
2. The most likely cause of poor water flow through an evaporative condenser is ____________________.
3. Define calibrating a float.
4. Water is added when using an evaporative condenser because ______ ______.
5. The static head of a cooling tower system is ____________________.

Answers

1. Sprayed with water.
2. Screen clogged.
3. Adjusting to provide the proper water level.
4. It is cooler.
5. The vertical height of the piping.

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 86

TASK: Clean foreign matter (dirt, water, metal particles) from system.

CONDITIONS: Basic tool kit, refrigerant, dry nitrogen, vacuum pump, suction and liquid drier, nitrogen regulator, duct tape, refrigerant oil, silver solder, sand cloth, manufacturer's specifications, a refrigeration system with foreign matter in it.

STANDARD: The system must cool to specifications, be free of foreign matter and leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Dismantle system.
2. Clean condenser.
3. Clean compressor.
4. Clean metering devise.
5. Clean interconnecting tubing.
6. After cleaning, seal each part.
7. Assemble complete system.
8. Flush system with refrigerant.
9. Put clean oil in compressor.
10. Leak test entire system.
11. Purge system with dry nitrogen.
12. Evacuate system.
13. Break vacuum with dry nitrogen.
14. Install suction and liquid driers.
15. Leak test where driers are installed.
16. Evacuate system.
17. Prepare system to be operated.
18. Charge system with proper refrigerant.
19. Test system for sufficient cooling.
20. Operate system for 24 hours and replace driers.
21. Test system for sufficient cooling.

ENABLING OBJECTIVE(S)

Use pressure gauges.
Use high pressure gas.
Read manufacturer's clean out specifications.

PERFORMANCE OBJECTIVE V-TECS 86 (Continued)

LEARNING ACTIVITIES

1. Read and discuss **Modern Refrigeration and Air Conditioning**, pp. 344, 349, 378, 380 and **Principles of Air Conditioning**, p. 275.
2. Install refrigerant gauges on the high pressure side and low pressure side of system.
3. Show how to discharge the refrigerant from system. Use goggles. Ventilate well.
4. Tell how to remove refrigerant oil and measure to assure replacement of the exact quantity.
5. Explain how to remove the expansion valve, disassemble and clean.
6. Show how to clean the compressor and flushing with refrigerant.
7. Show how to purge system with dry nitrogen.
8. Interact the process of installing filter driers in liquid and suction lines.
9. List the steps in pressurizing the system and checking for leaks.
10. Show how to fill with the exact amount of refrigerant oil.
11. Lecture on the procedure for evacuating the system with vacuum pump.
12. Illustrate how to charge system with exact weight of refrigerant.
13. Show how to start system and check for sufficient cooling.
14. Explain the importance of operating the system for 24 hours and taking oil sample to determine if system is acid free.
15. Tell how to install new filter driers.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 344, 349, 378, 380.

Lang, **Principles of Air Conditioning**, p. 275.

EVALUATION

Questions

1. What should be done with the oil after removing it from the compressor?
   a. It is redistilled.
   b. It is saved.
   c. It is measured and tested for acid.
   d. Nothing.
2. How may one best clean the compressor before assembly?
   a. Cloth
   b. Brush
   c. With water
   d. With mineral spirits.
3. Why must one be careful when handling the old oil?
   a. It may be hot.
   b. It may spill.
   c. It may be acidic.
   d. To keep it clean.
4. What action should be taken when removing the refrigerant from the system?
   a. Save the refrigerant.
   b. Purge it into a sewer.
   c. Purge it into a special purge line into a ventilated hood.

PERFORMANCE OBJECTIVE V-TECS 86 (Continued)

5. Where is the most common place to install a drier in the system?
   a. In the liquid line.
   b. Anywhere
   c. Between compressor and condenser.

Answers
1. c
2. d
3. c
4. c
5. a

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 87

TASK: Clean water-cooler condenser.

CONDITIONS: Refrigeration gauges, power driven wire brush, acid circulation pump, basic tool kit, manufacturer's specifications, a refrigeration system.

STANDARD: All corrosion must be removed and the condenser must maintain head pressure.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control**.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Turn water off.
3. Drain system of water.
4. Remove end plate of condenser.
5. Clean inside of tubes with power-driven wire brush.
6. Reassemble when tubes have been cleaned and flushed.
7. Turn water on.
8. Connect unit to power source.
9. Start unit.
10. Attach gauges.
11. Observe gauges for operating pressure and temperature.
12. Remove gauges.

ENABLING OBJECTIVE(S)
Use cleaning materials.
Use pressure gauges.
Read manufacturer's water-cooler condenser specifications.

LEARNING ACTIVITIES
1. Read **Principles of Refrigeration**, pp. 111, 159-162.
2. Demonstrate how to disconnect all electrical power to water-cooler condenser.
3. Show how to turn make-up water valve off to water cooler condenser.
4. Discuss how to remove all water from system.
5. Explain how to remove end plate from water cooler condenser.
6. Demonstrate how to clean inside of water tubes using power driven brush.
7. Use goggles.
8. Show how to install end plate on water cooler condenser.
9. Demonstrate how to close all drain lines.
10. Show how to turn make-up water valve on.
11. Demonstrate how to turn electrical power on to water cooler condenser.
12. Show how to install refrigerant gauges.
13. Show how to start system and check refrigerant pressure and temperature.
14. Demonstrate how to remove refrigerant gauges.

RESOURCES
Marsh, et al., **Principles of Refrigeration**, pp. 111, 159-162.

PERFORMANCE OBJECTIVE V-TECS 87 (Continued)

EVALUATION

Questions

1. Where is heat rejected from the refrigerant system?
   a. The evaporator
   b. The compressor
   c. The condenser
   d. The metering devise.
2. Pressure drop means which of the following statements:
   a. Pressure difference needed to push the refrigerant through a component.
   b. The difference in water pressure in tower basin.
   c. The cooling effect caused by the evaporation of water.
   d. The difference in refrigerant pressure in the crankcase.
3. What happens to the refrigerant in the condenser?
   a. It boils.
   b. It condenses.
   c. It evaporates.
   d. It absorbs heat.
4. Why should care be taken when cleaning tubes with abrasives?
   a. They may be weakened.
   b. They may transfer too much heat.
   c. To keep system from oxidation.
   d. To prevent water pressure difference in condenser.
5. What is the most common fault with condensers?
   a. Clogged
   b. Undersize
   c. Oil bound
   d. Overcharged.

Answers

1. c
2. a
3. b
4. a
5. a

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 88

TASK: Evacuate system.

CONDITIONS: Vacuum pump, basic tool kit, thermocouple vacuum gauge, an operating refrigeration system.

STANDARD: Evacuated system must be free of air and moisture.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control**.

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Attach gauges.
3. Purge system of refrigerant.
4. Connect vacuum pump.
5. Operates vacuum pump 15-30 minutes.
6. Check vacuum with vacuum gauge.
7. Observe vacuum gauge for indications of system leakage.
8. Recharge system (when air and moisture content are within prescribed limits -29.25" -29.9" Hg.).
9. Restore power to unit.
10. Start system and check operation.
11. Leak test.
12. Remove gauges.

ENABLING OBJECTIVE(S)

Use vacuum pump.
Use vacuum gauge.
Use pressure gauges.
Identify and describe high pressure and low pressure side of system.

LEARNING ACTIVITIES

1. Discuss reading assignment **Modern Refrigeration and Air Conditioning**, pp. 71, 384, 390. Study and review reference materials **Modern Air Conditioning Practice**, pp. 27-28, **Principles of Refrigeration**, pp. 261 and 268.
2. Demonstrate how to inspect the vacuum pump oil. If dirty, replace the oil.
3. Explain how to install refrigerant gauges to high pressure and low pressure side of unit.
4. Show how to shut off the refrigerant flow of the liquid receiver service valve. Operate the compressor to create a high vacuum. Exhaust to the atmosphere.
5. Discuss how to connect the high vacuum pump to the center gauge manifold opening.
6. Illustrate how to operate the high vacuum pump and draw as high a vacuum as possible and record.
7. List the steps in closing the manifold valve and disconnect the gauge manifold. Open the service valves and return the system to normal operation.
8. Emphasize the importance of safety and proper use of tools and equipment.

PERFORMANCE OBJECTIVE V-TECS 88 (Continued)

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 71, 384, 390.
Harris, **Modern Air Conditioning Practice**, pp. 27-28.
Marsh, **Principles of Refrigeration**, pp. 261 and 268.

EVALUATION

Questions

1. What limits the degree of vacuum that will develop in a compressor?
2. The service operations that may best be performed with the aid of a high vacuum pump is ______________.
3. The instrument that is often combined with the high vacuum pump as an assembly is ______________.
4. Measured in millimeters of mercury column, what is a good vacuum?
5. The micron equivalent of one inch of vacuum is ______________.

Answers

1. The clearance volume of the compressor
2. Dehydration of a system
3. A high vacuum gauge
4. 5-10
5. 25,400

Practical Application

Refer to Checklist Performance Objective 88. Evaluate system.

Method of Evaluation

Use Checklist Performance Objective 88 to evaluate student's performance to determine if the task was completed with at least a 90% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 88 EVALUATION

PERFORMANCE TEST FOR EVACUATING SYSTEM

Student's Name _______________ Date _______

DIRECTIONS TO STUDENT: Set up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completed the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Evacuate a refrigerant system using a mercury manometer.	_____	_____
2. Evacuate a refrigerant system using a vacuum gauge.	_____	_____
3. Set up equipment for evacuating the system.	_____	_____
4. Use the vacuum steam table.	_____	_____

APPROVED: Yes _____ No _____

Evaluator's Signature _______________ Date _______

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 89

TASK: Install accumulator.

CONDITIONS: Accumulator, basic tool kit, flux and solder, refrigerant, a refrigeration system.

STANDARD: The accumulator must be mechanically secure and leakproof.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, Environmental Control.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Attach gauges.
3. Discharge refrigerant.
4. Remove old accumulator.
5. Braze in replacement accumulator.
6. Evacuate system.
7. Recharge system.
8. Leak test.
9. Restore power to unit.
10. Start system and check operating temperature and pressure.
11. Remove gauges.

ENABLING OBJECTIVE(S)
Use pressure gauges.
Read manufacturer's accumulator specifications.

LEARNING ACTIVITIES
1. Read and discuss **Modern Refrigeration and Air Conditioning**, pp. 100, 102, 804.
2. Demonstrate how to connect refrigerant gauges to high pressure side and low pressure side of system.
3. Show how to pump system down. If service valves are not provided, discharge refrigerant. Ventilate well.
4. List the steps of removing old accumulator from system.
5. Tell how to install new accumulator. Braze lines.
6. Explain how to pressurize system and check for leaks.
7. Interpret the process of evacuating the system using vacuum pump.
8. Show how to charge system with the exact weight of refrigerant.
9. Demonstrate how to start the system and check for correct operating pressures.
10. Illustrate how to remove refrigerant gauges from system.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 100, 102 and 804.

PERFORMANCE OBJECTIVE V-TECS 89 (Continued)

EVALUATION

Questions

1. What is the main purpose of an accumulator?
   a. To prevent liquid from entering the compressor.
   b. To prevent oil from leaving the compressor.
   c. To help increase refrigerant flow.
2. The accumulator is usually between which two components?
   a. Compressor and condenser
   b. Evaporator and condenser
   c. Evaporator and compressor
   d. Metering devise and evaporator.
3. If liquid refrigerant enters the compressor, what would result?
   a. Considerable knocking and damage to the compressor
   b. Nothing
   c. Compression ratio will be lowered.
4. What happens to liquid refrigerant that enters the accumulator?
   a. It is pumped to the condenser.
   b. It evaporates.
   c. It returns to the compressor.
5. The accumulator will allow only vapor to enter which refrigerant line?
   a. The hot gas line
   b. The suction line
   c. The liquid line.

Answers

1. a
2. c
3. a
4. b
5. b

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 90

TASK: Install air-cooled condenser unit.

CONDITIONS: Air-cooled condenser, refrigerant, basic tool kit, flux and solder, manufacturer's installation manual/wiring schematic, soap solution/leak detector, vacuum pump, a refrigeration system.

STANDARD: The condenser must be level and mechanically secure, refrigerant lines must be mechanically secure and leakproof, and all electrical connections must be mechanically secure and in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**

PERFORMANCE GUIDE

1. Position the air-cooled condenser and the compressor unit.
2. Install the condenser line and the return line.
3. Connect the electrical devices.
4. Attach gauges.
5. Evacuate the system.
6. Charge the system.
7. Leak test.
8. Connect unit to power.
9. Operate system and check operating temperature and pressure.
10. Remove gauges.

ENABLING OBJECTIVE(S)

Use pressure gauges.
Use brazing outfit.

LEARNING ACTIVITIES

1. Discuss reading assignment **Modern Refrigeration and Air Conditioning**, pp. 105, 138, 349, 359, 361, 362, 374, 377, 384, and 390. Study and review reference materials **Principles of Air Conditioning**, pp. 290, 291, and 294.
2. Show how to attach the valve adapter or piercing valve, install the gauge manifold, purge the manifold line.
3. Demonstrate how to purge the refrigerant from the system to 0-5PSI and ventilate.
4. Tell how to cut the refrigerant line at outlet to condenser and outlet of filter drier. Clean and dry the tubing before cutting.
5. Explain how to remove the condenser and filter drier. Install new condenser and filter drier.
6. Illustrate how to clean the tubing. Swage the tubing or use couplings. Flux and then braze the joints.
7. Tell how to pressurize the system and test for leaks.
8. Show how to evacuate the system using high vacuum pump.
9. Demonstrate how to charge the unit with vapor refrigerant.
10. Emphasize safety and the proper use of and care of tools and equipment.

PERFORMANCE OBJECTIVE V-TECS 90 (Continued)

RESOURCES

Lang, **Principles of Air Conditioning,** Delmar Publishers, Copyright 1972, pp. 290, 291, and 294.

Althouse, et al., **Modern Refrigeration and Air Conditioning,** pp. 105, 138, 349, 359, 361, 362, 374, 377, 384, 390.

EVALUATION

Questions

1. The most common fault with condensers is ________________.
2. A condenser fan should operate only ______________.
3. The most frequent service operation performed on a condenser is ____________.
4. Avoid bending a condenser fan blade because the ________________.
5. One knows there is air in the system when ______________________.

Answers

1. Leaks
2. When the compressor is running.
3. Cleaning it.
4. Fan will vibrate.
5. Head pressure will be above normal.

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSER, EVAPORATORS AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 91

TASK: Install evaporative condenser.

CONDITIONS: Basic tool kit, soap solution/leak detector, vacuum pump, manufacturer's installation manual, a refrigerant system.

STANDARD: The condenser must be level and mechanically secure, piping and electrical connections must be according to manufacturer's specifications, and the refrigerant lines must be mechanically secure, leakproof, and hold charge.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**

PERFORMANCE GUIDE

1. Level condenser on concrete pad.
2. Connect piping according to manufacturer's installation manual.
3. Connect electrical supply.
4. Fill water pump.
5. Attach gauges.
6. Leak test refrigerant lines.
7. Evacuate refrigerant system.
8. Charge system.
9. Leak test.
10. Start system and check operating temperature and pressure.
11. Remove gauges.

ENABLING OBJECTIVE(S)
Use brazing equipment.
Read manufacturer's installation manual on evaporative condensers.

LEARNING ACTIVITIES

1. Discuss reading assignment **Modern Refrigeration and Air Conditioning**, pp. 408, 412, 435, 454, 461, 489, 495-502. Study and review reference materials, **Modern Air Conditioning Practice**, pp. 259 and 261.
2. Show how to position the evaporative condenser for piping and connect pipes.
3. Tell how to fill the system with water and check for leaks.
4. Demonstrate how to start the system and check operation.
5. Emphasize safety and the proper use of tools and equipment.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 408, 412, 435, 454, 461, 489, 495-502.
Harris, **Modern Air Conditioning Practice**, pp. 259, 261.
Marsh, et al., **Principles of Refrigeration**, pp. 162-163.

PERFORMANCE OBJECTIVE V-TECS 91 (Continued)

EVALUATION

Questions

1. How are the coils cooled in an evaporative condenser?
2. The most likely cause of poor water flow through an evaporative condenser is ______________.
3. Define calibrating a float.
4. Water must be added when using an evaporative condenser because ______________.
5. The static head of a cooling tower system is ______________.

Answers

1. Sprayed with water.
2. Screen clogged.
3. Adjusting to provide proper water level.
4. Some is evaporated.
5. The vertical height of the piping.

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 92

TASK: Install liquid receiver.

CONDITIONS: Liquid receiver, flux and solder, refrigerant, a refrigeration system.

STANDARD: The liquid receiver must be mechanically secure, free from restrictions, and leakproof.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control**.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Attach gauges.
3. Discharge refrigerant.
4. Cut liquid line at specified point.
5. Make either brazed or flared connections to accommodate receiver.
6. Install receiver and make connections.
7. Evacuate system.
8. Recharge system.
9. Leak test.
10. Restore power to unit.
11. Start system and check operating temperature and pressure.
12. Remove gauges.

ENABLING OBJECTIVE(S)
Use pressure gauge.
Use brazing equipment.

LEARNING ACTIVITIES
1. Read **Principles of Refrigeration**, pp. 155-158, 170.
2. Demonstrate how to connect refrigerant gauges to low pressure side and high pressure side of system.
3. Show how to remove refrigerant from system. Ventilate well.
4. Demonstrate how to cut lines on entering and leaving side of liquid receiver.
5. Discuss how to remove old receiver and attach new liquid receiver.
6. Demonstrate how to braze or flare entering and leaving lines to liquid receiver.
7. Show how to pressurize system and leak test.
8. Illustrate how to install new filter drier in liquid line.
9. Demonstrate how to evacuate system using vacuum pump.
10. Explain how to charge system with vapor refrigerant.
11. Show how to start system and record operating pressure and temperature. Remove refrigerant gauges.

PERFORMANCE OBJECTIVE V-TECS 92 (Continued)

RESOURCES

Marsh, et al., **Principles of Refrigeration**, pp. 155-158, 170.
Trane Reciprocating Refrigeration Manual, The Trane Company, pp. 72, 117.

EVALUATION

Questions

1. The liquid receiver is a storage tank for which of the following:
   a. Hot gas
   b. Liquid refrigerant
   c. Cold gas
   d. Compressor oil.
2. Where is the liquid receiver usually located?
   a. On the entering side of the condenser
   b. On the leaving side of the condenser
   c. Between the evaporator and compressor
   d. Between the compressor and condenser.
3. Which of the following is correct:
   a. Liquid receivers above a certain size are equipped with safety release valves.
   b. Large liquid receivers do not need safety release valves.
   c. All small liquid receivers have safety release valves.
4. When a liquid receiver does not work properly, what is the best way to make it operational?
   a. It is usually cheaper to replace it.
   b. Cut it open and check for obstructions.
   c. Blow system out with air.
5. Liquid receivers in commercial systems usually have which of the following shell seams:
   a. Bolted with steel plates
   b. Welded seams
   c. They have no seams.

Answers

1. b
2. b
3. a
4. a
5. b

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 93

TASK: Install oil separator.

CONDITIONS: Refrigeration system, oil separator, refrigerant, basic tool kit, flux and solder.

STANDARD: The oil separator must be mechanically secure and all connections must be leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Attach gauges.
3. Discharge refrigerant.
4. Cut hot gas line at specified point.
5. Make brazed or flared connections to accommodate oil separator.
6. Install oil separator and make connections.
7. Evacuate system.
8. Recharge system.
9. Leak test.
10. Restore power to unit.
11. Start system and check operating temperature and pressure.
12. Remove gauges.

ENABLING OBJECTIVE(S)

Use pressure gauges.
Use basic tool kit.
Read manufacturer's oil separator installation instruction.

LEARNING ACTIVITIES

1. Discuss reading assignment **Modern Refrigeration and Air Conditioning**, pp. 82, 83, 94, 449, 461. Study and review reference materials, **Principles of Air Conditioning**, pp. 215-216.
2. Show how to install refrigerant gauges on high pressure and low pressure side of unit.
3. Explain how to remove the refrigerant from the system. Remove the oil separator.
4. Demonstrate how to install the separator, test for leaks, evacuate the system, and charge with refrigerant.
5. Show how to run the unit for at least 20 minutes.
6. Emphasize the importance of safety and the proper use of tools and equipment.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 82, 83, 94, 449, 461.

Marsh, et al., **Principles of Air Conditioning**, pp. 215-216.

PERFORMANCE OBJECTIVE V-TECS 93 (Continued)

EVALUATION

Questions

1. The oil separator located in the system can be found ____________________.
2. Most oil separators are insulated because ______________________.
3. If the oil separator float collapses, the valve will ____________________.
4. The one advantage of an oil separator is ______________________.
5. An oil separator must be mounted ______________________.

Answers

1. Between the compressor and the condenser.
2. To keep the refrigerant from condensing in the separator.
3. Stay closed.
4. Keeps the oil in the compressor.
5. Level.

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 94

TASK: Install water-cooler condenser.

CONDITIONS: Water-cooled condenser, refrigerant, basic tool kit, flux and solder, a refrigeration system.

STANDARD: The condenser must be level and mechanically secure and the refrigerant and water lines must be mechanically secure and leakproof.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, Environmental Control.

PERFORMANCE GUIDE
1. Position the water-cooled condenser.
2. Install the condenser line and the return line.
3. Install water lines.
4. Attach gauges.
5. Evacuate system.
6. Charge system.
7. Leak test.
8. Connect unit to power source.
9. Start system and check operating temperature and pressure.
10. Check water pressure and temperature.
11. Remove gauges.

ENABLING OBJECTIVE(S)
Use pressure gauges.
Read manufacturer's water cooler condenser specifications.

LEARNING ACTIVITIES
1. Read and discuss Modern Refrigeration and Air Conditioning, pp. 408-410, 461, 507-510, 523-526, 551-552, 571 and Principles of Refrigeration, pp. 111, 159-162, 170.
2. Demonstrate how to connect refrigerant gauges to high pressure side and low pressure side of system.
3. Show how to discharge the refrigerant from water cooler condenser and ventilate.
4. Explain how to drain water from condenser and remove water lines.
5. Illustrate how to disconnect refrigerant line and remove old water cooler condenser.
6. Tell how to position new water cooler condenser and install on system.
7. List the steps in connecting water lines and purge condenser.
8. Interpret the process of connecting refrigerant lines to water cooler condenser.
9. Lecture on the process of pressurizing refrigerant system and checking for leaks.
10. Demonstrate how to vacuum system using a vacuum pump.
11. Show how to fill system with water.

PERFORMANCE OBJECTIVE V-TECS 94 (Continued)

12. Tell how to charge system with the exact amount of refrigerant.
13. List the steps in starting system and check water flow, gpm. Check and record refrigerant pressure.
14. Explain how to remove the refrigerant gauges from system.

RESOURCES

Althouse, et al., **Modern Refrigeration** and **Air Conditioning,** pp. 408-410, 461, 507-510, 523-526, 551-552, 571.

Marsh, et al., **Principles of Refrigeration**, pp. 111, 159-162, 170.

EVALUATION

Questions

1. Why is the condenser always purged after charging, if possible?
   a. To remove excess refrigerant.
   b. To help the unit pump down.
   c. To remove non-condensable gases.
2. Does the heat loss from the condenser equal the heat gain to the evaporator?
   a. It is more.
   b. It is less.
   c. They are equal.
   d. The heat gain is five times the heat loss.
3. What should be the approximate water rate of flow through a water-cooled condenser?
   a. As rapid as possible.
   b. Rate not important.
   c. 5 FPM.
   d. 200 FPM.
4. How is a shell and tube condenser constructed?
   a. Straight tubes inside receiver with a manifold on both ends.
   b. A coil within a tank.
   c. Tubes soldered together.
5. What is the rate of heat removal in a water-cooled condenser?
   a. Same as air-cooled.
   b. 10 times more rapidly than air.
   c. 15 times more rapid than air.
   d. Depends on the barometer reading.

Answers

1. c
2. c
3. d
4. a
5. c

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 95

TASK: Purge system of refrigerant.

CONDITIONS: Basic tool kit, nitrogen gas, vacuum pump, a refrigeration system.

STANDARD: The system must be free of all refrigerant and moisture.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Attach gauges.
3. Discharge refrigerant. NOTE: Nitrogent gas may be used to push refrigerant out of the system, or the system may be evacuated.
4. Recharge system.
5. Leak test.
6. Restore power to unit.
7. Start system and check operating temperature and pressure.
8. Remove guages.

ENABLING OBJECTIVE(S)
Use pressure gauges.
Use vacuum pump.

LEARNING ACTIVITIES
1. Read and discuss **Principles of Refrigeration**, pp. 262-263.
2. Demonstaté how to connect refrigerant gauges to high pressure side and low pressure side of refrigerant system.
3. Show how to discharge the refrigerant in acceptable area and ventilate well.
4. Explain how to purge the system with dry nitrogen.
5. Tell how to vacuum system using vacuum pump.
6. List the steps in charging the system with vapor refrigerant and test for leak.
7. Interpret the process of starting the system and checking pressures.
8. Illustrate how to remove refrigerant gauges from system.

RESOURCES
Marsh, et al., **Principles of Refrigeration**, pp. 262-263.
Trane Reciprocating Refrigeration Manual, The Trane Company, pp. 134, 138.

EVALUATION
Questions
1. When purging a refrigerant system, how much of the air is removed?
   a. All of it.
   b. Some of the air remains.
   c. None of the air is removed.

PERFORMANCE OBJECTIVE V-TECS 95 (Continued)

2. What instrument is often combined with the high vacuum pump as an assembly?
   a. A high vacuum gauge.
   b. A drier.
   c. A filter.
   d. An acid indicator.
3. What is a good vacuum, measured in millimeters of mercury column?
   a. 5-10
   b. 25-35
   c. 40-50
   d. 70-80.
4. Why is purging not the most desirable method of removing non-condensable gases?
   a. Some of the non-condensable gases remain.
   b. It is too expensive.
   c. It is too dangerous.
5. What is the micron equivalent of one inch of vacuum?
   a. 500
   b. 2,000
   c. 2,500
   d. 25,400.

Answers
1. b
2. a
3. b
4. a
5. d

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 96

TASK: Remove excess oil from compressor.

CONDITIONS: Oil pump, basic tool kit, containers, a refrigeration system.

STANDARD: The oil must be at the level line on the sight glass.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Close suction side valve and discharge side valve.
3. Discharge pressure from compressor.
4. Remove plug from side of compressor.
5. Insert hose from oil pump.
6. Suction oil from crank case until oil level drops to mark on sight glass on base of compressor (Bulls Eye) or approximately half way.
7. Purge or evacuate compressor.
8. Replace plug.
9. Back seat suction side valve and discharge side valve.
10. Start system.
11. Check oil level.
12. Check refrigerant charge by glass.

ENABLING OBJECTIVE(S)

Use refrigerant gauges.
Use hand tools.

LEARNING ACTIVITIES

1. Read and discuss **Modern Refrigeration and Air Conditioning**, pp. 367, 540, 929 and **Principles of Refrigeration**, pp. 209, 214.
2. Illustrate the correct method for connecting refrigerant gauges.
3. Explain the importance of maintaining the correct amount of refrigerant oil in the compressor.
4. Show how to close the suction and discharge valves and discharge the refrigerant.
5. Review the safety procedures.
6. Illustrate the correct procedure for removing non-condensable gases from the refrigerant system.
7. Review the precautions that must be taken when adding or removing oil from the system.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 367, 540, 929.
Marsh, et al., **Principles of Refrigeration**, pp. 209, 214.

PERFORMANCE OBJECTIVE V-TECS 96 (Continued)

EVALUATION

Questions

1. What is the primary purpose of oil in a refrigerant system?
   a. Lubricating and cooling.
   b. Removing heat.
   c. Quietness.
2. What does the term "pour point" mean?
   a. The temperature at which it will pour the fastest.
   b. Its lubricating ability at high speed.
   c. The lowest temperature at which the oil will pour.
3. How may one determine when the unit has been charged with the correct amount of refrigerant?
   a. By the head pressure.
   b. By the low side pressure.
   c. By the frost line on the evaporator.
4. What is a good vacuum, measured in a micron equivalent of one inch?
   a. 500
   b. 2,500
   c. 25,400.
5. What is the best method for removing non-condensable gases from the oil crank case?
   a. Purge the system.
   b. Evacuate the system.
   c. Blow air through it.

Answers

1. a
2. c
3. c
4. c
5. b

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 97

TASK: Remove moisture from tubing using dry nitrogen.

CONDITIONS: Vacuum pump, leak detector, nitrogen, refrigerant, basic tool kit, a refrigeration system.

STANDARD: The moisture level must be below 10 parts per million.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Attach gauges.
2. Discharge system.
3. Remove refrigerant lines at condenser outlet and drier.
4. Attach nitrogen tank to center base of gauge manifold.
5. Open nitrogen valve and low side gauge valve.
6. Open high side gauge valve.
7. Install new drier.
8. Evacuate system.
9. Charge system.
10. Leak test.
11. Remove gauges.
12. Start unit.
13. Observe moisture indicator.

ENABLING OBJECTIVE(S)
Use high pressure gas.
Use refrigerant gauges.

LEARNING ACTIVITIES
1. Read and discuss **Modern Refrigeration and Air Conditioning**, pp. 360, 459-460, 537 and **Principles of Air Conditioning**, p. 291.
2. Demonstate the correct method for connecting refrigerant gauges.
3. Emphasize the safety needed in working with high pressure gas.
4. Explain the importance of a system free of moisture.
5. Review the precautions that must be taken to have a system free from moisture.
6. Illustrate the correct method for purging high pressure nitrogen through the refrigerant lines.
7. Demonstrate the proper way to evacuate a system using a vacuum pump.
8. Explain how to charge the system with the exact amount of refrigerant.
9. Show how to properly close refrigerant valves and remove gauges.

RESOURCES
Lang, **Principles of Air Conditioning**, p. 291.
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 360, 459, 460, 537.

PERFORMANCE OBJECTIVE V-TECS 97 (Continued)

EVALUATION

Questions

1. Many troubles in refrigerating systems can be traced to which of the following:
   a. Not enough oil
   b. Too much oil
   c. Moisture in system.
2. When moisture is in a system, where does it usually freeze and clog?
   a. Condenser
   b. Metering devise
   c. Compressor.
3. Moisture causes which of the following problems?
   a. Too much cooling
   b. Chemical breakdown between the oil and refrigerant
   c. Oil foaming.
4. Acid is created by moisture and may ruin which of the following:
   a. The evaporator
   b. The condenser
   c. The motor winding.
5. Why do some service technicians install large driers on a temporary basis?
   a. To filter the oil
   b. To quickly clean a system
   c. To improve refrigerant flow.

Answers

1. c
2. b
3. b
4. c
5. b

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 98

TASK: Remove restrictions from expansion valve.

CONDITIONS: Refrigerant, basic tool kit, a refrigeration system, tools and equipment.

STANDARD: All restrictions must be removed from the valve and, when replaced, the system must be leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Attach gauges.
3. Discharge refrigerant.
4. Remove expansion valve.
5. Seal system.
6. Disassemble valve.
7. Clean strainer and orifice.
8. Assemble valve and replace.
9. Evacuate system.
10. Recharge to correct pressure and temperature.
11. Leak test.
12. Restore power to unit.
13. Start system and check operating temperature and pressure.
14. Remove gauges.

ENABLING OBJECTIVE(S)

Use pressure gauge.
Read manufacturer's expansive valve operating specifications.

LEARNING ACTIVITIES

1. Discuss reading assignment **Modern Refrigeration and Air Conditioning**, pp. 531, 533 and 535. Study and review reference materials **Principles of Refrigeration**, pp. 251-252.
2. Show how to install refrigerant gauges to high and low side of system.
3. Tell how to pump system down. If unit does not have valves, bleed refrigerant out of system and ventilate.
4. Demonstrate how to disassemble the expansion valve and clean.
5. Illustrate how to reassemble the valve making sure that none of the parts are missing.
6. Show how to charge the system and check for leaks.
7. Emphasize safety and the proper use and care of tools and equipment.

PERFORMANCE OBJECTIVE V-TECS 98 (Continued)

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 531, 533, 535.
Harris, **Modern Air Conditioning Practice**, pp. 251-252.

EVALUATION

Questions

1. What does the thermostatic expansion valve control?
   a. The amount of refrigerant in the evaporator.
   b. The vacuum.
   c. The pressure in the evaporator.
2. What will happen to the evaporator if the expansion valve is restricted?
   a. Flooded.
   b. Starve.
   c. Nothing.
3. How may the needle and seat be tested for leaks?
   a. Cooling the power bulb and using air pressure.
   b. With water.
   c. By turning the adjustment all the way out.

Answers

1. a
2. b
3. a

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 99

TASK: Remove restricted receiver drier core.

CONDITIONS: Basic tool kit, cartridge driers, refrigerant, vacuum pump, leak detector, a refrigeration system.

STANDARD: All restrictions must be removed from the receiver-drier and, after replacement, the system must be leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Attach gauges.
2. Pump system down to 5 PSI on low side.
3. Purge refrigerant from liquid line and drier shell.
4. Remove core from drier shell.
5. Remove restricted cartridges from core.
6. Install new cartridges.
7. Replace core in shell.
8. Replace gasket in service head of shell.
9. Replace shell head.
10. Pressurize liquid line and drier core with refrigerant from receiver.
11. Leak test drier core.
12. Evacuate drier core.
13. Release refrigerant from condenser and start system.
14. Allow machine to operate for 20 minutes and replace lost refrigerant.
15. Remove gauges.

ENABLING OBJECTIVE(S)

Use refrigerant gauges.
Identify high pressure and low pressure side of system.

LEARNING ACTIVITIES

1. Discuss reading assignment **Modern Refrigeration and Air Conditioning**, pp. 349, 359-360, 369-370, 372, and 384. Study and review reference material **Principles of Refrigeration**, pp. 57-61.
2. Show how to install value adaptor or piercing valve, connect manifold gauges, demonstrate how to remove refrigerant, and ventilate well.
3. Explain how to remove restricted drier cores.
4. Illustrate how to install new drier cores in drier shell.
5. Review the process of replacing drier shell gasket, pressurize system, and check for leaks.
6. Discuss how to evacuate drier and charge with refrigerant.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 349, 359-360, 369-370, 372, 384.
Marsh, et al., **Principles of Refrigeration**, pp. 57-61.

PERFORMANCE OBJECTIVE V-TECS 99 (Continued)

EVALUATION

Questions

1. One can tell when a drier without an indicator is absorbing moisture when ______________.
2. A strainer screen is supposed to remove to ____________________.
3. Moisture in an R-12 system ____________________.
4. The most common place to install a drier in the system is _______________.
5. A popuiar drier chemical is ____________________.

Answers

1. The drier becomes warm while the unit is operating.
2. Solid impurities.
3. Freezes at the refrigerant control.
4. In the liquid line.
5. Silica gel.

Practical Application

Refer to Checklist Performance Objective 99. Remove Restrictions From Receiver-Drier.

Method of Evaluation

Use Checklist Performance Objective 99 to evaluate student's performance to determine if the task was completed with at least a 90% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 99 EVALUATION

PERFORMANCE TEST FOR REMOVING RESTRICTIONS FROM RECEIVER-DRIER

Student's Name ____________________ Date ________

DIRECTIONS TO STUDENT: Set up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completed the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Install filter-drier with flare fittings.	______	______
2. Install filter-drier with sweat fittings.	______	______
3. Install refrigerant gauges and removing refrigerant.	______	______
4. Pressurize system and check for leaks.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ____________________ Date ________

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 100

TASK: Replace automatic expansion valve.

CONDITIONS: Basic tool kit, refrigerant, drier, automatic expansion valve, manufacturer's service manual, soap solution, vacuum pump, a refrigeration system.

STANDARD: The replacement valve must be mechanically secure and leakproof.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Attach gauges.
3. Discharge refrigerant.
4. Remove automatic expansion valve.
5. Secure new expansion valve.
6. Install drier.
7. Evacuate system.
8. Charge system with exact amount of refrigerant.
9. Leak test.
10. Restore power to unit.
11. Start system and operate about 20 minutes; adjust valve set if necessary.
12. Remove gauges.

ENABLING OBJECTIVE(S)

Identify and describe low pressure and high pressure side of system.
Read manufacturer's expansion valve specifications.
Use pressure gauges.

LEARNING ACTIVITIES

1. Read **Modern Refrigeration and Air Conditioning**, pp. 78, 144, 152, 159, 166, 532-533.
2. Demonstrate how to install refrigeration gauges on low pressure and high pressure side of refrigerant system.
3. Show how to pump system down. If unit does not have service valves, remove refrigerant and ventilate well.
4. Discuss how to remove the automatic expansion valve.
5. Explain how to install the new expansion valve.
6. Tell how to install new filter drier in liquid line.
7. Demonstrate how to connect vacuum pump and evacuate system.
8. Show how to charge system with refrigerant.
9. Demonstrate how to start system and after running unit for 20 minutes, adjust automatic expansion valve to manufacturer's specifications.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 78, 144, 152, 159, 166, 532-533.

PERFORMANCE OBJECTIVE V-TECS 100 (Continued)

EVALUATION

Questions

1. Which of the following is correct:
   a. The automatic expansion valve controls super heat.
   b. The automatic expansion valve maintains a constant evaporator pressure.
   c. The automatic expansion valve throttles in response to super heat.
2. The automatic expansion valve does which of the following?
   a. Permits flow in response to pressure in the evaporator.
   b. Strives to maintain a constant super heat.
   c. Reacts to super heat in the evaporator.
3. The automatic expansion valve is used with which of the following:
   a. Where the heat load frequently changes.
   b. When a constant evaporator pressure is required.
   c. When a constant evaporator pressure is not required.
4. By holding the suction pressure constant, how does this affect the compressor?
   a. The compressor load changes.
   b. The compressor load stays the same.
   c. The compressor current draw changes.
5. The automatic expansion valve is not suited for use:
   a. When compressors run constant.
   b. When evaporator load changes frequently.
   c. When constant evaporator pressure is needed.

Answers

1. b
2. a
3. b
4. b
5. a

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 101

TASK: Replace compressor service valve.

CONDITIONS: Basic tool kit, refrigerant, vacuum pump, service valve, soap solution, a refrigeration system.

STANDARD: The replacement valve must be mechanically secure and leakproof.

SOURCE FOR STANDARD:
Writing Team. State of Alabama.

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Attach gauges.
3. Pump down system.
4. Remove compressor service valve.
5. Mount new service valve.
6. Evacuate system.
7. Recharge system to full sight glass.
8. Leak test.
9. Restore power to unit.
10. Start system and check operation.
11. Remove gauges.

ENABLING OBJECTIVE(S)

Use pressure gauges.
Identify and describe the low pressure and high pressure side of system.

LEARNING ACTIVITIES

1. Read and discuss **Principles of Refrigeration**, pp. 204, 258-267 and **Modern Refrigeration and Air Conditioning**, pp. 70, 104, 134, 353-454, 495, 513, 917.
2. Review the safety precautions used in working with refrigerant.
3. Demonstrate the correct way to install refrigerant gauges.
4. Show how to pump a system down to make repairs on the low pressure side of refrigerant system.
5. List the components in the refrigerant system that can be required or serviced by pumping the system down to save the refrigerant.
6. Show how to remove the service valve and install new service valve.
7. Discuss the importance in keeping a system free of contaminants.
8. Explain how to evacuate a system using a vacuum pump.
9. Demonstrate the correct method to charge a system.
10. Show how to start the system and check operating pressure and temperature.

RESOURCES

Marsh, et al., **Principles of Refrigeration**, pp. 204, 258-267.
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 70, 104, 134, 353, 454, 495, 513, 917.

PERFORMANCE OBJECTIVE V-TECS 101 (Continued)

EVALUATION

Questions

1. Does the service valve attachment have threads on it?
   a. Yes
   b. No
   c. On some models.
   d. Only if it is a high pressure unit.
   e. No valve stem is used.
2. How is maximum refrigerant flow obtained through a Shrader or Dill valve core?
   a. Core all the way out.
   b. Core depressed half way.
   c. Core removed.
   d. Core all the way in.
3. What permits the service valve attachment to be swiveled to any position?
   a. Tapered threads.
   b. A swival nut on the attachment.
   c. A compressible gasket.
4. Which compressor service valve can be changed after pump down?
   a. Both.
   b. The suction.
   c. The high pressure.

Answers

1. a
2. c
3. b
4. b

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 102

TASK: Replace condenser.

CONDITIONS: Basic tool kit, refrigerant, leak detector, drier, vacuum pump, a refrigeration system.

STANDARD: The replacement condenser and the gas and liquid lines must be mechanically secure, free from restrictions, and leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Weaver and Kirkpatrick, **Environmental Control.**
State Department of Education, Alabama, **Air Conditioning and Refrigeration.**

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Attach gauges.
3. Discharge refrigerant.
4. Remove air-cooled condenser.
5. Place new condenser and connect hot gas and liquid lines.
6. Leak test.
7. Install new drier.
8. Evacuate system.
9. Charge system.
10. Leak test.
11. Restore power to unit.
12. Start unit and check air flow across condenser and head pressure.
13. Remove gauges.

ENABLING OBJECTIVE(S)
Use pressure gauges.
Read manufacturer's condenser specifications.

LEARNING ACTIVITIES
1. Read and discuss **Modern Refrigeration and Air Conditioning**, pp. 105, 138, 349, 359, 361-362, 374, 377, 384, 390 and **Principles of Air Conditioning**, pp. 290-291, 294.
2. Explain how to remove condenser shroud and fan.
3. Demonstrate how to attach the valve adaptor or piercing valve, install the refrigerant gauges.
4. Show how to purge the refrigerant from the system to 0-5 PSI and ventilate.
5. Demonstrate how to cut the refrigerant lines at outlet to condenser and outlet of filter drier. Cut the lines at places where brazing will be easier later. Immediately plug the lines still connected to the system.
6. Review how to remove the condenser and filter drier and install new condenser and filter drier.

7. List the steps in cleaning the tubing, swaging the tubing or use couplings, fluxing, and then brazing the joints and removing the flux.
8. Tell how to pressurize the system and test for leaks.
9. Show how to evacuate the system using the vacuum pump.
10. Demonstrate how to charge the unit with vapor refrigerant.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 105, 138, 349, 359, 361-362, 374, 377, 384, 390.

Lang, **Principles of Air Conditioning**, pp. 290-291, 294.

EVALUATION

Questions

1. The most common fault with condensers?
2. A condenser fan operates ________________.
3. The most frequent service operation performed on a condenser is ____________.
4. One should avoid bending a condenser fan blade because the ____________.
5. One knows there is air in the system when _____________.

Answers

1. Leaks
2. Only when the compressor is running.
3. Cleaning it.
4. Fan will vibrate.
5. The head pressure will be above normal.

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 103

TASK: Replace evaporator.

CONDITIONS: Basic tool kit, evaporator, refrigerant, leak detector, drier, vacuum pump, manufacturer's specifications/wiring schematic, a refrigeration unit with a defective evaporator.

STANDARD: The replaced evaporator lines and electrical connections must be mechanically secure and in accordance with wiring diagram and/or manufacturer's specifications. The evaporator must be free of internal moisture and leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Weaver and Kirkpatrick, **Environmental Control**.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Attach gauges.
3. Discharge refrigerant.
4. Cut and seal refrigerant lines.
5. Remove evaporator.
6. Mount new evaporator.
7. Connect suction line.
8. Mount metering device to evaporator inlet.
9. Connect liquid line to metering device.
10. Leak test.
11. Install new drier.
12. Evacuate system.
13. Charge system with proper refrigerant according to sight glass. Allow 20 minutes for system to balance pressures.
14. Leak test.
15. Restore power to unit.
16. Start unit and check super heat and adjust, if required.
17. Remove gauges.

ENABLING OBJECTIVE(S)
Use pressure gauges.
Read manufacturer's evaporator specifications.

LEARNING ACTIVITIES
1. Read **Modern Refrigeration and Air Conditioning**, pp. 101-102, 334, 349, 359, 361-362 and **Principles of Refrigeration**, pp. 134-151.
2. Demonstrate how to remove the parts to expose the evaporator.
3. Show how to attach the adaptor or piercing valve. Install the refrigerant gauges.
4. Demonstrate how to remove the refrigerant from the system and ventilate.
5. Show how to cut the refrigerant lines at the evaporator.
6. Illustrate how to remove the evaporator by unbolting it from the cabinet and install the new evaporator.

PERFORMANCE OBJECTIVE V-TECS 103 (Continued)

7. Demonstrate how to swage the tubing or use couplings. Braze the connections using the correct brazing procedure.
8. Show how to remove and install a new filter-drier.
9. Demonstrate how to pressurize the system and check for leaks.
10. Demonstrate how to evacuate the system using a vacuum pump.
11. Show how to charge the system. Use the exact weight of refrigerant charge.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 101, 102, 334, 349, 359, 361-362.

Marsh, et al., **Principles of Refrigeration**, pp. 134-151.

EVALUATION

Questions

1. The type of evaporator used with a capillary tube is ________________.
2. The service valve attachment installation should be checked for leaks in order ____________________.
3. The tubing is cut with a tube cutter instead of being cut with a hacksaw ________________.
4. Which tubing lines are cut?
5. The action that should be taken when removing the refrigerant from the system is ________________________.

Answers

1. Dry
2. To save needed refrigerant.
3. To keep copper chips out of the refrigerant lines.
4. Capillary tubing and suction tubing.
5. Purge it into a special purge line into a ventilation hood.

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 104

TASK: Replace heat exchanger.

CONDITIONS: Basic tool kit, refrigerant, heat exchanger, brazing alloys, drier, vacuum pump, leak detector, a refrigeration system.

STANDARD: The replaced heat exchanger and lines must be mechanically secure and leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Attach gauges.
3. Discharge refrigerant.
4. Cut liquid and suction lines on each side of defective heat exchanger.
5. Install new heat exchanger.
6. Braze/solder tube connections.
7. Leak test.
8. Install new drier.
9. Evacuate system.
10. Charge system to a full sight glass.
11. Leak test.
12. Restore power to unit.
13. Start unit and check system for efficient cooling.
14. Remove gauges.

ENABLING OBJECTIVE(S)
Use pressure gauges.
Use brazing equipment.
Read manufacturer's heat exchanger specifications.

LEARNING ACTIVITIES
1. Read and discuss **Modern Refrigeration and Air Conditioning**, pp. 432, 584.
2. Demonstrate the correct method to install refrigerant gauges.
3. Explain the correct procedure to discharge the refrigerant.
4. Review safety procedures in handling refrigerants and brazing equipment.
5. Demonstrate the correct procedure to remove refrigerant lines from the heat exchanger.
6. Explain how to remove old heat exchanger and install new heat exchanger.
7. Show the correct procedure to braze the refrigerant lines.
8. Emphasize the importance of a leak tight system.
9. Demonstrate the correct procedure to vacuum a system down.
10. Discuss the procedure used to charge a system with refrigerant.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 432, 584.
Trane Reciprocating Refrigeration Manual, Trane Company, p. 66.

PERFORMANCE OBJECTIVE V-TECS 104 (Continued)

EVALUATION

Questions

1. Heat exchangers are frequently installed between which two lines in R-12 systems:
   a. Suction and hot gas
   b. Suction and liquid
   c. Liquid and hot gas.
2. Heat exchangers help prevent which problem below:
   a. Flash gas in the liquid line
   b. Oil foaming
   c. Acid build up.
3. Increasing the heat of the suction gas helps prevent which problem below:
   a. Liquid in the suction line
   b. Liquid in the hot gas line
   c. Proper expansion valve control.

Answers

1. b
2. a
3. a

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 105

TASK: Replace hot gas by-pass valve.

CONDITIONS: Hot gas by-pass valve, vacuum pump, refrigerant, leak detector, basic tool kit, manufacturer's specifications/wiring schematic, a refrigeration system.

STANDARD: The replaced valve and electrical connections must be mechanically secure and installed in accordance with wiring diagram and/or manufacturer's specifications. All connections must be leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electrical Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE
1. Locate hot gas by-pass valve.
2. Disconnect power to unit.
3. Attach gauges.
4. Discharge system.
5. Disconnect electrical wires to valve.
6. Remove valve.
7. Install new valve.
8. Connect electrical wires.
9. Leak test valve.
10. Evacuate system.
11. Charge to correct pressure and run system.
12. Restore power to unit.
13. Start unit and check defrost cycle.
14. Remove gauges.

ENABLING OBJECTIVE(S)
Use pressure gauges.
Read manufacturer's hot gas by-pass valve specifications.

LEARNING ACTIVITIES
1. Read and discuss **Modern Refrigeration and Air Conditioning,** pp. 423, 425-431, 461 and **Principles of Refrigeration,** pp. 146-147.
2. Demonstrate how to install refrigeration gauges on low pressure side and high pressure side of system.
3. Explain how to remove the refrigerant from the system.
4. Sketch the wiring diagram. Disconnect electrical wires to valve.
5. Discuss how to remove old valve from system and install new valve.
6. Show how to connect electrical wires to new valve.
7. Review the process of pressurizing the system and checking for leaks.
8. Tell how to evacuate system using vacuum pump.
9. Demonstrate how to charge system with exact weight of refrigerant.
10. Interpret the process of starting the system and checking operation of hot gas valve using manufacturer's specifications.

PERFORMANCE OBJECTIVE V-TECS 105 (Continued)

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 423, 425-431, 461.

Marsh, et al., **Principles of Refrigeration**, pp. 146-147.

EVALUATION

Questions

1. The valve that controls the hot gas flow to the evaporator is the ________________.
2. The hot gas valve is closed (end of defrost cycle) by the ________________.
3. "Hot gas" comes from the ________________.
4. Capping the body of the valve to open it will be a good repair. (True or False)
5. The compressor runs during the "hot gas" defrost operation. (True or False)

Answers

1. Solenoid valve
2. Timer or thermostat
3. Compressor
4. False
5. True

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 106

TASK: Replace solenoid valve.

CONDITIONS: Basic tool kit, new solenoid valve, drier, refrigerant, vacuum pump, manufacturer's specifications/wiring schematic, a refrigeration system.

STANDARD: The replaced solenoid valve and electrical connections must be mechanically secure and installed in accordance with wiring diagram and/or manufacturer's specifications. All connections must be leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Weaver and Kirkpatrick. **Environmental Control.**

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Attach gauges.
3. Discharge refrigerant or pump system down.
4. Remove defective solenoid valve.
5. Solder/braze new valve in place.
6. Leak test and install drier.
7. Evacuate system.
8. Connect wires from solenoid to power source.
9. Charge system to a full sight glass.
10. Operate solenoid several times to assure blocking of refrigerant flow.
11. Remove gauges.

ENABLING OBJECTIVE(S)

Use pressure gauges.
Read manufacturer's solenoid valve specifications.
Use brazing equipment.

LEARNING ACTIVITIES

1. Read and discuss **Principles of Refrigeration**, pp. 294-352 and **Modern Refrigeration and Air Conditioning**, pp. 94-95, 157-158, 166, 268-269, 274, 415-427, 446-447, 451, 461, 547, 551.
2. Demonstrate how to install refrigerant gauges on low pressure side and high pressure side of system.
3. Explain how to discharge the refrigerant or pump the system down if system has service valves and ventilate well.
4. Show how to remove wiring and valve body from system.
5. Discuss how to install new valve in line and braze lines.
6. Illustrate how to remove old drier and install new filter-drier.
7. List the steps in pressurizing the system and checking for leaks.
8. Review the process of evacuating the system using vacuum pump.
9. Show how to charge system with the exact amount of refrigerant.
10. Demonstrate how to start system and check operation of new solenoid valve, making sure refrigerant flow will stop.

PERFORMANCE OBJECTIVE V-TECS 106 (Continued)

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 94-95, 157-158, 166, 268-269, 274, 425-427, 446-447, 451, 461, 547, 551.

Marsh, et al., **Principles of Refrigeration**, pp. 294, 352.

EVALUATION

Questions

1. The part of a solenoid that moves is ________________.
2. The two popular types of solenoid valves are ______________ and ____________.
3. There are three different voltages that are popular for solenoids. (True or False)
4. The fluid pressure helps operate the solenoid valve by _________________.
5. Some solenoid valves must be plumbed vertically in order ______________________.

Answers

1. Core
2. Two-way and three-way
3. False
4. Helping close the valve
5. To permit core to move freely

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 107

TASK: Replace thermostatic expansion valve.

CONDITIONS: Superheat thermometer, drier, refrigerant, thermostatic expansion valve, manufacturer's specifications, a refrigeration system.

STANDARD: The replaced thermostatic expansion valve must be mechanically secure and installed in accordance with manufacturer's specifications. All connections must be leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Weaver and Kirkpatrick, **Environmental Control**.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Attach gauges.
3. Pump system down.
4. Purge refrigerant from liquid and suction lines.
5. Remove thermostatic expansion valve (TXV).
6. Install new thermostatic expansion valve.
7. Leak test.
8. Install new drier.
9. Evacuate system.
10. Charge system according to sight glass.
11. Observe operating pressures.
12. Install superheat thermometer.
13. Allow time for system to begin normal operation.
14. Check superheat and record.
15. Adjust superheat to 7^{o} — 12^{o} F.
16. Remove superheat thermometer.
17. Remove gauges.

ENABLING OBJECTIVE(S)
Identify high pressure side and low pressure side of system.
Use pressure gauges.
Read manufacturer's thermostatic expansion valve specifications and use thermometers.

LEARNING ACTIVITIES
1. Read and discuss **Modern Refrigeration and Air Conditioning**, pp. 78, 144, 152, 159-160, 166, 532-534, 551, **Modern Air Conditioning Practice**, pp. 250-252, and **Principles of Air Conditioning** pp. 26-27.
2. Demonstrate how to connect the refrigerant gauges to the high pressure side and low pressure side of system.
3. Explain how to pump system down. If system does not have service valves, discharge refrigerant and ventilate well.
4. Show how to remove defective thermostatic valve and install new valve.
5. Discuss how to pressurize system and check for leaks.
6. Tell how to remove old filter drier and install new filter drier.

PERFORMANCE OBJECTIVE V-TECS 107 (Continued)

7. Review the process of evacuating the system using a vacuum pump.
8. Interpret the process of charging the system with the exact amount of refrigerant.
9. Demonstrate how to start system and adjust thermostatic expansion valve to a 10^{o}F superheat setting.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 78, 144, 152, 159, 160, 166, 532-534, 551.

Harris, **Modern Air Conditioning Practice**, pp. 250-252.

Lang, **Principles of Air Conditioning**, pp. 26-27.

EVALUATION

Questions

1. The power bulb is located on ____________________ when controlling an air-cooling evaporator.
2. The thermostatic expansion valve controls ____________________.
3. The needle and seat may be tested for leaks by ____________________.
4. If the TEV adjustment screw is turned out the evaporator will ________________.
5. If the power element is located in a warm air stream the evaporator will ________________.

Answers

1. On the suction line near the evaporator
2. The quantity of refrigerant in the evaporator
3. Cooling the power bulb and using air pressure
4. Flood
5. Flood

DUTY: INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS, AND WATER TOWERS

PERFORMANCE OBJECTIVE V-TECS 108

TASK: Straighten condenser fins.

CONDITIONS: Fin comb set, 6" rule, condenser coil with bent fins.

STANDARD: When the condenser fins are straightened, there must be no restriction of air flow.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Count the number of fins in one inch.
2. Select proper fin comb.
3. Insert comb teeth betweeen fins and pull comb.
4. Repeat until all fins are straight.

ENABLING OBJECTIVE(S)
Use measuring rule.
Use fin comb.

LEARNING ACTIVITIES
1. Read and discuss **Modern Refrigeration and Air Conditioning**, p. 522 and **Principles of Refrigeration**, p. 156.
2. Explain the importance of a condenser with minimum air restriction.
3. Show how to determine the number of fins in one inch.
4. Demonstrate the proper way to use a fin comb.
5. Review the safety procedures for working with condenser fins.
6. Show how to select the proper fin comb.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, p. 522.
Marsh, et al., **Principles of Refrigeration**, p. 156.

EVALUATION
Questions
1. How should you select the correct fin comb?
   a. Any comb will work.
   b. By determining how many fins to the inch
   c. By condensers appearance.
2. Damaged fins could cause which problem below?
   a. High head pressure
   b. Low head pressure
   c. Low suction pressure.
3. How should a fin comb be used?
   a. Push the comb.
   b. By working comb back and forth
   c. By pulling comb.

PERFORMANCE OBJECTIVE V-TECS 108 (Continued)

Answers

1. b
2. a
3. c

INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 109

TASK: Adjust refrigerator/freezer doors.

CONDITIONS: Extension cord with 40 watt test light, .003 inch shims, feeler gauge, wiping cloth, cleaning solvent, basic tool kit, a refrigerator or freezer.

STANDARD: The door must fit tight against the cabinet with a maximum clearance of .003 inch.

SOURCE FOR STANDARD:
State Department of Education, Alabama, **Air Conditioning and Refrigeration.**

PERFORMANCE GUIDE
1. Test adjustment with test light or feeler gauge.
2. Make adjustments by adding or removing shims or moving hinges in or out.
3. Level refrigerator/freezer.
4. Retest with light or gauge.
5. Make necessary adjustments.
6. Retest.

ENABLING OBJECTIVE(S)
Use feeler gauge.
Read manufacturer's door clearance specifications.
Use spirit level.

LEARNING ACTIVITIES
1. Read **Modern Refrigeration and Air Conditioning** pp. 66-67, 71, 331-334, 337-339.
2. Demonstrate how to use the spirit level and adjust the cabinet to a level position.
3. Show how to check the sealing ability of the gasket with either a feeler gauge or with a 40-watt test lamp. Check door clearance specifications.
4. If the door hardware is out of alignment, tell how to repair by changing the adjustment at the hinge.
5. Lecture on the importance of checking gasket tightness and adjusting hinges.
6. Show how to check with a test light to determine fit.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 66, 67, 71, 331, 332, 334, 337, 338.

EVALUATION
Questions
1. Shims can be used to raise the door. (True or False)
2. The type screw that is used to hold the hinges in place is the ______________.
3. The purpose of shims used under the hinge and the hinge bolt is to ______________.
4. How is the bottom of the door adjusted if it is too far away from the frame?
5. The kind of bushings used in modern hinges are ____________.

PERFORMANCE OBJECTIVE V-TECS 109 (Continued)

Answers

1. True
2. Flat head machine screws
3. Adjust the distance between the door and the frame.
4. Adjust the door liner screws.
5. Nylon

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 110

TASK: Adjust water valve switch in a flex tray icemaker.

CONDITIONS: A refrigerator with a flex tray icemaker, basic tool kit.

STANDARD: The water valve switch must be adjusted until "ice cubes" will form.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Remove cover from icemaker.
2. Locate adjusting screw.
3. Turn screw in appropriate direction and allow time to make ice.
4. Repeat step 3 as necessary.

ENABLING OBJECTIVE(S)
Read manufacturer's water valves switch adjustment specifications.

LEARNING ACTIVITIES
1. Read and discuss **Modern Refrigeration and Air Conditioning**, pp. 254-257.
2. Show how to remove panels and locate adjusting screw.
3. Emphasize the importance of using the manufacturer's specifications to adjust the water valve switch.
4. Demonstrate how to adjust water valve switch to desired setting.
5. List and describe the parts in a water valve switch.
6. Explain how to determine if switch has the correct adjustment setting.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 254-257.

EVALUATION
Questions
1. During the freezing cycle, the temperatures in the freezing compartment is at which temperature?
   a. 20F to 18F
   b. 32F to 26F
   c. 8F or lower.
2. Water flows into the ice tray for how many seconds?
   a. 30 seconds
   b. 50 seconds
   c. 7.5 seconds.
3. The cold cut in thermostat starts which process below?
   a. The harvest cycle
   b. The water fill cycle
   c. The cold cycle.

PERFORMANCE OBJECTIVE V-TECS 110 (Continued)

Answers
1. c
2. c
3. a

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 111

TASK: Clean restricted capillary tube.

CONDITIONS: Capillary tube cleaner, leak detector, brazing outfit, clamp-on service valve, refrigerant, basic tool kit, a restricted capillary tube.

STANDARD: When the tube is cleaned, all restrictions must be removed.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Attach gauges.
2. Purge system.
3. Unbraze capillary tube.
4. Remove restriction using capillary tube cleaner.
5. Replace capillary tube.
6. Evacuate system.
7. Recharge system.
8. Leak test system.
9. Start system and check operation.
10. Remove gauges.

ENABLING OBJECTIVE(S)
Use brazing equipment.
Use refrigerant gauges.

LEARNING ACTIVITIES
1. Read and discuss **Principles of Refrigeration**, pp. 228-230 and **Modern Refrigeration and Air Conditioning**, pp. 79, 109-110, 138, 163-167, 360-366, 369-373, 377-379.
2. Show how to properly install refrigerant gauges.
3. Review the safety precautions used while working with high pressure gases.
4. Discuss the importance of keeping the refrigerant clean and dry.
5. Demonstrate how to install a clamp on service valve.
6. Explain the importance of charging the system with the exact amount of refrigerant.
7. Show how to remove the refrigerant and unbraze the capillary tube.
8. Demonstrate how to use the capillary tube cleaner.
9. Explain how to install the capillary tube.
10. Show how to pressurize the system and check for leaks.
11. Demonstrate how to start the system and check operating pressure and temperature to be sure the system has no restrictions.

RESOURCES
Marsh, et al., **Principles of Refrigeration**, pp. 228, 229, 230.
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 79, 109, 110, 138, 163-167, 360-366, 369-373, 377-379.

PERFORMANCE OBJECTIVE V-TECS 111 (Continued)

EVALUATION

Questions

1. A capillary tube is made of ___________________.
2. The effect of internal moisture on a capillary tube system will ________________.
3. The most popular refrigerant control in domestic refrigerators is ________________.
4. A filter is out at the inlet of the capillary tube to _____________.
5. When a capillary tube system is overcharged, it will _________________.

Answers

1. Copper
2. Make it defrost
3. Capillary tube
4. Remove solid foreign particles.
5. Sweat and frost back.

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 112

TASK: Clean system after burnout.

CONDITIONS: Basic tool kit, cleaning materials, rubber gloves, vacuum pump, refrigerant, new compressor, new driers, moisture indicator, leak detector, thermocouple vacuum, dry nitrogen, a refrigeration system after burnout.

STANDARD: All replaced parts must be mechanically secure and the system must be clean, free of contaminants, and leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Dismantle system.
2. Clean condenser.
3. Clean evaporator.
4. Clean metering device.
5. Clean interconnecting tubing.
6. Seal each part after cleaning.
7. Assemble complete system.
8. Flush system.
9. Install new compressor.
10. Leak test entire system.
11. Purge system with dry nitrogen.
12. Evacuate system.
13. Break vacuum with dry nitrogen.
14. Install suction and liquid driers.
15. Leak test where driers are installed.
16. Evacuate system.
17. Prepare system for operation.
18. Charge system with proper refrigerant.
19. Test system for adequate cooling.
20. Operate system for 24 hours and replace driers.
21. Test system for adequate cooling.

ENABLING OBJECTIVE(S)
Use pressure gauges.
Use cleaning materials.
Identify and describe high and low pressure side of system.

LEARNING ACTIVITIES
1. Read and discuss **Modern Refrigeration and Air Conditioning**, pp. 375-378, 380, 727.
2. Demonstrate how to connect refrigerant gauges to high pressure and low pressure side of system.
3. Show how to remove refrigerant from system. Use rubber gloves handling all equipment during cleanout and ventilate well.
4. List the steps in removing burned out compressor and wear goggles.
5. Show how to flush system with refrigerant.

PERFORMANCE OBJECTIVE V-TECS 112 (Continued)

6. Explain how to install new suction line filter and liquid line filter drier.
7. Explain the need to purge the system with dry nitrogen.
8. Review the process of pressurizing the system and testing for leaks.
9. Show how to evacuate system using vacuum pump.
10. Demonstrate how to charge the system with exact weight of refrigerant.
11. Show how to start system and test for maximum cooling.
12. Explain the importance of operating the system for 24 hours and removing filter-driers and installing new ones.

RESOURCES

Althouse, et al., Modern Refrigeration and Air Conditioning, pp. 375-376, 378, 380, 727.

EVALUATION

Questions

1. In addition to the tubing connection, the ________________ must be removed from the dome.
2. After removing oil from the dome, the next step is to ________________.
3. The unit should be run before the dome is put in place in order to ____________.
4. The best way to clean the mechanism before assembly is ______________.
5. The service recommended for compressor valves is ____________________.

Answers

1. The electrical connections
2. Measure and test for acid.
3. See if the assembly operates correctly.
4. Wash with mineral spirits.
5. Replacing.

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 113

TASK: Clean water-fill valve.

CONDITIONS: A refrigeration system, basic tool kit, necessary parts for valve repair.

STANDARD: The water-fill valve must be clean, mechanically secure, and adjusted to completely cut-off water flow at the water-fill level.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Turn water off.
2. Drain filled area.
3. Remove valve.
4. Dismantle and clean valve.
5. Repair or replace worn parts.
6. Assemble valve carefully and reinstall.
7. Turn water on.
8. Visually inspect water level.
9. Make necessary adjustments to obtain correct water level.

ENABLING OBJECTIVE(S)
Read manufacturer's water-fill valve specifications.

LEARNING ACTIVITIES
1. Read and discuss Modern Refrigeration and Air Conditioning, pp. 527-529.
2. Show how to turn make-up water off and drain system.
3. Check for restrictions.
4. Explain how to check moving parts of water-fill valve for wear.
5. List and identify the parts of a water-fill valve.
6. Illustrate what can happen if a system runs with a low water level.
7. Demonstrate how to install the water, fill valve. Fill System with water to the proper water level.

RESOURCES
Althouse, et al., Modern Refrigeration and Air Conditioning, pp. 527-529.

EVALUATION
Questions
1. If water flow is too little which answer below could be true:
   a. Too much water pressure
   b. Clogged screen
   c. Valve adjustment turned in too far.

PERFORMANCE OBJECTIVE V-TECS 113 (Continued)

2. Some of the trouble caused by water valves could be:
   a. Too little water
   b. Too much water
   c. Water flow does not stop when unit is idle.
   d. All of the above.
3. What may cause too great a water flow?
   a. Water pressure too high
   b. Leaking water valve
   c. All of the above.

Answers
1. b
2. d
3. c

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 114

TASK: Charge refrigeration system.

CONDITIONS: Refrigerant, manufacturer's manual, basic tool kit, temperature-pressure chart, charging cylinder, leak detector, manufacturer's specifications, a refrigeration system without charge.

STANDARD: Refrigerant amount and type must be in accordance with manufacturer's specifications. The system must be free of noncondensables and not leak when pressurized.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
State Department of Education, Alabama. **Air Conditioning and Refrigeration.**

PERFORMANCE GUIDE
1. Attach gauges.
2. Determine correct type and amount of charge.
3. Pressurize and leak test.
4. Evacuate system.
5. Recharge system.
6. Start unit, check system pressure against specifications.
7. Remove gauges.

ENABLING OBJECTIVE(S)
Use pressure gauges.
Use pressure temperature chart.
Read manufacturer's refrigerant charging specifications.

LEARNING ACTIVITIES
1. Read and discuss **Principles of Refrigeration**, pp. 263-268 and Modern **Refrigeration and Air Conditioning**, pp. 293, 298-300, 364-367.
2. Demonstrate how to connect refrigerant gauges to the high pressure side and low pressure side of system.
3. Explain how to pressurize the system with proper refrigerant and test for leaks.
4. Show how to evacuate the system using a vacuum pump.
5. Demonstrate how to charge the system with vapor refrigerant.
6. List the steps in removing the refrigerant gauges and testing for leaks.

RESOURCES
Marsh, et al., **Principles of Refrigeration**, pp. 263-268.
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 293, 298-300, 364-367.

PERFORMANCE OBJECTIVE V-TECS 114 (Continued)

EVALUATION

Questions

1. The most common indication of a shortage of refrigerant in a hermetic system is the ________________.
2. The most important thing to do if a shortage of refrigerant is discovered is to ________________.
3. The best way to heat a service cylinder is ________________.
4. To determine when the unit has been charged with the correct amount of refrigerant, you check ________________.
5. The best leak testing method is ________________.

Answers

1. Lowering of frost line on the evaporator.
2. Find the leak.
3. Use hot water.
4. By the frost line on the evaporator.
5. Electronic sniffer.

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 115

TASK: Check efficiency of compressor motor.

CONDITIONS: A compressor or complete system, basic tool kit, vacuum pump.

STANDARD: Compressor should pull a vacuum of 15" — 25" in less than one minute and not rise more than 4 — 5 pounds when discharge side valve is closed.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Attach gauges.
2. Close suction side valve.
3. Operate compressor one minute or less.
4. Observe pressures. Compressor should pull a vacuum of 15" — 25" in less than one minute.
5. Close discharge side valve (DSV). Pressure should not rise more than 4 or 5 pounds.
6. Remove gauges.

ENABLING OBJECTIVE(S)
Use vacuum pump.
Use pressure gauges.

LEARNING ACTIVITIES
1. Read and discuss **Modern Refrigeration and Air Conditioning**, p. 382.
2. Demonstrate how to connect the refrigerant gauges to the high pressure side and low pressure side of system.
3. Explain the importance of closing suction side valve and record pressure.
4. Lecture on the need to run the system for one minute or less and record vacuum. Compressor should pull 15" — 25" vacuum.
5. Show how to close service valve on high side of system and record pressure.
6. Explain why the compressor does not run with high pressure service valve closed.
7. Explain the need to open all valves.
8. Demonstrate how to remove refrigerant gauges.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, p. 382.

EVALUATION
Questions
1. The material usually used for compressor cylinders is ________________.
2. A good compressor should be capable of creating ________ inches by vacuum.
3. The type of piston crankshaft arrangement which does not use a connecting rod is a ______________.

PERFORMANCE OBJECTIVE V-TECS 115 (Continued)

4. The type of compressor which has the cylinders parallel to the crankshaft is the ________________.
5. Compressor valves are usually located on open type compressors in a ________________.

Answers
1. Cast iron
2. 28
3. Scotch yoke
4. Swash plate
5. Valve plate

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 116

TASK: Check temperature-pressure.

CONDITIONS: Pressure-temperature chart, basic tool kit, manufacturer's specifications, a heating and cooling system.

STANDARD: The temperature-pressure must be adjusted to manufacturer's specifications for the system design.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Determine unit temperature or pressure reading.
2. Convert temperature to pressure or vice versa.
3. Compare temperature pressure to manufacturer's specifications.
4. Make temperature/pressure adjustments, as necessary.

ENABLING OBJECTIVE(S)
Use temperature chart to show to determine pressure and temperature.
Use refrigerant gauges to get pressure.
Use knowledge of installing gauges.

LEARNING ACTIVITIES
1. Instruct students to read **Modern Refrigeration and Air Conditioning**, pp. 277-278, 297-339.
2. Show that the temperature of the refrigerant in the evaporator is the same as the evaporator temperature when the compressor is not running.
3. Explain that the temperature of the refrigerant in the evaporator is about 8F. to 12F. colder than the evaporator when the compressor is not running.
4. Explain that the temperature of the refrigerant in an air-cooled condenser is approximately 30F. to 35F. warmer than the room temperature.
5. Explain that the temperature of the refrigerant in a water cooled condensor is approximately 20F. warmer than the water temperature at the drain outlet.
6. Show that the temperature of the refrigerant will be about the same as the temperature of the cooling medium after the unit has been shut off for 15 to 30 minutes.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 277-278, 297-339.

EVALUATION
Questions
1. To what part of the system is the compound gauge connected?
2. What part of the system is the high-pressure gauge connected?
3. How much warmer is the air at the condensing unit than the room air?
4. What do you use to determine the relation between pressure and temperature?

PERFORMANCE OBJECTIVE V-TECS 116 (Continued)

Answers

1. Suction or low side
2. Discharge or high side
3. 30F. to 35F.
4. Pressure temperature chart

DUTY: INSTALL AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 117

TASK: Evacuate refrigeration system.

CONDITIONS: A refrigeration system, basic tool kit, refrigerant, vacuum pump.

STANDARD: The system must be free of air and moisture.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick. **Environmental Control.**

PERFORMANCE GUIDE
1. Attach gauges.
2. Purge system.
3. Attach vacuum pump to gauges and start pump.
4. Pull to lowest vacuum possible, as close to zero as possible.
5. Determine presence of moisture or leakage using vacuum gauge.
6. Repeat, as necessary, until air and moisture are removed.

ENABLING OBJECTIVE(S)
Identify high side and low side.
Read gauges.
Use of the vacuum pump.
Identify two methods of evacuation.

LEARNING ACTIVITIES
1. Instruct students to read **Modern Refrigeration and Air Conditioning**, pp. 384-497 and **Heating, Ventilating and Air-Conditioning Fundamentals**, p. 263.
2. Explain how to install pressure gauges.
3. Demonstrate how to use vacuum pump.
4. Show how to install pressure gauges on vacuum pump.
5. Explain a vacuum of 500 microns.
6. Explain 28" Hg (Hg is measurement in inches of mercury).
7. Demonstrate charging system to Opsi with vapor refrigerant.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 384-497.
Harvello, **Heating, Ventilating and Air-Conditioning Fundamentals**, p. 263.

EVALUATION
Questions
1. What service operation may best be performed with the aid of a high vacuum pump?
2. What instrument is often combined with the high vacuum pump as an assembly?
3. What is a good vacuum, measured in millimeters of inches of mercury?
4. What is the micron equivalent of one inch of vacuum?

PERFORMANCE OBJECTIVE V-TECS 117 (Continued)

Answers

1. Dehydrate system
2. A high vacuum gauge
3. 5-10
4. 25,400

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 118

TASK: Install access core-type service valve.

CONDITIONS: Core-type service valve, silver solder, stand cloth, flux, wet rag, basic tool kit, a refrigeration system.

STANDARD: An access core-type service valve must be installed so that the installation site will be free of excess flux and leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Clean area to be soldered.
2. Solder valve in position.
3. Remove excess flux from soldered joint.
4. Leak test.

ENABLING OBJECTIVE(S)
Use core type valves for access to pressure and vacuum of system.
Use knowledge of silver brazing and soldering.

LEARNING ACTIVITIES
1. Instruct students to read Modern Refrigeration and Air Conditioning, pp. 359-360.
2. Identify safety rules pertinent to installing access core-type service valve.
3. Explain the purpose of the core type service valve.
4. Demonstrate preparation of the tubing to install tee type filling.
5. Demonstrate how to remove core for pulling vacuum on system.

RESOURCES
Althouse, et al., Modern Refrigeration and Air Conditioning, pp. 359-360.

EVALUATION
Questions
1. You leave the core in a core type valve for pulling a vacuum. (True or False)
2. The core type valve is a piercing valve. (True or False)
3. You can charge a system and read head pressure with a core type valve. (True or False)

Answers
1. False
2. False
3. True

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 119

TASK: Install suction line filter-drier.

CONDITIONS: Suction line filter-drier, silver solder and flux, flare nuts, flare nut wrenches, leak detector, refrigerant, dry nitrogen, sand cloth, basic tool kit, a refrigeration system.

STANDARD: A suction line filter-drier must be installed so that the installation is clean, leakproof, and in specified direction.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Attach gauges.
3. Purge system.
4. Locate drier installation site.
5. Cut tube equal to take-up of new drier.
6. Position drier in proper direction.
7. Solder flare drier in position.
8. Remove excess flux from joint, if necessary.
9. Evacuate system.
10. Charge system.
11. Leak test.
12. Restore power to unit.
13. Start system and check operation.
14. Remove gauges.

ENABLING OBJECTIVE(S)

Use the filter to prevent foreign particles, acid, sludge and moisture to enter compressor.

Use knowledge of brazing, flaring and sizing of filters.

LEARNING ACTIVITIES

1. Instruct students to read **Modern Refrigeration and Air Conditioning**, pp. 359-360.
2. Instruct the students to read **Heating, Ventilating and Air Conditioning**, pp. 37-38.
3. Explain the purpose of the filter dryer in the suction.
4. Demonstrate and explain the two ways of installing a filter.
5. Demonstrate what a filter looks like.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 359-360.
Harvello, **Heating, Ventilating and Air Conditioning**, pp. 37-38.

PERFORMANCE OBJECTIVE V-TECS 119 (Continued)

EVALUATION

Questions

1. Name two methods of installing a filter.
2. What is the largest particle that can enter a compressor?

Answers

1. Brazing and flaring
2. 5 microns

DUTY: INSTALLIN' \ND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 120

TASK: Install line tap service valve.

CONDITIONS: A refrigeration system, assorted line taps, basic tool kit, leak detector.

STANDARD: A line tap service valve must be installed so that it is mechanically secure and leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Locate and clean area.
2. Select line tap to be used.
3. Clamp valve on line.
4. Pierce the tube with a self-piercing valve.
5. Attach gauges and read pressure.
6. Remove gauges.
7. Leak test.

ENABLING OBJECTIVE(S)

Use knowledge of installing line tap service valve for access to reading pressures and vacuum.

Use knowledge of installing gauge manifolds.

LEARNING ACTIVITIES

1. Instruct students to read **Modern Refrigeration and Air Conditioning**, p. 357.
2. Explain function of line tap service valve.
3. Explain cleaning of surface before clamping line tap service valve.
4. Demonstrate how to use gauge manifold on line tap service valves.
5. Show process for leak testing.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, p. 357.

EVALUATION

Questions

1. What size service valve do you use on a 1/2 inch line?
2. You install a service valve to ____________ ____________ on system.

Answers

1. 1/2" valve
2. Read pressure.

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 121

TASK: Install sightglass.

CONDITIONS: A refrigeration system, sightglass, leak detector, solder, basic tool kit, refrigerant.

STANDARD: The sightglass must be mechanically secure and leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Attach gauges.
2. Purge system.
3. Cut liquid line to locate sightglass.
4. Make connection for either flare or sweat-type sightglass.
5. Clean excess flux from joint, if necessary.
6. Install sightglass.
7. Purge or evacuate noncondensables from system.
8. Recharge system.
9. Remove gauges.
10. Leak test.

ENABLING OBJECTIVE(S)
Use knowledge of flaring and brazing.
Use knowledge of the purpose of a sight glass.

LEARNING ACTIVITIES
1. Instruct students to read **Modern Refrigeration and Air Conditioning**, pp. 458-508.
2. Explain the types of sight glasses.
3. Demonstrate how a sight glass helps in reading the charge in a system.
4. Explain that there are two ways of installing a sight glass -- flare and brazing.
5. Show that the sight glass is always placed in liquid.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 458-508.

EVALUATION
Questions
1. Name two ways of installing a sight glass.
2. A sight glass indicates the shortage of refrigerant. (True or False)
3. How does the sight glass indicate a shortage of refrigerant?
4. A sight glass indicates the presence of moisture. (True or False)

Answers
1. Brazing and flaring
2. True
3. By bubbles
4. True

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 122

TASK: Install service stub.

CONDITIONS: Tees, tubing, stub kit adapter, refrigerant, leak detector, solder, sand cloth, basic tool kit, a refrigeration system.

STANDARD: The service stub must be mechanically secure and leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Discharge system.
2. Locate, clean, and cut tubing.
3. Install tee of correct size.
4. Install sufficient length of tubing for stub.
5. Braze joints.
6. Clean joints.
7. Install stub kit adapter.
8. Attach gauges.
9. Evacuate system.
10. Recharge system.
11. Leak test.
12. Start unit and check operation.
13. Remove gauges.

ENABLING OBJECTIVE(S)

Use knowledge of installing line tap service valve for access to reading pressures and vacuum.

Use knowledge of installing gauge manifolds.

LEARNING ACTIVITIES

1. Instruct students to read **Modern Refrigeration and Air Conditioning**, p. 357.
2. Identify safety rules for installing service stub.
3. Explain the function of service stub.
4. Explain cleaning of stub before installing service stub.
5. Demonstrate how to use stub kit adapter.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, p. 357.

EVALUATION

Questions

1. What do you install in a suction line to pick up particles, acid sludge and moisture?
2. What is the screen made of in a filter which is installed before the service stub?

Answers

1. Filter
2. Monel metal

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 123

TASK: Test for leaks.

CONDITIONS: Basic tool kit, refrigerant, wipe cloth, halide torch leak detector, electronic leak detector, soap solution, a refrigeration system.

STANDARD: All leaks must be detected and repaired.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Attach gauges.
2. Pressurize system with refrigerant.
3. Leak test by sniffing tubing and components with electronic detector or halide torch or daubing tubing and components with soap solution.
4. Repair detected leaks.
5. Retest for leaks.
6. Remove gauges.

ENABLING OBJECTIVE(S)
Use knowledge that most leaks are usually very tiny.
Use knowledge that the detecting devices must be very sensitive.

LEARNING ACTIVITIES
1. Instruct students to read **Modern Refrigeration and Air Conditioning**, pp. 361, 496, 929.
2. Explain the three methods of detecting a leak which are:
   a. Soap solution
   b. Halide torch
   c. Electronic detector.
3. Illustrate the action of soap solution in the presence of a leak.
4. Demonstrate how a halide torch takes on a light green color in the presence of freon.
5. Show how the electronic leak detector squeals with the presence of refrigerant.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 361, 496, 929.

EVALUATION
Questions
1. How is a leak indicated using a soap solution?
2. What indicates the presence of refrigerant on the halide torch?
3. What indicates a presence of refrigerant to the electronic leak detector?
4. Which method is the most used?

PERFORMANCE OBJECTIVE V-TECS 123 (Continued)

Answers

1. Bubbles
2. Light green color
3. Squealing noise
4. Soap solution

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 124

TASK: Level refrigerator/freezer.

CONDITIONS: A refrigerator/freezer, spirit level.

STANDARD: The refrigerator/freezer unit must be level.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Place refrigerator/freezer in desired location.
2. Adjust leveling guide to level unit. (Some units use adjusting screws to level unit).
3. Check with level.
4. Continue adjustments until unit is level.

ENABLING OBJECTIVE(S)
Use of knowledge condition of space that refrigerator is being installed.
Use manufacturer's specifications.

LEARNING ACTIVITIES
1. Instruct students to read **Modern Refrigeration and Air Conditioning**, pp. 336-338.
2. Identify safety rules for leveling refrigerator/freezer.
3. Demonstrate how refrigerators with front rollers are adjusted with the rollers.
4. Show how the levelers are screwed out or in to level a refrigerator that does not have front rollers.
5. Explain that the refrigerator must be level because of condensate pan and liquids in box.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 336-338.

EVALUATION
Questions
1. The contents in refrigerator have a relationship with leveling. (True or False)
2. The refrigerator comes from factory with a need to be leveled. (True or False)
3. You level a refrigerator that has rollers. (True or False)
4. You level a refrigerator that does not have rollers. (True or False)

Answers
1. True
2. True
3. True
4. True

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 125

TASK: Liquid charge a refrigeration system.

CONDITIONS: An operating refrigeration system, refrigerant, basic tool kit, manufacturer's specifications.

STANDARD: Pressures in the high and low sides must be in accordance with manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Connect the refrigerant cylinder to the gauge manifold with a flexible charging line to high side.
2. Let liquid into high side until pressure equalizes in container and high side.
3. Let pressure in high side and low side equalize.
4. Start unit.
5. Add additional refrigerant (gas only) through low side.
6. Let unit run long enough to be sure pressures are correct.
7. Remove gauge.

ENABLING OBJECTIVE(S)
Use gauges and freon to charge liquid side.
Use knowledge of pressure behavior.

LEARNING ACTIVITIES
1. Instruct students to read **Modern Refrigeration and Air Conditioning**, pp. 498-501.
2. Explain the dangers of charging from high side.
3. Lecture on the importance of the refraining from charging on the high side with the compressor running.
4. Explain that if the exhaust valves are weak that liquid will get into compressor and ruin it.
5. Explain why you never use disposable refrigerant tank.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 498-501.

EVALUATION
Questions
1. It is a good practice to charge on liquid side. (True or False)
2. The compressor should be running when charging. (True or False)
3. You use a disposable refrigerant cylinder to charge on high side. (True or False)
4. When is it practical to charge from high side?

PERFORMANCE OBJECTIVE V-TECS 125 (Continued)

Answers

1. False
2. False
3. False
4. After vacuuming

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 126

TASK: Purge refrigeration system.

CONDITIONS: A refrigeration system, refrigerant, basic tool kit, nitrogen.

STANDARD: The system must be free of air and noncondensables.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Attach gauges.
2. Front seat service valves slightly for a few seconds.
3. Back seat service valves.
4. Remove center hose from keeper.
5. Crack and close gauge manifold to purge air from hose and gauge.
6. Crack high side manifold valve and close to purge air or noncondensable for high side.
7. Remove gauges.

ENABLING OBJECTIVE(S)
Use gauges and refrigerant.
Use hand tools.

LEARNING ACTIVITIES
1. Instruct students to read **Modern Refrigeration and Air Conditioning** pp. 71-494.
2. Demonstrate installing gauges on system and refrigerant tank.
3. Explain that refrigerant is put into system so that moisture, vapor and unwanted air is forced from system.
4. Explain that neutral gas or the same gas in the system can be used to purge the system.
5. Show how to purge until the system is clear of all moisture and unwanted air.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 71-494.

EVALUATION
Questions
1. It is proper to use freon to purge system. (True or False)
2. Purging removes moisture and vapor from the system. (True or False)
3. You install a gauge manifold on the high and low side. (True or False)

Answers
1. True
2. True
3. True

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 127

TASK: Replace capillary tube.

CONDITIONS: A refrigeration system, capillary tube, basic tool kit, flux, sand cloth, refrigerant.

STANDARD: The replaced capillary tube must be mechanically secure and leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Discharge refrigerant.
3. Unbraze capillary tube.
4. Remove capillary tube.
5. Position new capillary tube and secure.
6. Evacuate system.
7. Recharge system.
8. Leak test.
9. Restore power to unit.
10. Start system and check operational temperature and pressure.
11. Remove gauges.

ENABLING OBJECTIVE(S)
Use knowledge of cutting cap tubes for replacement.
Use manufacturer's specification for cap tube size.

LEARNING ACTIVITIES
1. Instruct students to read **Modern Refrigeration and Air Conditioning**, pp. 369-370.
2. Explain the operation of the capillary tube.
3. Identify the proper capillary tube by manufacturer's specifications.
4. Explain that cap tube has to be correct size and length.
5. Demonstrate cutting a cap tube by scoring with fill and bending back and forth breaking it.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 369-370.

EVALUATION
Questions
1. One capillary tube fits all systems. (True or False)
2. What happens to head pressure if cap tube is too long, is it too high or too low?
3. What happens to suction pressure if cap tube is too long, is it too high or too low?
4. What do you cut a cap tube with?

PERFORMANCE OBJECTIVE V-TECS 127 (Continued)

Answers

1. False
2. High
3. Low
4. File

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 128

TASK: Replace compressor.

CONDITIONS: Basic tool kit, flux, wiping cloth, replacement compressor, manufacturer's specifications/wiring schematic, a refrigeration system.

STANDARD: The replacement compressor must be of type and size recommended by the manufacturer, securely mounted, and wired in accordance with manufacturer's specifications and/or wiring diagram. Brazed joints must be free of excess flux and leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Attach gauges.
3. Purge system.
4. Cut or unbraze lines to compressor.
5. Unbolt and remove wiring.
6. Remove compressor.
7. Tape or plug the system lines to keep moisture and dirt out of system.
8. Check that replacement compressor meets manufacturer's specifications.
9. Reverse above procedures to install replacement compressor.
10. Pressurize and leak test.
11. Evacuate system.
12. Recharge system.
13. Remove gauges.
14. Replace electrical wiring and components.
15. Connect unit to power source.
16. Start up and check out.

ENABLING OBJECTIVE(S)

Read data plate.
Use of knowledge of brazing.
Use of knowledge of manifold hook-up.

LEARNING ACTIVITIES

1. Instruct students to read **Refrigeration and Air Conditioning Technology**, pp. 344-349.
2. Instruct students to read **Modern Refrigeration and Air Conditioning**, pp. 374-376.
3. Explain that unit requires exact replacement.
4. List the steps in installing a replacement motor compressor.
5. Discuss the need to compare compressors to be sure of same piping.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 374-376.
Miller, **Refrigeration and Air Conditioning Technology**, pp. 344-349.

PERFORMANCE OBJECTIVE V-TECS 128 (Continued)

EVALUATION

Questions

1. Where do you find size replacement information?
2. What happens if the low side tubing on compressor is not same size as low side tubing on the unit?
3. What type refrigerant is used to clean out system?

Answers

1. Data plate
2. Wrong size compressor
3. R-11

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 129

TASK: Replace door seal.

CONDITIONS: Replacement gasket, basic tool kit, wiping cloth, feeler gauge, test light, gasket notcher, a refrigerator.

STANDARD: The seal must fit uniformly to a .003" measurement.

SOURCE FOR STANDARD:
State Department of Education, Alabama, **Air Conditioning and Refrigeration.**

PERFORMANCE GUIDE
1. Level cabinet.
2. Check sealing ability of gasket.
3. Remove old gasket and clean all surfaces.
4. Replace the gasket with same style gasket.
5. Check gasket fit in all corners.
6. Check seal with a test light or feeler gauge.

ENABLING OBJECTIVE(S)
Use knowledge of recognizing bad gasket.
Use hand tools.

LEARNING ACTIVITIES
1. Students should read **Refrigeration and Air Conditioning Technology**, p. 297 and **Modern Refrigeration and Air Conditioning**, p. 332.
2. Explain that students check manufacturer's design specifications for gasket size.
3. Explanation of removal of inner door and gasket panel as an assembly.
4. Show how to put gasket properly on inner door assembly.
5. Demonstrate how to secure inner door to outer door.
6. Illustrate how to adjust door on refrigerator.

RESOURCES
Miller, **Refrigeration and Air-Conditioning Technology**, p. 297.
Althouse, et al., **Modern Refrigeration and Air-Conditioning**, p. 332.

EVALUATION
Questions
1. Where do you find size of door gasket seal?
2. Why would a door gasket seal be replaced?
3. What is the last thing you do prior to putting unit back into service?

Answers
1. Manufacturer's design specification
2. Gasket worn.
3. Adjust door.

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 130

TASK: Replace drain heater.

CONDITIONS: Drain heater, basic tool kit, manufacturer's specifications/wiring schematic, a refrigerator.

STANDARD: The replaced drain heater must be mechanically secure and all electrical connections made in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
State Department of Education, Alabama, **Air Conditioning and Refrigeration.**

PERFORMANCE GUIDE

1. Disconnect unit from power source.
2. Remove cabinet parts to expose drain heater wire terminals.
3. Locate the junction box ends of the drain heater wires.
4. Locate the drain heater.
5. Disconnect the wires from the junction box terminals.
6. Label wires for future identification.
7. Test circuit resistance.
8. Remove the old drain heater.
9. Mount the new drain heater.
10. Test circuit resistance.
11. Connect wires to the junction box terminals.
12. Connect unit to power source.
13. Start unit.
14. Check drain heater operation.

ENABLING OBJECTIVE(S)

Use knowledge that drain heater is wired in series with defrost terminator thermostat and contacts two to three of the defrost timer.
Read schematic.
Use ohmmeter.

LEARNING ACTIVITIES

1. Instruct students to read **Refrigeration and Air-Conditioning Technology**, p. 239.
2. List the steps in removing drain heater.
3. Explain why it is necessary to make sure the power is off.
4. Explain how to disconnect wires from junction box.
5. Explain the need to check all wiring connections before installing the box.

RESOURCES

Miller, **Refrigeration and Air-Conditioning Technology**, p. 339.

PERFORMANCE OBJECTIVE V-TECS 130 (Continued)

EVALUATION

Questions

1. Name electrical device used to check drain heater?
2. Where is the drain heater located?
3. Why do you use mastic sealer?

Answers

1. Ohmmeter
2. Drain trough
3. To form positive air seal

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 131

TASK: Replace mold heater.

CONDITIONS: Mold heater, basic tool kit, manufacturer's specifications/wiring schematic, a refrigerator with a mold heater.

STANDARD: The replaced mold heater must be mechanically secure and all electrical connections made in accordance with manufacturer's specifications and/or wiring diagram.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
State Department of Education, Alabama, **Air Conditioning and Refrigeration.**

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Locate the junction boxes.
3. Locate the mold heater.
4. Disconnect the junction wire terminals.
5. Label wires for identification.
6. Remove the mold heater.
7. Mount the new mold heater.
8. Connect the heater wires to the junction box terminals.
9. Connect unit to power source.
10. Start unit.
11. Check mold heater operation.
12. Connect unit to power source.
13. Start unit.
14. Check mullion heater operation.

ENABLING OBJECTIVE(S)
Use of knowledge that mold heater is rated at 165 watts.
Use of knowledge of manufacturer's design.
Read ohmmeter.

LEARNING ACTIVITIES
1. Instruct students to read **Refrigeration and Air-Conditioning Technology,** pp. 306-311.
2. List the steps in replacing the mold heater.
3. Explain the need to disconnect wires from junction box and label.
4. Show how to locate junction box.
5. Demonstrate heater operation.

RESOURCES
Miller, **Refrigeration and Air-Conditioning Technology,** pp. 306-311.

PERFORMANCE OBJECTIVE V-TECS 131 (Continued)

EVALUATION

Questions

1. Why is alumilastic used between the heat and the mold?
2. What is the mold heater watt rating?
3. What determines the type mold heater?

Answers

1. Good thermo contact
2. 165 watts
3. Manufacturer's design

DUTY: INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

PERFORMANCE OBJECTIVE V-TECS 132

TASK: Replace mullion heater.

CONDITIONS: Mullion heater, basic tool kit, manufacturer's specifications/wiring schematic, a refrigerator with a mullion heater.

STANDARD: The replaced mullion heater must be mechanically secure and all electrical connections made in accordance with manufacturer's specifications and/or wiring diagram.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
State Department of Education, Alabama, **Air Conditioning and Refrigeration.**

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Remove cabinet parts to expose mullion heater wire terminals.
3. Locate the junction box.
4. Locate the mullion heater.
5. Disconnect the junction wire terminals.
6. Label wires for identification.
7. Test circuit resistance.
8. Remove the mullion heater.
9. Mount new mullion heater.
10. Test circuit resistance.
11. Connect the heater wires to the junction box terminals.
12. Connect unit to power source.
13. Start unit.
14. Check mullion heater operation.

ENABLING OBJECTIVE(S)
Use knowledge of a refrigerator system.
Use knowledge of reading wiring diagrams.

LEARNING ACTIVITIES
1. Instruct students to read **Modern Refrigeration and Air-Conditioning,** pp. 312-313, 320.
2. Demonstrate how to remove parts necessary to expose the wire terminals for the mullion heater.
3. Show how to locate the junction box ends of the mullion heater works.
4. Illustrate how to disconnect the junction wire terminals. Use masking tape to identify wires and terminals..
5. List the steps in removing the heater and replacing the heater.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air-Conditioning,** pp. 312-313, 320.

PERFORMANCE OBJECTIVE V-TECS 132 (Continued)

EVALUATION

Questions

1. The mullion heater circuit opens when ________________.
2. The mullion heater rather than the butter heater uses more electricity. (True or False)
3. Some cabinets have two mullion heaters located in the same place in order to ________________.
4. A mullion heater prevents condensation by ________________.
5. Single door refrigerators have mullion heaters. (True or False)

Answers

1. Ambient air is over 80F.
2. False
3. Allow adjustment for different climates.
4. Heating the air above the dew point temperature
5. True

INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING/HEATING SYSTEMS

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 133

TASK: Align blower motor.

CONDITIONS: A blower motor needing alignment, basic tool kit.

STANDARD: All mechanical and electrical connections must be secure and the pulleys must be in alignment.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Loosen mount.
2. Adjust position of direct drive motor to provide clearance for fan blades.
3. Inspect belt and pulley for wear, if applicable.
4. Position motor so belt runs straight.
5. Tighten motor.
6. Tighten electrical connections.
7. Set speed.
8. Secure all mechanical connections.

ENABLING OBJECTIVE(S)
Use knowledge of direct drive fans and belt driven fans.
Use hand tools.

LEARNING ACTIVITIES
1. Instruct students to read **Heating, Ventilating, and Air Conditioning Fundamentals**, pp. 259-262.
2. Demonstrate taking sides from unit to expose fan.
3. Show that a squirrel cage fan, if not centered on shaft rubs the housing.
4. Illustrate how a belt driven fan depends on a liner pulley.
5. Instruct students on the importance of turning off the power.

RESOURCES
Harvella, **Heating, Ventilating, and Air-Conditioning Fundamentals**, pp. 259-262.

EVALUATION
Questions
1. It is important that the squirrel cage be ________________ on the shaft.
2. You position the motor so that the belt runs ________________.
3. What is the first thing done before inspecting fan system?
4. What do you do to make the squirrel cage run?

Answers
1. Centered
2. Straight
3. Power off
4. Center it.

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 134

TASK: Adjust gas pressure regulator.

CONDITIONS: A residential air conditioning/heating system, manometer, basic tool kit, soap solution, manufacturer's specifications.

STANDARD: The gas pressure regulator must be adjusted to manufacturer's specifications and be leakproof.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**
Langley, **Electric Controls for Refrigeration and Air Conditioning.**

PERFORMANCE GUIDE
1. Attach manometer.
2. Measure gas pressure.
3. Set gas pressure to manufacturer's specifications.
4. Remove manometer.
5. Leak test.

ENABLING OBJECTIVE(S)
Read a manometer.
Use hand tools.

LEARNING ACTIVITIES
1. Instruct students to read **Heating, Ventilating, and Air Conditioning Fundamentals,** pp. 136-137.
2. Explain that the gas regulator comes from factory pre-set.
3. Explain that the longer the lines are, the greater the pressure drop.
4. Explain that a manometer is a device that is used in setting a gas regulator.
5. Demonstrate removing of seal cap on top of regulator.
6. Show that you insert a screw driver and turn the adjustment clockwise to increase pressure.

RESOURCES
Harvella, **Heating, Ventilating and Air Conditioning Fundamentals,** pp. 136-137.

EVALUATION
Questions
1. What meter is used to adjust a regulator?
2. Where is the manometer connected on gas line?
3. You remove the ____________ ___ __________ ________ on top of the regulator.
4. Which way is the adjustment nut turned to increase pressure?

Answers
1. Manometer
2. Downstream of pressure top
3. Seal tap
4. Clockwise

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 135

TASK: Adjust primary air flow on burner.

CONDITIONS: A gas heating system, basic tool kit.

STANDARD: When the primary air flow on the burner is adjusted, the flame will be soft blue and will not lift from burner.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Light gas burner.
2. Completely close air shutter.
3. Open shutter until all yellow tips are gone and flame is soft blue.
4. Lock shutter in position with locking screw.

ENABLING OBJECTIVE(S)
Use hand tools.

LEARNING ACTIVITIES
1. Instruct students to read and discuss **Heating, Ventilating, and Air Conditioning Fundamentals**, p. 135.
2. Demonstrate removal of shutter panel.
3. Demonstrate how to adjust shutter.
4. Explain effects of heat on heat exchanger.
5. Explain the importance of showing burner flame blue.

RESOURCES
Harvella, **Heating, Ventilating and Air Conditioning Fundamentals**, p. 135.

EVALUATION
Questions
1. What must be mixed before ignition?
2. What air surrounds the flame?
3. The _______________ must be removed prior to adjusting shutter.

Answers
1. Air fuel
2. Secondary
3. Panel

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 136

TASK: Align flue and mount draft diverters.

CONDITIONS: A heating system, basic tool kit, sheet metal screws, applicable fire codes.

STANDARD: The flue must be plumb, level, and fastened to the draft diverter. The system must draw according to applicable fire code specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Set draft diverter on top of furnace.
2. Align flue with draft diverter.
3. Plumb and level.
4. Fasten flue to draft diverter.
5. Test draw in accordance with fire code specifications.

ENABLING OBJECTIVE(S)
Use of the knowledge for installing piping.
Identify the proper type and size of piping.

LEARNING ACTIVITIES
1. Instruct students to read and discuss **Heating, Ventilating and Air Conditioning Fundamentals**, p. 134.
2. Explain that a draft diverter provides a fixed rate of dilution air.
3. Describe how excess air and dilution air carry away the water vapor.
4. Demonstrate how they prevent condensation from forming in the flue pipe.

RESOURCES
Harvella, **Heating, Ventilation and Air Conditioning Fundamentals**, p. 134.

EVALUATION
Questions
1. The draft ______________ provides a fixed rate of diluted air.
2. Where does the fixed rate of dilution air come from?

Answers
1. Diverter
2. Ceiling vent

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 137

TASK: Align gas burners.

CONDITIONS: A gas heating system, basic tool kit.

STANDARD: Burners must be aligned 90° to manifold with spud directly in the center of the primary air opening.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**

PERFORMANCE GUIDE
1. Remove manifold.
2. Remove burners from heat exchanger.
3. Clean burner darts.
4. Replace burners in heat exchanger.
5. Replace manifold.
6. Align burners 90° to manifold.
7. Secure all bolts, screws, etc.
8. Adjust primary air flow on burner.

ENABLING OBJECTIVE(S)
Use knowledge of proper flame.
Use hand tools.

LEARNING ACTIVITIES
1. Instruct students to read **Modern Refrigeration and Air Conditioning** pp. 719-721.
2. Demonstrate how flame looks with proper air and gas.
3. Show that flame has to have proper color and size.
4. Explain that system has to be completely shut down.
5. Explain that all power must be shut off of system.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 719-721.

EVALUATION

Questions
1. What does the excess air and dilution air carry away?
2. At what degree must the anemometer be placed?

Answers
1. Water vapor
2. 90°

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 138

TASK: Balance the air flow of an entire system.

CONDITIONS: A forced air heating/cooling system, basic tool kit, step ladder, velocity meter.

STANDARD: The air flow must be balanced so that the ambient temperature will not vary over 1° from room to room.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Inspect the complete system; locate all ducts, openings and dampers.
2. Open all dampers in the ducts and at the grilles.
3. Check the velocities at each outlet.
4. Determine the free grille area.
5. Calculate the volume of air flow per minute at each outlet.

   (area in sq. in. =)
   (fpm x 144 cu. ft./min. (volume per minute)

6. Total the cu. ft./min.
7. Determine the floor areas of each room. Add to determine total area.
8. Determine the proportion each room should have.

   (area of room)
   (total floor area x total cfm = cfm for room)

9. Adjust duct dampers and grille dampers to obtain these values.
10. Recheck all outlet grilles.

ENABLING OBJECTIVE(S)
Use of an anemometer.
Use hand tools.

LEARNING ACTIVITIES
1. Instruct students to read and discuss **Modern Refrigeration and Air-Conditioning**, pp. 651-652.
2. Explain that placement of anemometer must be at a 90° angle to the air flow.
3. Explain that the instrument must be in place a minimum of one (1) minute.
4. Explain the necessity for more than one reading.
5. Explain the comfortable rate of air flow.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 651-652.

PERFORMANCE OBJECTIVE V-TECS 138 (Continued)

EVALUATION

Questions

1. The anemometer must be in place for a minimum of __________ __________.
2. At what rate is the air rate considered comfortable?

Answers

1. One minute
2. 15-20 FPM

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 139

TASK: Clean furnace filter.

CONDITIONS: A furnace, cleaning solution, basic tool kit, air tank.

STANDARD: Filter must be clean, dry, and not restrict air flow.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Locate furnace filter.
2. Remove old filter.
3. Blow out loose dust.
4. Wet filter with cleaning solution.
5. Rinse with water.
6. Dry and replace filter.

ENABLING OBJECTIVE(S)
Recognition of throw away type and reversable type filter.
Identify the various types of filters.

LEARNING ACTIVITIES
1. Instruct students to read and discuss **Modern Refrigeration and Air Conditioning**, pp. 792-796.
2. Show the various types of throw-away filters.
3. Explain that an electronic filter can be used in place of a throwaway filter.
4. Demonstrate the cleaning of a filter with soap and water solution and then rinse until water is clear.
5. Show how the filters are placed back in the system.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 792-796.

EVALUATION
Questions
1. ______________ air flow is the first indication of a dirty filter.
2. _____________ and _____________ solution is used to clean a filter.
3. A __________ ____________ is an instrument used to determine if a filter is dirty.
4. How much dirt will a filter collect if it does not become loaded?

Answe
1. Poor
2. Soap and water
3. Water manometer
4. 90%

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 140

TASK: Clean gas valve.

CONDITIONS: A gas furnace, basic tool kit, manometer, cleaning solution, gaskets, soap solution.

STANDARD: The gas valve must be clean and dry. Gas supply connections must not leak when pressurized.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Turn off gas supply and disconnect.
2. Remove gas valve.
3. Disassemble gas valve.
4. Clean filter.
5. Clean body with cleaning solution.
6. Dry all parts with compressed air and cloth.
7. Assemble valve with new gaskets.
8. Install valve.
9. Connect gas supply.
10. Leak test.
11. Attach manometer.
12. Light pilot.
13. Fire off burners.
14. Check gas pressure and adjust, if required.
15. Turn off gas to burners.
16. Remove manometer.

ENABLING OBJECTIVE(S)
Use knowledge of gas valve parts and function.
Use hand tools.

LEARNING ACTIVITIES
1. Instruct students to read **Heating, Ventilating, and Air Conditioning Fundamentals**, pp. 137-138.
2. Discuss the importance of cutting off the gas.
3. Identify a gas valve.
4. Show how to disassemble a gas valve.
5. Explain that a gas valve after cleaning must be leak tested.
6. Show methods of leak testing.

RESOURCES
Harvella, **Heating, Ventilating and Air Conditioning Fundamentals**, pp. 137-138.

PERFORMANCE OBJECTIVE V-TECS 140 (Continued)

EVALUATION

Questions

1. The first thing you do before removing valve is to cut off the ________.
2. What is the last thing you do before putting a gas valve into service?
3. What type meter do you use to adjust the gas valve?
4. With what do you clean the valve body?

Answers

1. Gas
2. Leak test
3. Manometer
4. Cleaning solution

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 141

TASK: Clean main burner.

CONDITIONS: A furnace, basic tool kit, compressed air, drill bits.

STANDARD: The burner and flame ports must be free of dust and rust. The flame must be soft blue and not lift from burner.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disassemble furnace.
2. Remove dust and rust from burner.
3. Clean flame ports.
4. Reassemble furnace.
5. Light pilot.
6. Fire off furnace.
7. Observe flame.
8. Adjust primary air as needed.

ENABLING OBJECTIVE(S)
Use of the ability to assemble and disassemble the side of a furnace.
Use hand tools.

LEARNING ACTIVITIES
1. Instruct students to read **Modern Refrigeration and Air Conditioning**, pp. 720-721.
2. Explain the different types of gas burners.
3. Explain that the slots or ports in the burner are designed for a specific amount of gas and air for proper flame.
4. Demonstrate cutting the gas off and removing the nut that allows the removal of the burner.
5. Show the proper flame which results from a clean burner.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 720-721.

EVALUATION
Questions
1. How often do you clean the main burner?
2. ____________ and ____________ must be removed from the burners when cleaning.
3. First __________ flame ports when cleaning the main burner.
4. You observe the __________ and adjust primary air when cleaning the main burner.
5. After __________ __________ air, you get proper flame.

PERFORMANCE OBJECTIVE V-TECS 141 (Continued)

Answers
1. Once a year
2. Dust, rust
3. Clean
4. Flame
5. Adjusting primary

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 142

TASK: Clean pilot orifices.

CONDITIONS: A furnace, basic tool kit, flashlight, compressed air, soap solution.

STANDARD: All foreign matter and restrictions must be removed, the threaded connections clean, and the pilot must not leak when reassembled.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Locate pilot and remove.
2. Disassemble pilot.
3. Blow out foreign particles and restrictions.
4. Clean threaded connections.
5. Reassemble pilot.
6. Turn on gas and check for leaks.
7. Light pilot.
8. Adjust pilot flame.

ENABLING OBJECTIVE(S)
Use knowledge of different pilot lights.
Use of knowledge of manufacturer's specifications.

LEARNING ACTIVITIES
1. Instruct students to read Modern Refrigeration and Air Conditioning, pp. 720-721.
2. Discuss the importance of cutting off the gas.
3. Identify a pilot light and its orifice.
4. Demonstrate proper pilot flame.
5. Instruct students on the value of checking for a leak after replacing cleaned pilot orifice.

RESOURCES
Althouse, et al., Modern Refrigeration and Air Conditioning, pp. 720-721.

EVALUATION
Questions
1. A __________ or __________ pilot orifice will not light.
2. How do you clear a pilot orifice?
3. A pilot has to be adjusted. (True or False)
4. What does the pilot orifice control?

Answers
1. Dirty or clogged
2. Blow it out
3. True
4. Pilot light

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 143

TASK: Compute cubic feet per hour gas requirements for furnace.

CONDITIONS: Gas furnace, pencil and paper, manufacturer's specifications

STANDARD: The cubic feet per hour gas requirements must be computed without error.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Determine BTU rating of furnace.
2. Determine heat released (BTU) per cubic foot of gas:
   a. Natural gas = 1000 to 1100
   b. Manufactured gas = 500 to 600
   c. Liquid petroleum (LP) = 2500 to 3200.
3. Compute specific gas requirements for type of gas used.

ENABLING OBJECTIVE(S)
Measure in metric.

LEARNING ACTIVITIES
1. Read and discuss Modern Refrigeration and Air Conditioning, Chapter on "Cubic Gas Measurement."
2. Explain the term "BTU."
3. Review cubic measurements.
4. Demonstrate sample measurements in natural gas, manufactured gas and liquid petroleum.
5. Identify the safety rules necessary for gas measurement.

RESOURCES
Althouse, et al., Modern Refrigeration and Air Conditioning — Chapter "Cubic Gas Measurement."

EVALUATION
Questions
1. Cubic gas measurement is measured by ________________.
2. Heat is determined by the amount of gas released. (True or False)

Answers
1. BTU
2. True

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 144

TASK: Determine dew-point temperature of air.

CONDITIONS: Thermometers -- 120°F., bottle ether, air aspirator, bright metal container, equipment, tools.

STANDARD: The dew-point temperature of air must be determined within + 1 degree F.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick, **Environmental Control.**

PERFORMANCE GUIDE

CAUTION: Ether is extremely flammable. Use extreme caution.

1. Put ether in bright metal container.
2. Stir the ether with air aspirator.
3. Place thermometer in fluid.
4. Note the temperature at which a mist or fog appears on the outside of the metal container.
5. Record this reading as dew-point.

ENABLING OBJECTIVE(S)

Use knowledge of dew point theory.
Use knowledge of psychrometric chart.

LEARNING ACTIVITIES

1. Instruct students to read **Modern Refrigeration and Air-Conditioning,** pp. 644-646.
2. Explain that dew point temperature can be determined with accuracy by placing a volatile fluid in a bright metal container and stirring the fluid with an aspirator. The temperature has a cloggy mist.
3. Demonstrate an aspirating psychrometer.
4. Show a window with moisture on it as an example.
5. Explain that dew point is the 100% humidity point.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning,** pp. 644-646.

EVALUATION

Questions

1. Dew point is the ____________ humidity point.
2. What instrument is used to determine dew point?
3. The ____________ on a window pane is a good example of dew point.

Answers

1. 100%
2. Aspirating psychrometer
3. Moisture

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 145

TASK: Install gas pressure regulator.

CONDITIONS: Basic tool kit, plumbing codes, manufacturer's specifications, manometer, soap solution, a furnace.

STANDARD: The gas pressure regulator must be mechanically secure and the pipe and regulator must be installed to manufacturer's specifications and be leakproof.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Make sure gas supply is off.
2. Determine location for regulator installation.
3. Determine pipe size.
4. Determine female pipe size of regulator.
5. Pipe in regulator.
6. Check for gas leaks with soap solution.
7. Relight pilot.
8. Fire off furnace.
9. Take gas pressure reading.
10. Adjust pressure to manufacturer's specifications.
11. Turn off gas to burner.
12. Remove manometer.
13. Relight burner.
14. Leak test with soap solution.

ENABLING OBJECTIVE(S)
Use manufacturer's specifications.
Use knowledge of piping.

LEARNING ACTIVITIES
1. Instruct students to read and discuss **Modern Refrigeration and Air-Conditioning**, pp. 724-725.
2. Explain the purpose of the pressure regulator.
3. Demonstrate the threading of the pipe into the regulator.
4. Show why it is a good practice to install a pipe driping in the gas pipe to furnace.
5. Explain the purging of air from installed gas piping.

RESOURCES
Althouse, et al., Modern Refrigeration and Air-Conditioning, pp. 724-725.

PERFORMANCE OBJECTIVE V-TECS 145 (Continued)

EVALUATION

Questions

1. When first starting a gas furnace, first __________ the air from the installed gas piping.
2. What do you use to check for leaks?
3. The regulator and valve housing are usually made of a __________ die casting.
4. The drip leg is installed to keep __________ and __________ from entering the pressure regulator.

Answers

1. Purge
2. Soap solution
3. Zinc
4. Dirt, moisture

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 146

TASK: Install heat exchanger.

CONDITIONS: A furnace, basic tool kit, soap solution, matches, heat exchanger.

STANDARD: The heat exchanger must be mechanically secure and the gas supply must not leak.

SOURCE FOR STANDARD:
Weaver and Kirkpatrick. **Environmental Control.**

PERFORMANCE GUIDE

1. Remove service panel.
2. Disconnect gas and electrical supply.
3. Dismantle furnace.
4. Remove heat exchanger.
5. Examine replacement heat exchanger to see that it is the same as the original.
6. Position new heat exchanger.
7. Align screw holes and insert screws.
8. Assemble furnace.
9. Connect gas supply and pressure test for leaks with solution.
10. Connect electrical supply.
11. Light pilot.
12. Fire off burners.
13. Turn on fan.
14. Inspect for wavering flame.
15. Adjust primary air and pilot, if necessary.
16. Set thermostat.

ENABLING OBJECTIVE(S)

Use knowledge of manufacturer's design of the heat exchanger and specifications.

Use hand tools.

LEARNING ACTIVITIES

1. Instruct students to read **Modern Refrigeration and Air Conditioning** pp. 703-705.
2. Demonstrate removal of service panel.
3. Demonstrate the heat exchanger and how to check for proper size and any possible defect in welds.
4. Discuss the necessity of insuring that gas and electricity are off.
5. Demonstrate to students the proper way to check flame to be sure there is no air leaking in.
6. Show how to leak test gas connections.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 703-705.

PERFORMANCE OBJECTIVE V-TECS 146 (Continued)

EVALUATION

Questions

1. The first thing you do is ____________ __________ and ____________.
2. Does one heat exchanger fit all?
3. Name one way of checking an installed heat exchanger to make sure it is sealed.
4. What does a wavering flame mean?

Answers

1. Disconnect gas and electricity.
2. You have to inspect, because one heat exchanger does not fit all.
3. Wavering flame.
4. Heat exchanger is not sealed.

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 147

TASK: Install piping.

CONDITIONS: Pipe die stock, pipe die set, cutting oil, black iron or galvanized pipe, vise, pipe dope, pipe fittings (trees, elbows, etc.), pipe wrench, nitrogen or refrigerant, basic tool kit, piping diagram/specifications.

STANDARD: The threads must have no splits, cracks, or burrs and the piping must be installed according to the piping diagram/specifications and not leak.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Acquire piping materials.
2. Layout piping according to piping diagram/specifications.
3. Place first piece of pipe in vise and secure firmly.
4. Select correct die for the pipe size.
5. Turn die stock in a clockwise direction until the pipe is threaded the same distance as the die.
6. Apply cutting oil every two revolutions.
7. Reverse the ratchet mechanism and turn die counterclockwise until the die is removed.
8. Inspect the new threads for splits, cracks, or burrs.
9. Apply pipe dope to the threads and attach appropriate fitting.
10. Tighten fitting with a pipe wrench.
11. Repeat steps 3 - 10 as necessary until all piping is installed.
12. Leak test.

ENABLING OBJECTIVE(S)
Use of piping and pipe dies.
Use of diagram and print reading.

LEARNING ACTIVITIES
1. Instruct students to read and discuss **Modern Refrigeration and Air Conditioning**, pp. 50-51.
2. Explain how pipe fittings are threaded.
3. Show the different fittings, couplings, reducing couplings, unions, 45° elbows, 90° elbows and reducing elbows.
4. Demonstrate the threading of a pipe with a pipe die.
5. Explain the use of pipe compound to seal threads and make leak proof joints.

RESOURCES
Althouse, et al., Modern Refrigeration and Air Conditioning, pp. 50-51.

PERFORMANCE OBJECTIVE V-TECS 147 (Continued)

EVALUATION

Questions

1. The threads are made self sealing by pressing together of the sharp ____________ as they are assembled.
2. What is used to help seal the threads?
3. What is used to keep pipe dies from being abused?
4. The external pipe threads are cut with a ____________ ____________.
5. Are pipe threads NF or NC?

Answers

1. V-threads
2. Pipe compound
3. Cutting compound
4. Pipe die
5. Both

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 148

TASK: Install vents.

CONDITIONS: Basic tool kit, sheet metal shears, sheet metal screws, flashlight, extension cord, 6 ft. rule, specification sheet/blueprint.

STANDARD: Vents must be securely fastened and installed according to specifications sheet and/or blueprints.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE

1. Locate sites for vent installation.
2. Install register boot.
3. Install take-off in trunk line.
4. Connect round pipe from take-off to register boot.
5. Install three #8 sheet metal screws in each joint.

ENABLING OBJECTIVE(S)

Use knowledge of blue print reading.
Use hand tools.

LEARNING ACTIVITIES

1. Instruct students to read **Modern Refrigeration and Air Conditioning**, pp. 768-780.
2. Explain the different places vents are installed.
3. Demonstrate different air movement through the different air diffusers.
4. Illustrate a complete duct and vent system drawing.
5. Explain that a properly vented room will not over cool and over heat.

RESOURCES

Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 768-780.

EVALUATION

Questions

1. List two ways smaller vents may be used to distribute heated air and maintain good heating temperatures.
2. List three uses for an air duct.
3. What is the purpose of a grill?
4. Name three places air vents are placed?

Answers

1. a. Increase rate of flow
   b. Increase temperature
2. a. Carry warm air
   b. Carry cool air
   c. Return air
3. To spread air
4. Ceiling, wall, floor

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 149

TASK: Insulate ducts.

CONDITIONS: Basic tool kit, six ft. rule, staple gun and staples, duct tape, insulation knife, building codes.

STANDARD: Insulation type and thickness must conform to applicable building code specifications, ends must overlap at least three inches and be taped or stapled.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Locate uninsulated duct.
2. Measure circumference.
3. Cut insulation to length plus 3" overlap.
4. Strip insulation from foil backing on 3" strip.
5. Wrap insulation around pipe.
6. Even ends to lap over last piece of insulation.
7. Pull tight and staple flap to foil backing.
8. Tape ends.

ENABLING OBJECTIVE(S)
Use hand tool.
Read and interpret building codes.

LEARNING ACTIVITIES
1. Instruct students to read **Modern Refrigeration and Air Conditioning**, p. 776.
2. Show students how to cut insulation, adding three inch over lap.
3. Explain that the insulation is installed on duct by tape, staples, or adhesive.
4. Explain why the duct is insulated.
5. Instruct students on the importance of having insulation air tight.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, p. 776.

EVALUATION
Questions:
1. How much overlap do you cut?
2. What forms on duct if insulation is not tight?
3. When a comfort cooling air duct has condensation on its outer surface, does the air become warmer or cooler?
4. How do you seal the insulation?

Answers
1. Three inches
2. Condensation
3. Warmer
4. Tape or glue

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 150

TASK: Light and adjust pilots.

CONDITIONS: Basic tool kit, equipment, materials.

STANDARD: Pilot must stay lit when bypass is released and be adjusted to a soft blue flame.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Turn on gas.
2. Depress gas safety by-pass.
3. Put lighted match to pilot assembly.
4. When pilot lights, hold by-pass open 60 seconds.
5. Release by-pass.
6. Adjust pilot to a soft blue flame.

ENABLING OBJECTIVE(S)
Use knowledge of the function of a gas valve.
Use hand tools.

LEARNING ACTIVITIES
1. Instruct students to read **Heating, Ventilation and Air Conditioning**, pp. 137-138.
2. Explain that pilot switch on gas valve has to be depressed to allow gas to flow through to pilot.
3. Demonstrate a gas valve showing the pilot with pilot outlet.
4. Explain that pilot flame only comes in contact with last 1/2 inch of thermal coupling.
5. Explain the need to wait five minutes if the pilot does not ignite.

RESOURCES
Harvella, **Heating, Ventilating and Air Conditioning Fundamentals**, pp. 137-138.

EVALUATION
Questions
1. The pilot flame only touches the last ______________ of thermal couple.
2. How long do you wait between lighting the pilot if it fails the first time?
3. A pilot flame that stays on all the time is called a ______________.
4. A pilot has a safety device. (True or False)

Answers
1. 3/8 to 1/2 inch
2. Five minutes
3. Standing pilot
4. True

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 151

TASK: Replace four-way reversing valve.

CONDITIONS: Basic tool kit, solder/brazing alloy, wet cloth, refrigerant, manufacturer's specifications, dry nitrogen.

STANDARD: The reversing valve must be aligned with piping stubs and mechanically secure. Brazed/soldered joints must be clean of excess flux and not leak.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect unit from power source.
2. Attach gauges.
3. Discharge refrigerant.
4. Remove defective valve from system.
5. Align new valve to piping stubs.
6. Wrap valve with wet cloth.
7. Braze or solder valve in place.
8. Remove cloth and clean soldered/brazed joints.
9. Evacuate system.
10. Charge system with refrigerant to proper level.
11. Leak test.
12. Restore power to unit.
13. Start system and check operation.
14. Remove gauges.

ENABLING OBJECTIVE(S)
Use knowledge of brazing.
Use knowledge of manufacturer's specifications.

LEARNING ACTIVITIES
1. Instruct students to read **Heating, Ventilating and Air Conditioning Fundamentals**, pp. 137-138.
2. Demonstrate a four way valve.
3. Discuss with students why the valve heat must never exceed 250°F during brazing.
4. Explain that while brazing a 4-way valve that you must direct flame away from valve.
5. Demonstrate wrapping valve with a soaked wet rag to absorb the heat.

RESOURCES
Harvella, **Heating, Ventilating and Air Conditioning Fundamentals**, pp. 137-138.

PERFORMANCE OBJECTIVE V-TECS 151 (Continued)

EVALUATION

Questions

1. What method do you use for installing a four way valve?
2. What do you use to absorb heat from the valve?
3. Which way do you direct heat when brazing a four way valve?
4. What happens if the valve is over heated during installation?

Answers

1. Brazing
2. Soaked wet rag
3. Away from the valve
4. Prevents it from operating properly.

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 152

TASK: Replace gas valves.

CONDITIONS: A furnace, basic tool kit, soap solution, gas valve.

STANDARD: The gas valve must be mechanically secure and the gas supply connections must not leak.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Turn off gas supply and disconnect.
2. Remove gas valve.
3. Compare old valve with new valve.
4. Install new valve.
5. Connect gas supply and pressurize.
6. Leak test with soap solution.
7. Light pilot.
8. Fire off furnace.

ENABLING OBJECTIVE(S)
Use knowledge of manufacturer's specification for gas valve.
Use of knowledge of manufacturer's identification on wiring.

LEARNING ACTIVITIES
1. Instruct students to read **Heating, Ventilating and Air Conditioning Fundamentals**, pp. 137-138.
2. Explain that the first thing you do, before starting the removal of the gas valve, is to shut gas off. If cut off is not on the furnace, cut the gas off and tag. Explain that the thermostat wires may now be removed.
3. Explain the three functions of gas valve.
4. Demonstrate different types of valves to be sure the proper one has been selected.
5. Show how to leak test newly installed gas valves.

RESOURCES
Harvella, **Heating, Ventilating and Air Conditioning Fundamentals**, pp. 137-138.

EVALUATION
Questions
1. The first thing done to change a gas valve is to ______________.
2. How many functions does the gas valve perform?
3. What voltage is usually on a gas valve?

Answers
1. Cut off the gas.
2. 3
3. 24V

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 153

TASK: Replace pilot solenoid valve coil.

CONDITIONS: Basic tool kit, ohmmeter, wire connectors, pilot solenoid valve coil, manufacturer's specifications/wiring schematic.

STANDARD: All electrical connections must be secure and in accordance with wiring diagram and/or manufacturer's specifications.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.

PERFORMANCE GUIDE
1. Disconnect unit from power supply.
2. Locate defective pilot solenoid valve coil.
3. Disconnect solenoid wires.
4. Remove solenoid.
5. Test resistance.
6. Compare defective coil with replacement coil.
7. Install replacement coil.
8. Connect wires.
9. Restore power to unit.
10. Test operation.

ENABLING OBJECTIVE(S)
Use knowledge of reading millivolts.
Use knowledge of manufacturer's specifications.

LEARNING ACTIVITIES
1. Instruct students to read **Modern Refrigeration and Air Conditioning**, pp. 721-724.
2. Demonstrate the use of a millivolt meter.
3. Explain that a pilot solenoid valve must have at least seven millivolts to function.
4. Show students that the need to compare the new and old coil is to be sure that the proper coil has been selected.
5. Explain the need to remove only the coil from valve, and not the whole valve.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning**, pp. 721-724.

EVALUATION
Questions
1. How many millivolts does it take to open a pilot solenoid?
2. Do you replace the whole valve?
3. You should _________ both coils when replacing pilot solenoid valve coil.
4. How do you check voltage on pilot solenoid?

PERFORMANCE OBJECTIVE V-TECS 153 (Continued)

Answers

1. Seven millivolts
2. Not necessary
3. Compare
4. Millivolt meter

DUTY: INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 154

TASK: Replace thermocouple.

CONDITIONS: Basic tool kit, millivolt meter, matches, flashlight, thermocouple.

STANDARD: The thermocouple must be placed such that it will not be ruined or destroyed by the pilot or burner flames.

SOURCE FOR STANDARD:
Writing Team, State of Alabama.
Althouse, et al., **Modern Refrigeration and Air Conditioning**, p. 724.

PERFORMANCE GUIDE
1. Turn off gas supply.
2. Remove thermocouple threaded end from pilot safety valve.
3. Remove the hot junction end from holder.
4. To replace reverse steps 1 through 3.
5. Test thermocouple by lighting pilot.

ENABLING OBJECTIVE(S)
Use knowledge of millivolt meter.
Use hand tools.

LEARNING ACTIVITIES
1. Instruct students to read **Heating, Ventilating and Air Conditioning Fundamentals**, pp. 138-139.
2. Explain that even though the safety shut off valve disk holds the gas valve closed, the gas should always be cut off.
3. Demonstrate how to check thermocouple after it is placed, using millivoltmeter.
4. Explain that the same type thermocouple is used for gas valve pilot solenoid.
5. Show how the pilot light will burn even with faulty thermocouple.

RESOURCES
Harvella, **Heating, Ventilating and Air Conditioning Fundamentals**, pp. 138-139.

EVALUATION
Questions
1. The power generating source of a millivolt system is the ______________.
2. What increases as heat is applied?
3. How do you check the closed circuit voltage?
4. What is the main gas valves safety devise?

Answers
1. Thermocouple
2. Voltage
3. Millivolt meter
4. Thermocouple

APPENDICES

APPENDIX A

CROSS-REFERENCE TABLE OF DUTIES, TASKS AND PERFORMANCE OBJECTIVES

APPENDIX A

CROSS-REFERENCE TABLE OF DUTIES, TASKS AND PERFORMANCE OBJECTIVES

Duty/Task		Performance Objective	Page Number
I.	BRAZING, CUTTING, FITTING, SOLDERING AND WELDING PIPING, AND TUBING		4
	Silver soldering tubing.	V-TECS 1	5
	Bend copper tubing.	V-TECS 2	7
	Cut copper tubing/pipe/PVC.	V-TECS 3	9
	Cut mild steel with oxyacetylene torch.	V-TECS 4	11
	Dislodge restricitons from tubing.	V-TECS 5	13
	Flare copper tubing.	V-TECS 6	15
	Solder tubing.	V-TECS 7	17
	Solder electrical connections.	V-TECS 8	19
	Weld metal with filler rod.	V-TECS 9	21
	Weld metal without filter rod.	V-TECS 10	23
II.	INSTALLING AND SERVICING CONTROLS		25
	Calibrate temperature controls.	V-TECS 11	26
	Adjust defrost time clock.	V-TECS 12	28
	Calibrate pressure controls.	V-TECS 13	29
	Adjust superheat setting on expansion valve.	V-TECS 14	31
	Calibrate air sensitive thermostats.	V-TECS 15	33
	Align proportional thermostat.	V-TECS 16	35
	Clean thermostat contacts.	V-TECS 17	37
	Replace pressure control switch	V-TECS 18	38
	Replace temperature control.	V-TECS 19	40
	Replace oil pressure safety control switch.	V-TECS 20	42
	Replace summer-winter switch-over control.	V-TECS 21	45
	Replace thermostat.	V-TECS 22	47
	Replace water regulating valve.	V-TECS 23	49
	Test thermostat controls.	V-TECS 24	51

APPENDIX B

DEFINITION OF TERMS

APPENDIX B
DEFINITION OF TERMS

The following terms are supplied to establish operational definitions as they apply to this study.

CAREER LADDER: A vertical arrangement of jobs within an occupational area to indicate skill distinction and progression.

CATALOGS: A comprehensive collection of performance objectives, performance guides, criterion-referenced measures, and related data organized by a job structure or career ladder within a domain of interest.

CONSORTIUM: A group of state agencies, institutions, or other entities which have been legally constituted through letters of commitment, agreements, or by assignment of higher authorities to work together toward the solution of problems in education. A membership from autonomous agencies and institutions which cuts across state boundaries as they attempt to solve problems or meet goals.

D.O.T. CODE: A nine-digit number used to identify a specific job within a given domain.

INSTRUCTIONAL SYSTEM DEVELOPMENT (ISD): A deliberate, orderly process for planning and developing instructional programs which insures that personnel are taught the knowledge, skills, and attitudes essential for successful job performance. Depends on a description and analysis of the tasks necessary for performing the job, objectives, evaluation procedures to determine whether or not the objectives have been reached, and methods for revising the process based on empirical data.

OCCUPATIONAL INVENTORY (TASK INVENTORY BOOKLET): A survey instrument containing tasks performed by job incumbents within D.O.T.'s complete with background information and a list of tools and equipment.

PERFORMANCE-BASED INSTRUCTION: Instruction which, when properly designed and applied, results in the learner's demonstration of certain abilities. The desired abilities are selected before the instruction is designed and are clearly defined as observable performance objectives. In V-TECS catalogs, the abilities are primarily psychomotor. This type of instruction is also referred to as competency-based instruction.

PERFORMANCE GUIDE (PG): A series of steps, arranged in a sequence ordinarily followed, which when completed may result in the performance of a task. Also, called "teaching steps."

PROJECT: An occupational domain area selected by a V-TECS member state for catalog development based upon the U.S. Department of Labor's Dictionary of Occupational Titles (D.O.T.).

STATE-OF-THE-ART (SOA STUDY): Research conducted to determine the current status of performance-based instructional materials and practices in the domain area under study and to obtain other information that might be useful in catalog development.

TASK: A unit of work activity which constitutes logical and necessary steps in the performance of a duty. A task has a definite beginning and ending point in its accomplishments and generally consists of two or more definite steps.

TASK ANALYSIS: A characteristic of a task statement which makes its accomplishments crucial to the acceptance performance of a worker or student. A method of analysis which identifies the critical tasks and aids in determining the consequence of poor performance or lack of performance by a worker or student.

WRITING TEAM: A team of people representing instructors with subject matter expertise, persons having knowledge and experience in developing criterion-referenced measures, local or state supervisors of incumbent workers whose function is to analyze occupational data and develop performance objectives and criterion-referenced measures for specific D.O.T. areas.

APPENDIX C

TOOLS AND EQUIPMENT

APPENDIX C

TOOLS AND EQUIPMENT

EQUIPMENT BY PERCENTAGE RATING

Equipment Number	Equipment Description	Percentage Using	Number Using
2*	Ammeter	95.92	94
6	Aviation Snips, Right Hand	95.92	94
16	Copper, Soldering	94.90	93
75*	Punch, Center	94.90	93
82*	Saw, Hack	94.90	93
52	Leak Detector, Halide Torch	93.88	92
55*	Light, Drop	93.88	92
100	Striker	93.88	92
133	Wrench, Combination	93.88	92
135	Wrench, Flare Nut	93.88	92
7*	Awl, Scratch	92.86	91
93*	Socket, Deep	92.86	91
14	Comb, Fin	91.84	90
8*	Bar, Pry	90.82	89
101*	Stripper, Wire	90.82	89
13*	Can, Oil	89.80	88
18*	Crimper, Hand	89.80	88
21	Cylinder, Charging	89.80	88
25*	Drill, Straight	88.78	87
105*	Thermometer, Pocket	88.78	87
111	Threading tool, Tap	88.78	87
115	Torch, Oxyacetylene	88.78	87
50	Kit, Hermetic Service Valve	87.76	86
53	Leak Detector, Soap Solution	86.73	85
97*	Socket, Speed Handle	86.73	85
106	Thermometer, Remote Bulb	86.73	85
116	Truck, Appliance	86.73	85
134	Wrench, Flare Nut	86.73	85
56	Manometer	85.71	84
57	Millivoltmeter	85.71	84
112	Threading Tool, T-Hand Tap Wrench	84.69	83
144	Thermometer, Super Heat	84.69	83
131	Wrench, Air-Acetylene Cylinder	83.67	82
140	Jacks, Lift	83.67	82
47	Hygrometer, Humidity Recorder	82.65	81
54*	Level	82.65	81
92	Snips, Pattern	82.65	81
95*	Socket, Hinge	81.63	80
120*	Tubing Bender, Lever	81.63	80
142	Drill, Star	81.63	80
42	Hammer, Sledge	80.61	79
73	Pump, Low Vacuum	80.61	79
96*	Socket, Ratchet Handle	80.61	79
103	Thermometer, Flue and Stack	80.61	79

Equipment Number	Equipment Description	Percentage Using	Number Using
35*	Gauge, Set, Refrigeration	79.59	78
36*	Glasses, Safety	79.59	78
118	Tube Cleaner, Hydraulic	79.59	78
141	Wrench, Electric Impact	79.59	78
86*	Screwdriver, Phillips	78.57	77
109	Threading Tool, Die Stock	78.57	77
17*	Chisel, Flat	77.55	76
88*	Screwdriver, Stubby	77.55	76
94*	Socket Extension	77.55	76
132	Wrench, Box End	77.55	76
5	Aviation Snips, Left Hand	76.53	75
43*	Hammer, Softface	75.51	74
145	Extinguisher, Fire	75.51	74
15	Copper, Air Acetylene Soldering	72.45	71
45	Hose, B-Size with Left-hand Nuts	72.45	71
89	Seamer, Hand	72.45	71
98*	Socket, Universal Joint	72.45	71
90	Service Valve Kit, Hermetic	71.43	70
91*	Snips, Double Cut	71.43	70
20*	Cutter, Tubing	70.41	69
85*	Screwdriver, Offset	69.39	68
51	Leak Detector, Electronic	68.37	67
83	Scales	68.37	67
87*	Screwdriver, Standard Slot	68.37	67
40*	Hammer, Claw	67.35	66
33	Gauge, Mercury Manometer	66.33	65
41	Hammer, Riveting	66.33	65
143	Recorder, Amp and Voltage	66.33	65
19	Cutter, Knock-out	64.29	63
31*	Flaring Block, Tubing	64.29	63
146	Kit, First Aid	64.29	63
130	Wrench, Adjustable	63.27	62
137	Wrenches, Hex-Key (Small and Long)	63.27	62
3	Analyzer, Capacitor	62.24	61
26*	File, Flat	62.24	61
28*	File, Point	62.24	61
138	Iron, Soldering	62.24	61
122	Valve, Core Type	61.22	60
10*	Bit, Twist	60.20	59
44	Helmet, Welding	60.20	59
117	Tube, Pitot	59.18	58
123	Valve, Line Piercing	59.18	58
136	Wrench, Pipe	59.18	58
108	Threading Tool, Die	58.16	57
4	Analyzer, Hermetic	57.14	56
30*	File, Taper	56.12	55
107	Thermometer, Thermal Electric	56.12	55
110	Threading Tool, Hand Tap Wrench	56.12	55
32	Gauge, Compound	54.08	53
46	Hygrometer, Dial Type	54.08	53
113*	Torch, Air-Acetylene	54.08	53

Equipment Number	Equipment Description	Percentage Using	Number Using
99*	Starter, Screw	53.06	52
125	Vise, Bench	53.06	52
29*	File, Round	52.04	51
34	Gauge, Thermocouple Micron	48.98	48
128*	Watt-Meter	48.98	48
84*	Screwdriver, Clutch Head	47.96	47
114*	Torch, Air-propane	45.92	45
22	Cylinder, Liquified Petroleum	43.88	43
12*	Brush, Wire	42.86	42
48	Hygrometer, Sling-Psychrometer	42.86	42
104	Thermometer, Manual Wind	41.84	41
124	Valve, Process Tube Adapters	41.84	41
11*	Bit, Wood	40.82	40
27*	File, Half Round	40.82	40
1	Air Meter, Inclined	39.80	39
119	Tube Cleaner, Manual	39.80	39
39	Hammer, Chipping	35.71	35
121*	Tubing Bender, Spring	35.71	35
49	Kit, Combustion Testing	34.69	34
23	Detector, Halide Leak	33.67	33
127*	Voltmeter	33.67	33
81	Riveter	31.63	31
38*	Hammer, Ball Peen	30.61	30
102	Thermometer, Electric	30.61	30
129	Welder, Electric	30.61	30
37	Grinder, Bench	29.59	29
126	Vise, Pipe	26.53	26
9*	Bit, Masonry	25.51	25
24*	Drill, Offset	25.51	25
79*	Rachet, Refrigeration	19.39	19
80*	Reamer, Tubing	19.39	19
139	Compression, Air	19.39	19
61*	Pliers, Diagonal Cutters	14.29	14
60	Ohmmeter	13.27	13
62*	Pliers, Electrical	13.27	13
64*	Pliers, Long-nose	13.27	13
78*	Punch, Tubing Swage	13.27	13
58	Multimeter	12.24	12
63*	Pliers, Fuse Puller	12.24	12
65	Pliers, Pinch-off	11.22	11
66*	Pliers, Slip Groove	11.22	11
67*	Pliers, Slip Joint	11.22	11
68*	Pliers, Vise Grip	11.22	11
72	Pump, Deep Vacuum	10.20	10
76*	Punch, Double Flare Tubing	8.16	8
59	Notcher, Hand	7.14	7

Equipment Number	Equipment Description	Percentage Using	Number Using
69	Puller, Bearing	6.12	6
70	Puller, Gear	6.12	6
74	Pump, Oil	6.12	6
71	Puller, Wheel	5.10	5
77*	Punch, Pin	5.10	5

TOTAL RESPONDENTS 98

NOTE: Items marked with * indicate Basic Tool Kit Items

APPENDIX D

SOURCES OF STANDARDS

APPENDIX D

Sources of Standards

1. Lang, V. Paul, **Principles of Air Conditioning.** New York: Delmar, 1979.

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APPENDIX E

STATE-OF-THE-ART LITERATURE

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STATE-OF-THE-ART LITERATURE

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APPENDIX F

BIBLIOGRAPHY COMPILED BY THE SOUTH CAROLINA WRITING TEAM

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APPENDIX G

WRITTEN EVALUATION QUESTIONS AND ANSWERS

APPENDIX G

Evaluation Questions

I. BRAZING, CUTTING, FITTING SOLDERING AND WELDING PIPING AND TUBING

V-TECS 01	1.	How does swaging affect the ID of tubing? a. No Change b. Larger c. Only the OD is larger d. Smaller e. Thickens the tubing wall
V-TECS 01	2.	If the tubing splits while it is being swaged the tubing is to ________________.
V-TECS 01	3.	When three pieces of tubing are joined with a coupling and a swage joint, ______________ solder joints are made.
V-TECS 01	4.	How far above the swaging block should the tubing extend? a. 1/4 inch b. 3/8 inch c. Length of swaging tool shoulder
V-TECS 01	5.	When we swage a 3/8 inch tubing a ________________ size tubing will fit inside it.
V-TECS 02	6.	What are the two types of tube benders that we use?
V-TECS 02	7.	Why should the diameter of a bend be at least five times the diameter of the tube size?
V-TECS 02	8.	A lever type bender is a ________________ type bender.
V-TECS 02	9.	How do we anneal copper tubing?
V-TECS 02	10.	When do we use the annealing process on copper tubing?
V-TECS 03	11.	Why is it important that we use the proper cutting tool on a given type metal?
V-TECS 03	12.	Which direction do we rotate the tubing cutter when cutting a piece of tubing?
V-TECS 03	13.	Why should we not tighten the tubing cutter too tight?
V-TECS 03	14.	Why do we remove the burrs and file the cut ends on the tubing?
V-TECS 03	15.	Why is it important to reseal the end of the tubing after we make a cut from the roll?
V-TECS 04	16.	Identify each hose that uses right- or left-handed threads.
V-TECS 04	17.	What is the recommended working pressure that is to be adjusted on acetylene regulators?
V-TECS 04	18.	How do you determine the working pressure on oxygen regulators?
V-TECS 04	19.	The oxygen lever on the torch has what purpose?
V-TECS 04	20.	How are leaks discovered on the oxyacetylene welding and cutting station?
V-TECS 05	21.	When testing for a restriction, we normally use ________________.
V-TECS 05	22.	In a refrigeration system a restriction is sometimes indicated by a ________________ pattern.
V-TECS 05	23.	How do we normally remove a restriction?

V-TECS 05 24. How can we check to insure that the restriction has been removed?

V-TECS 06 25. What is the meaning of ACR as applied to tubing?

a. It is cold pulled.
b. It is suitable for air conditioning and refrigeration applications.
c. It is intended for air cooled applications only.
d. It is a certain manufacturer's brand symbol.
e. It is air cooled rolled.

V-TECS 06 26. When sawing soft copper tubing, how may the chips be prevented from entering the length of tubing to be immediately used?

a. Apply air pressure on this length of the tube.
b. Slant the tube so that the chips will not fall into the length being used.
c. Pinch the tube.
d. Stuff rags in the tube.
e. Use a sawing fixture.

V-TECS 06 27. What type connections should be made when soft copper tubing is being used?

a. Threaded
b. Flared or soldered
c. Welded
d. Use compression fittings.
e. Swaged.

V-TECS 06 28. Why are bending springs used?

a. To provide a better grip on the tube.
b. To make a uniform curve.
c. To keep the tube from kinking.
d. To keep the cutside of the tube clean.
e. To keep the inside of the tube clean.

V-TECS 06 29. Why should the end of copper tubing to be flared be filed square?

a. To keep the tubing bright.
b. To make the flare equal all around.
c. To make it easy to attach the flaring feel.
d. To make the flare of proper thickness.
e. To keep the flare from splitting.

V-TECS 07 30. What is the usual composition of soft solder?

a. Lead and antimony
b. Lead and tin
c. Tin and zinc
d. Zinc and copper
e. Spelter.

V-TECS 07 31. What is the base of most silver brazing flux?

a. Vaseline
b. Tallow
c. Zinc chloride
d. Borax
e. Sodium Chloride.

V-TECS 07 32. What is the advantage of silver brazing over sold soldering?

a. Cheaper
b. Quicker
c. Neater
d. Stronger
e. Lighter

V-TECS 07 33. What is the approximate temperature at which silver brazing allows flow?

a. 1000° F.
b. 1050° F.
c. 1100° F.
d. 1145° F.
e. 1200° F.

V-TECS 07 34. Why must the flux be removed after soldering and brazing?

a. It is not
b. To help one see the quality of the job
c. To prevent corrosion
d. To polish the joint
e. To make the joint stronger

V-TECS 08 35. How should a solid wire be wrapped around a terminal screw?

a. Opposite the direction the screw turns as it is tightened
b. The same directions the screw is turned as it is tightened
c. It should be wrapped twice around the screw
d. It should be kept straight
e. A terminal should be used

V-TECS 08 36. Which of the following is the largest conductor?

a. No. 8
b. No. 10
c. No. 12
d. No. 14
e. No. 16

V-TECS 08 37. What should be heated when soldering a terminal to a stranded wire?

a. The wire only
b. The terminal only
c. The solder only
d. The flux and solder only
e. The wire and terminal only

V-TECS 08 38. How should stranded wire be connected to a screw terminal?

a. Wrap wire clockwise around screw
b. Wrap wire counter-clockwise around the screw
c. Solder the wire, then wrap around the screw
d. Fasten a terminal to wire end
e. Separate the strands of wire and wrap around screw in both directions.

V-TECS 08 39. What should be the resistance across a clean tight terminal?
a. 0 ohms
b. 50 ohms
c. 5,000 ohms
d. 50,000 ohms
e. 100,000 ohms

V-TECS 09 40. What is the purpose of cleaning the surfaces of the welding joints?

V-TECS 09 41. What is the standard working pressure adjustment on the acetylene regulators?

V-TECS 09 42. How is the pressure of the oxygen regulators determined?

V-TECS 09 43. What is the proper motion in heating the seam of the metal?

V-TECS 09 44. What finishing steps are taken after the weld is completed?

V-TECS 10 45. Identify each hose as to right or left handed threads.
a. Red hose (acetylene)
b. Green hose (oxygen)

V-TECS 10 46. How are leaks detected on the oxyacetylene cutting and welding station?

V-TECS 10 47. What purpose does the oxygen lever on the torch serve?

V-TECS 10 48. What is the final step of any welding job?

V-TECS 10 49. What is the purpose of cleaning the surface of the welding joints?

II. INSTALLING AND SERVICING CONTROLS

V-TECS 11 50. What is one type of differential control?
a. Range
b. Temperature
c. Cut-in only
d. Pressure
e. Cycling.

V-TECS 11 51. Where are thermostatic motor control bulbs usually located?
a. In the brine
b. On the top of evaporator
c. On the bottom of evaporator
d. On the side of evaporator
e. At the outlet of the evaporator.

V-TECS 11 52. How may a thermostat be tested and adjusted?
a. With a brine bath
b. With a pressure pump
c. With an electric heating coil
d. With a vacuum pump
e. With air pressure.

V-TECS 11 53. With what is the thermostatic element charged?
a. Alcohol and water
b. Sulphur dixoide
c. Metinyl chloride
d. R-12
e. A volatile liquid.

V-TECS 11	54.	Why must the thermostat bulb be clamped firmly to the evaporator? a. To enable good heat transfer. b. To stop rattles. c. To prevent leaks. d. To make a good electrical ground. e. To prevent breakage.
V-TECS 12	55.	In a defrost timer the pins screwed into the face of the clock determines the ____________ and ____________ of the defrost cycle.
V-TECS 12	56.	What is the purpose of a defrost timer?
V-TECS 12	57.	What is the normal length of times of the average defrost cycle?
V-TECS 13	58.	Why are high-pressure safety motor cut-outs used? a. To cycle the unit. b. To economize on power consumption. c. To protect the motor control. d. To protect the unit from high pressures. e. To keep the high pressures up to normal.
V-TECS 13	59.	Where should the low-side connection of the pressure motor control be connected into the system? a. To the suction line of the warmest evaporator. b. To the compressor high side. c. To the crankcase. d. To the liquid receiver. e. Anywhere on the low-pressure side.
V-TECS 13	60.	Where is a high-pressure safety motor cut-out line connected into the system? a. At the condenser. b. At the compressor head. c. To the liquid line. d. To the evaporator. e. To the suction line.
V-TECS 13	61.	What are the relative pressures in the low-pressure side while the unit is running? a. The same throughout. b. Higher at the evaporator. c. Lower at the evaporator. d. Higher at the suction service valve. e. Higher as the temperature drops.
V-TECS 13	62.	What is the most common pressure motor control trouble which will cause the system to short cycle? a. Lack of refrigerant. b. Low-pressure setting too low. c. Clogged screen. d. Too low a range. e. Too low a high-pressure cut-out setting.
V-TECS 14	63.	Where is the power bulb located when controlling an air-cooling evaporator? a. On the evaporator. b. On the liquid line. c. On the suction line near the evaporator. d. On the suction line outside the cabinet. e. Anywhere outside the cabinet.

V-TECS 14 64. What does thermostatic expansion valve control?

a. The temperature of the refrigerant in the evaporator
b. The quantity of refrigerant in the evaporator
c. The pressure in the evaporator
d. The temperature of the evaporator
e. The high-side pressure.

V-TECS 14 65. How may needle and seat be tested for leaks?

a. High pressure air
b. Vacuum
c. Turning the adjustment all the way out
d. Cooling the power bulb and using air pressure
e. With water.

V-TECS 14 66. What will happen to the evaporator if the TEV adjustment screw is turned out?

a. Starve
b. Flood
c. Become warmer
d. Become colder
e. Nothing.

V-TECS 14 67. What will happen to the evaporator if the power element is located in a warm air stream?

a. Flood
b. Starve
c. Nothing
d. Unit will not run
e. Unit will run constantly.

V-TECS 15 68. What is the voltage of a line voltage thermostat?

a. 24V
b. 120V
c. 240V
d. 30V
e. 6 to 12V.

V-TECS 15 69. In an electronic combination thermostat, what is the heating and cooling difference?

a. 0.5°F.
b. 1°F.
c. 2°F.
d. 3°F.
e. 4°F.

V-TECS 15 70. How does a low voltage thermostat operate the heating and cooling fan?

a. A direct line circuit
b. Relay
c. Stepdown transformer
d. Thermostat
e. Solenoid.

V-TECS 15 71. What does the least complicated combination thermostat contain?

a. Bimetal strip
b. Bimetal strip and heat anticipater
c. Bimetal strip, heat anticipater, and cold anticipator
d. Two separate circuits in sequence
e. Two separate mercury tube switches.

V-TECS 15 72. What does the thermostat control?

a. Heating
b. Cooling
c. Humidity and odor
d. Cooling and humidity
e. Heating and cooling.

V-TECS 16 73. A proportional thermostat depends on the temperature difference between the thermostat ____________ and ____________ temperature.

V-TECS 16 74. When the thermostat is controlling a flame it is burning larger when the temperature difference is ____________.

V-TECS 16 75. The unit starts to flame at what percent of capacity?

V-TECS 16 76. Basically the proportional thermostat is a ____________ ____________ thermostat.

V-TECS 17 77. What in the thermostat is the moveable contact mounted on?

V-TECS 17 78. Contacts can be calibrated. (True or False)

V-TECS 17 79. A regular thermostat senses ____________ ____________.

V-TECS 18 80. Why are high-pressure safety motor cut-outs used?

a. To cycle the unit
b. To economize on power consumption
c. To protect the motor control
d. To protect the unit from high pressure
e. To keep the high pressure up to normal.

V-TECS 18 81. Where should the low-side connection of the pressure motor control be connected into the system?

a. To the suction line of the warmest evaporator
b. To the compressor high side
c. To the crankcase
d. To the liquid receiver
e. Anywhere on the low-pressure side.

V-TECS 18 82. Where is a high-pressure safety motor cut-out line connected into the system?

a. At the condenser
b. At the compressor head
c. To the liquid line
d. To the evaporator
e. To the suction line.

V-TECS 18 83. What are the relative pressures in the low-pressure side while the unit is running?

a. The same throughout
b. Higher at the evaporator
c. Lower at the evaporator
d. Higher at the suction service valve
e. Higher at the temperature drops.

V-TECS 18 84. What is the most common pressure motor control trouble which will cause the system to short cycle?

a. Lack of refrigerant.
b. Low-pressure setting too low.
c. Clogged screen.
d. Too low a range.
e. Too low a high-pressure cut-out setting.

V-TECS 19 85. Why are high-pressure safety motor cut-outs used?

a. To cycle the unit.
b. To economize on power consumption.
c. To protect the motor control.
d. To protect the unit from high-pressures.
e. To keep the high pressures up to normal.

V-TECS 19 86. Where should the low-side connection of the pressure motor control be connected?

a. To the suction line of the warmest evaporator.
b. To the compressor high side.
c. To the crankcase.
d. To the liquid receiver.
e. Anywhere on the low-pressure side.

V-TECS 19 87. Where is a high-pressure safety motor cut-out line connected into the system?

a. At the condenser.
b. At the compressor head.
c. To the liquid line.
d. To the evaporator.
e. To the suction line.

V-TECS 19 88. What are the relative pressures in low-pressure side while the unit is running?

a. The same throughout.
b. Higher at the evaporator.
c. Lower at the evaporator.
d. Higher at the suction service valve.
e. Higher as the temperature drops.

V-TECS 19 89. What is the most common pressure motor control trouble which will cause the system to short cycle?

a. Lack of refrigerant.
b. Low-pressure setting too low.
c. Clogged screen.
d. Too low a range.
e. Too low a high-pressure cut-out setting.

V-TECS 20 90. Where is the oil separator located in the system?

a. Between the condenser and the liquid line.
b. Between the receiver and the liquid line.
c. Between the compressor and the condenser.
d. Between the suction line and the compressor.
e. Between the liquid line and the evaporator.

V-TECS 20 91. Why are most oil separators insulated?

a. To keep the oil warm.
b. To keep any moisture in the separator from freezing.
c. To keep the refrigerant from condensing in the separator.
d. Only hot oil will separate from refrigerant.
e. To minimize noise.

V-TECS 20 92. What will happen if the oil separator float collapses?

a. Nothing.
b. The valve will stay open.
c. The valve will stay closed.
d. The liquid refrigerant will short circuit into the crankcase.
e. The head pressure will become excessive.

V-TECS 20 93. What is one advantage of an oil separator?

a. Keeps the oil in the compressor.
b. Low cost.
c. Easy to service.
d. Traps the moisture.
e. May be used as a service cylinder.

V-TECS 20 94. How must an oil separator be mounted?

a. Any position.
b. Level.
c. Suspend from the condensor line.
d. Below the compressor.
e. Above the compressor.

V-TECS 21 95. The thermostat controls ____________________.

V-TECS 21 96. How does a low voltage thermostat operate the heating and cooling fan?

V-TECS 21 97. What is the voltage of a line voltage thermostat?

a. 240V.
b. 120V.
c. 24V.
d. 6 to 12V.
e. 30V.

V-TECS 21 98. What does the least complicated combination thermostat contain?

a. Bimetal strip.
b. Two separate mercury tube switches.
c. Bimetal strip and heat anticipator.
d. Two separate circuits in sequence.
e. Bimetal strip, heat anticipator, and cold anticipator.

V-TECS 21 99. In an electronic combination thermostat, what is the heating and cooling differential?

a. 4^{o}F.
b. 2^{o}F.
c. 0.5^{o}F.
d. 1^{o}F.
e. 3^{o}F.

V-TECS 22 100. How can a low voltage thermostat operate from a 120V system?

a. Use a solenoid valve.
b. Use a transformer.
c. Use a relay.
d. Use a sequence control.
e. Use a resistance.

V-TECS 22 101. How is a 24V circuit obtained?

a. From the power company.
b. Use a solenoid.
c. Use a thermostat.
d. Use a step-up transformer.
e. Use a step-down transformer.

V-TECS 22 102. Where is a limit control located in the electrical circuits?

a. In the 24V circuit.
b. In the 120V circuit.
c. In the 240V circuit.
d. In both 24V and 120V circuit.
e. In either the 24V or 120V circuit.

V-TECS 22 103. What are the control devices which may be used on the 24V circuit in a domestic gas fueled heating hydronic system?

a. Thermostat.
b. Thermostat and relay, safety pilot.
c. Thermostat, relay and circulation pump.
d. Thermostat, relay, gas solenoid, limit control and safety pilot.
e. Thermostat, relay, gas solenoid, limit control, safety pilot, and circulation pump.

V-TECS 22 104. In a low voltage system, what voltage operates the heat anticipator?

a. 24V.
b. 6V.
c. 120V.
d. 12V.
e. 240V.

V-TECS 23 105. What is one main advantage of a pressure operated water valve?

a. No cost of operation.
b. Turns the water on and off.
c. Easiest to install.
d. Varies the rate of water flow.
e. Will operate satisfactorily under high water pressure.

V-TECS 23 106. Where is the refrigerant line to the water valve usually connected into the system?

a. Suction line.
b. Compressor crankcase.
c. Receiver.
d. Compressor head.
e. Condenser.

V-TECS 23 107. What is the usual temperature difference between the water outlet and the water inlet?

a. 0°F.
b. 10°F.
c. 30°F.
d. 40°F.
e. None.

V-TECS 23 108. What happens to the water flow when the condensing unit stops?

a. Stops instantly.
b. Keeps on running.
c. Continues running but at a lower rate of flow.
d. Stops quickly.
e. Increases.

V-TECS 23 109. What is one of the advantages of an electric water valve?

a. Easy to install.
b. Turns the water on and off.
c. No cost of operation.
d. Can operate under high pressure.
e. Varies the rate of water flow.

V-TECS 24 110. What is one type of differential control?

a. Range.
b. Temperature.
c. Cut-in only.
d. Pressure.
e. Cycling.

V-TECS 24 111. Where are thermostatic motor control bulbs usually located?

a. In the brine.
b. On the top of evaporator.
c. On the bottom of the evaporator.
d. On the side of the evaporator.
e. At the outlet of the evaporator.

V-TECS 24 112. How may a thermostat be tested and adjusted?

a. With a brine bath.
b. With a pressure pump.
c. With an electric heating coil.
d. With a vacuum pump.
e. With air pressure.

V-TECS 24 113. With what is the thermostatic element charged?

a. Alcohol and water.
b. Sulpher dioxide.
c. Methyl chloride.
d. R-12.
e. A volatile liquid.

V-TECS 24 114. Why must the thermostatic bulb be clamped firmly to the evaporator?

a. To enable good heat transfer.
b. To stop rattles.
c. To prevent leaks.
d. To make a good electrical ground.
e. To prevent breakage.

III. INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS AND MOTORS

V-TECS 25 115. The A belt is __________ inches in width.

V-TECS 25 116. To reduce bearing and belt wear, the shafts should be ______________.

V-TECS 25 117. The most common way to measure the belt length is the ______________.

V-TECS 25 118. In what direction should a belt rotate?
- a. Clockwise
- b. Counterclockwise
- c. With pull on top section of belt
- d. With pull on bottom section of belt
- e. In any direction.

V-TECS 25 119. In checking for the correct belt tension, the belt ______________.
- a. Should not slip.
- b. Should not glaze on wearing surfaces.
- c. Should not move 1/2 inch out of line with a 10 lb. force.
- d. Should not move 1/2 inch out of line with a 150 lb. force.
- e. Does not flap.

V-TECS 26 120. What does a limit control on a heating system using oil or gas test for?

V-TECS 26 121. If a limit control senses an excessive ______________ ______________ it will shut the system down.

V-TECS 26 122. What is the normal differential of a limit switch?

V-TECS 26 123. On most heating systems the limit switch is installed in the ______________ volt circuit.

V-TECS 27 124. What is the width of an A belt?
- a. 1/4 in.
- b. 3/8 in.
- c. 1/2 in.
- d. 5/8 in.
- e. 3/4 in.

V-TECS 27 125. What is the most common way to measure the length of a belt?
- a. Inside length
- b. The length around the complete distance around the belt.
- c. The inside length times two.
- d. The length 1/2 of its depth.
- e. The length 2/3 of its depth.

V-TECS 27 126. In what direction should a belt rotate?
- a. Clockwise
- b. Counterclockwise
- c. With the pull on the top section of the belt.
- d. With the pull on the bottom section of the belt.
- e. In any direction.

V-TECS 27 127. Why should the shafts be parallel?
a. To keep the pulley from loosening
b. To keep proper tension
c. To keep the belt from coming loose
d. To reduce vibration
e. To reduce bearing and belt wear.

V-TECS 27 128. What is one way to check for correct belt tension?
a. There is no evidence of slipping
b. There is no glazing of belt wearing surfaces
c. The belt does not flap as it revolves
d. The belt will move 1/2 inch out-of-line with a ten lb. force.
e. The belt will move 1/2 inch out-of-line with a 150 lb. force.

V-TECS 28 129. What is the main purpose of keeping the exterior of the motor clean?
a. To keep it from overheating
b. To make it run faster
c. To improve appearance
d. To increase service years.

V-TECS 28 130. What is the purpose of marking the end bells?
a. To keep from putting them on the wrong end
b. To observe motor polarity
c. To insure proper alignment of the bell end
d. To keep the motor from running at a lower speed.

V-TECS 28 131. What should the motor be cleaned with?
a. Alcohol
b. Compressed air
c. Soap and water
d. Cleaning solvent.

V-TECS 28 132. When the motor is reassembled, we must check the alignment of the ________________ and ________________.

V-TECS 29 133. When we use a systemation load calculation we are looking for the total ____ ____ of the electrical service.

V-TECS 29 134. What rules do we use to show the relationship of wire size to its amperage capacity?

V-TECS 29 135. In the average entrance cable there are normally ________________ cables?

V-TECS 29 136. When we strip the entrance cable we normally unwind ____________ feet for making connections?

V-TECS 30 137. What determines the location of the meter base?

V-TECS 30 138. Using conduit the size is indicated by the _________ of the wire.

V-TECS 30 139. What do we normally cut conduit with?

V-TECS 30 140. What is the purpose of using conduit?

V-TECS 31 141. Which ohmmeter test of the three motor terminals has the highest resistance?
a. Start to common
b. Run to common
c. Start to run
d. All are the same
e. The resistance is 0 for each test.

V-TECS 31 142. If one lead of an ohmmeter is on a terminal, where must the other one be to check for grounds?

a. On one other terminal
b. On two other leads
c. Neither of the leads on the terminal
d. On the hermetic housing
e. On the over load protector terminal.

V-TECS 31 143. What happens when one installs an under-capacity capacitor?

a. No change
b. Motor will over heat
c. Motor will run too fast
d. Capacitor will over heat
e. Motor will run too slowly.

V-TECS 31 144. What is the best way to test for a shorted winding?

a. Test light
b. Ammeter
c. Volt meter
d. Ohmmeter
e. Thermometer.

V-TECS 32 145. What does a lockout relay check for?

V-TECS 32 146. What voltage does a lockout relay normally operate in?

V-TECS 32 147. Is the lockout relay adjustable?

V-TECS 32 148. How can we correct a problem in a lockout relay?

V-TECS 33 149. When installing a meter base the distance from the ground to the meter base is ______________.

V-TECS 33 150. When installing a service entrance what is the minimum distance between the ground and the weather head.

V-TECS 33 151. The conduit that extends from the meter base to the weather head is called the ______________.

V-TECS 33 152. A straping that secures the conduit is located ________ feet below the weather head.

V-TECS 33 153. After connecting all wires we always check for a ______________ condition.

V-TECS 34 154. The weather head is mounted at the top of the ______________.

V-TECS 34 155. What is the purpose of the weather head?

V-TECS 34 156. What are the three parts of a weather head?

V-TECS 35 157. What is the purpose of checking the RPM?

V-TECS 35 158. In checking the motor speed, where do we attach the tachometer?

V-TECS 35 159. Using the recorded RPM, we check this recording with the ______________ to make a comparison of the motor speed.

V-´ . S 35 160. We can also reduce the motor speed by adding __________ in the motor circuit.

V-TECS 36 161. In a breaker panel the two hot bus bars are referred to as the ____________ bus and the ___________ bus.

V-TECS 36 162. How many bus bars does a single pole breaker connect on to?

V-TECS 36	163.	How many volts can we use from the breaker panel using a single pole breaker?
V-TECS 36	164.	A double pole breaker is connected to ________ bus of the breaker panel.
V-TECS 36	165.	What item of test equipment choice is used to check for a shorted condition?
V-TECS 37	166.	The position of the structure and the location of the power lines determine the location of the ____________.
V-TECS 37	167.	What is the distance between the meter base and the ground?
V-TECS 37	168.	When mounting the meter base why must we make sure the socket jaws are truly vertical.
V-TECS 37	169.	A meter base is made of materials that are ____________.
V-TECS 38	170.	Which of the following will cause an air flow control to react. a. If the air temperature in the room is too high or too low. b. If the air temperature to the room is too high or too low. c. If the temperature in the fresh air is too high or too low. d. If the temperature in the exhaust air is too high or too low. e. All of the above.
V-TECS 38	171.	What usually causes a fire damper to close? a. The heating of a fusible leak. b. The lack of airflow in the ducts. c. A pressure stat in the room indicating overheating. d. The recycling of the air conditioner. e. All of the above.
V-TECS 38	172.	What is the air fed into a fan called? a. Forced draft. b. Induced draft. c. Inertia. d. Axial flow. e. Radial flow.
V-TECS 39	173.	What is the most popular way to drive the open compressor and large fans?
V-TECS 39	174.	A poorly aligned belt will do what to the life of the motor?
V-TECS 39	175.	How far should one be able to depress a properly tensioned belt when applying a 10 pound force?
V-TECS 39	176.	Where is the belt adjusting and aligning tool applied to tension the belt?
V-TECS 39	177.	What are the three standard widths that most belts fall into?
V-TECS 40	178.	Which two motor "drives" are used to connect the motor to the load?
V-TECS 40	179.	Which color wire lead (speed tap) coming from a four speed motor is normally used for low speed?

V-TECS 40	180.	Which color wire lead (speed tap) coming from a four speed motor is normally used for high speed?
V-TECS 40	181.	How many set screws does an adjustable motor pulley have?
V-TECS 41	182.	Other than the contacts, name the portion of a contactor that moves.
V-TECS 41	183.	When the coil and a contactor is energized, what is created around the laminated core within the coil?
V-TECS 41	184.	Contactor contacts are normally made of which two types of metal?
V-TECS 41	185.	What resistance will be shown on the ohmmeter if the contactor coil is shorted?
V-TECS 41	186.	The ohmmeter reading will show what resistance if the contactor coil is open?
V-TECS 42	187.	Which terminal of the current relay is the "hot" power supply hooked up to?
V-TECS 42	188.	Terminal "M" of the current relay is electrically connected to which compressor motor terminal?
V-TECS 42	189.	Is the coil of the current relay constructed of large wire or small wire?
V-TECS 42	190.	Within the current relay, what is located and connected between terminals "L" and "M"?
V-TECS 43	191.	The defrost limiter switch (defrost termination thermostat) normally opens at approximately what temperature?
V-TECS 43	192.	Most defrost heaters are attached to which refrigeration component?
V-TECS 43	193.	What ohmmeter reading indicates an open defrost heater?
V-TECS 43	194.	Is the defrost heater wired in series or paralled with the defrost termination thermostat?
V-TECS 44	195.	Is the defrost thermostat electrically wired in parallel or in series with the defrost heater?
V-TECS 44	196.	What ohmmeter reading indicates that the defrost thermostat contacts are closed?
V-TECS 44	197.	At what approximate temperature does the defrost thermostat contacts close?
V-TECS 44	198.	Is the defrost thermostat a manual reset or automatic reset switch?
V-TECS 45	199.	Domestic refrigerator defrost timer motors normally use ________ volts for their operation. a. 24 b. 115 c. 230 d. 440
V-TECS 45	200.	Are defrost timer defrost contacts electrically wired in series or in paralled with the defrost thermostat?
V-TECS 45	201.	Are defrost timer defrost contacts electrically wired in series or in parallel with the defrost heater?
V-TECS 45	202.	Name a circuit that the defrost timer will complete (energize) after completion of the defrost cycle.

V-TECS 45	203.	Is the defrost timer located on the evaporator coil? (True or False)
V-TECS 46	204.	Does the "A" width pulley fit belts 1/2 inch to 11/16 inch wide or belts up to 17/32 inch in width?
V-TECS 46	205.	When using a variable pitch pulley, how much may the speed of the driven unit be varied?
V-TECS 46	206.	What device may be used to adapt (reduce) a pulley with a 3/4 inch base to a 1/2 inch base?
V-TECS 46	207.	Do pulley set screws usually have a "natural fine" thread or a "natural course" thread?
V-TECS 47	208.	Which test meter should be used to check an electric actuating valves' motor windings?
V-TECS 47	209.	Which testing meter should be used to check the electrical power supply to the actuating valve?
V-TECS 47	210.	After installing a new actuating valve, the valve must be calibrated. (True or False)
V-TECS 48	211.	Name two particles which collect on a fan and reduce its efficiency.
V-TECS 48	212.	How often should dirt be removed from a fan?
V-TECS 48	213.	Name two types of drive for a radial flow fan.
V-TECS 48	214.	The fan speed can be changed by using an adjustable (variable pitch) pulley. (True or False)
V-TECS 48	215.	Does a propeller fan move by radial flow or axial flow?
V-TECS 49	216.	How many sets of contacts are normally located within a fan control relay switch?
V-TECS 49	217.	Is a fan control relay switch coil normally energized for high speed fan operation or low speed fan operation?
V-TECS 49	218.	Are the normally closed relay contacts used for high fan speed or low fan speed?
V-TECS 49	219.	The normally open contacts are wired in series with the fan motor low speed winding tap. (True or False)
V-TECS 49	220.	Is the relay coil energized for heating or cooling when using a gas furnace and air conditioning unit?
V-TECS 50	221.	Are fuses rated in amperage or ohms?
V-TECS 50	222.	Which type fuse allows for temporary overloads in motor circuits?
V-TECS 50	223.	Which type of cartridge fuse is constructed so that the fuse element may be replaced, instead of the complete fuse?
V-TECS 50	224.	What electrical test meter may be used to check a fuse in the circuit with the circuit power on?
V-TECS 50	225.	When checking a fuse that is good, what reading will an ohmmeter indicate?
V-TECS 51	226.	Which compressor motor terminal is the simple bimetal overload protector wired to?
V-TECS 51	227.	What causes the overload protector bimetal disc to snap open the contacts?

V-TECS 51 228. When checking an overload protector with an ohmmeter, the meter will read ____________ if the overload is open.
a. Infinity
b. 115 volts
c. Zero
d. 230 volts.

V-TECS 51 229. Some overload protectors have heaters within the overload. (True or False)

V-TECS 52 230. What does "current draw" cause the "hot wire" in a hot wire relay to do when heated?

V-TECS 52 231. When the hot wire relay "hot wire" is cold, what position are the relay contacts in?

V-TECS 52 232. Which set of hot wire contacts acts as an overload contact?

V-TECS 52 233. How soon does the hot wire relay start winding contacts open?

V-TECS 53 234. Is the SPDT fan relay energized for heating or cooling?

V-TECS 53 235. Are the normally open or normally closed contacts wired in series with the high speed tap of the fan motor?

V-TECS 53 236. If the thermostat fan switch is set for continuous fan operation, which contacts are being used the SPDT fan relay?

V-TECS 53 237. All fan relays have two sets of contacts. (True or False)

V-TECS 54 238. If the limit switch opens (breaks the circuit), does the furnace start up or stop?

V-TECS 54 239. Are furnace limit switch contacts normally open or normally closed?

V-TECS 54 240. What causes the limit switch contacts to open?

V-TECS 54 241. Limit switches are sometimes wired in the 115 volts circuit. (True or False)

V-TECS 54 242. Limit switches are sometimes wired in the 24 volts circuit. (True or False)

V-TECS 55 243. Does the coil create a magnetic field when it is energized or de-energized?

V-TECS 55 244. Are contactor coils rated in amperage or voltage?

V-TECS 55 245. The voltage applied to a coil is always the same as the voltage applied to the contacts. (True or False)

V-TECS 55 246. If a coil is shorted, should the ohmmeter read zero or infinity?

V-TECS 55 247. A measurable resistance on the ohmmeter usually indicates an open coil. (True or False)

V-TECS 56 248. Magnetic starter overloads are sometimes called heaters. (True or False)

V-TECS 56 249. How many general classes of overloads are used in magnetic starters?

V-TECS 56 250. Name two general classes of overloads that are used in magnetic starters.

V-TECS 56 251. Do magnetic starters have mechanical linkage? (True or False)

V-TECS 56 252. Are magnetic starters used more on single phase equipment or three phase equipment?

V-TECS 57	253.	Which causes the potential relay to work properly, an increase in current or an increase in voltage (back EMF)?
V-TECS 57	254.	When the unit is "off", are the relay contacts open or closed?
V-TECS 57	255.	As the thermostat closes and starts, the refrigeration unit, is there any arcing of the potential relay contacts?
V-TECS 57	256.	Are the contacts located between terminals 1 & 2, or terminals 2-5?
V-TECS 58	257.	All time delay relays have the same delay period. (True or False)
V-TECS 58	258.	List two voltages that are used with time delay relay heaters.
V-TECS 58	259.	What type of relay is used to delay the starting of a load for a designated period of time?
V-TECS 58	260.	Time delay relays have bimetal elements. (True or False)
V-TECS 59	261.	What is used to check the 24 volt output of a transformer?
V-TECS 59	262.	Show the schematic symbol for a transformer.
V-TECS 60	263.	What is the most common type of three-phase motor used in heating, cooling and refrigeration?
V-TECS 60	264.	Three-phase motors use motor starting relays. (True or False)
V-TECS 60	265.	In which part of the motor is the rotating magnetic field produced in?
V-TECS 60	266.	A dual voltage three-phase motor can be obtained. (True or False)
V-TECS 60	267.	Which test meter should be used to check the three-phase motor windings for shorts or opens?
V-TECS 61	268.	Stuck 115 volt compressor motors can sometimes be started by using 230 volts for just a second. (True or False)
V-TECS 61	269.	How long should the capacitor be energized in the circuit when trying to reverse a stuck compressor motor?
V-TECS 61	270.	Is the start capacitor connected in series or in parallel with the run winding when trying to free a seized compressor motor.
V-TECS 61	271.	How many methods may be used to free a stuck compressor motor — one, two, or three?
V-TECS 62	272.	With the evaporator coated with frost and ice, will the defrost thermostat contacts usually be opened or closed?
V-TECS 62	273.	It is possible for a defrost thermostat to stop the defrost cycle. (True or False)
V-TECS 62	274.	With the electrical power turned "off," what electrical testing device would usually be used to check the defrost thermostat contacts position?
V-TECS 62	275.	If the defrost thermostat temperature is 90°F, would the contacts normally be opened or closed?
V-TECS 63	276.	Are defrost timers used for hot gas defrost systems or electrical defrost systems?
V-TECS 63	277.	The defrost timer normally cuts off the compressor motor during electric defrosting of the evaporator. (True or False)

V-TECS 63	278.	Defrost timers cut off the compressor motor during hot gas defrosting of the evaporator. (True or False)
V-TECS 63	279.	During electrical defrost, should the evaporator fan motor be on or off?
V-TECS 64	280.	Which will open quicker, a bimetal overload with a heater or a bimetal overload without a heater?
V-TECS 64	281.	What does the bimetal do to open the circuit when the bimetal gets warm (hot)?
V-TECS 64	282.	Most domestic refrigerators use magnetic overload relays. (True or False)
V-TECS 65	283.	What determines if the secondary winding puts out more or less voltage than the primary winding voltage?
V-TECS 65	284.	If the primary winding is 120 volts and the secondary winding has 1/5 the number of windings as the primary winding, what is the secondary windings output voltage?
V-TECS 65	285.	A direct current power source can be used for a transformer. (True or False)
V-TECS 66	286.	Is the hot wire relay resistance heater located between "L-5" terminals or "L-M" terminals?
V-TECS 66	287.	Do the "L-M" contacts or the "L-5" contacts act as overload contacts in the hot wire relay?
V-TECS 66	288.	With the compressor motor running at full speed, should the hot wire relay "L-5" contacts be open or closed?
V-TECS 66	289.	With the refrigeration unit "off" should the hot wire relay "L-5" contacts be open or closed?
V-TECS 67	290.	Is the contactor armature a stationary part or a moving part?
V-TECS 67	291.	Which device usually has built-in overloads, the contactor or the motor starter?
V-TECS 67	292.	Name a type of alloy used in the manufacture of contactor contacts.
V-TECS 67	293.	How many movable contacts are in a three-spoke contactor?
V-TECS 68	294.	Which compress motor terminal is potential relay terminal 2 connected to "C", "S", or "R"?
V-TECS 68	295.	Are the potential relay contacts normally closed or normally open?
V-TECS 68	296.	What is another name for a potential relay?
V-TECS 68	297.	Which potential relay terminal is the "Common Terminal"?
V-TECS 68	298.	The coil is located between which potential relay terminals?
V-TECS 69	299.	Are current relay contacts normally open or normally closed?
V-TECS 69	300.	Should current relay terminal "M" be connected to compressor motor terminal ____________, "C", "S", or "R"?
V-TECS 69	301.	Should current relay terminal "S" ____________ be connected to compressor motor terminal "C", "S", or "R"?
V-TECS 69	302.	The current relay coil is usually located between which terminals in the relay?

V-TECS 70	303.	The fan relay coil normally has the same voltage power supply as the fan relay contacts. (True or False)
V-TECS 70	304.	A fan relay has 230 volt contacts and a 24 volt coil. (True or False)
V-TECS 70	305.	A fan relay has 115 volt contacts and a 24 volt coil. (True or False)
V-TECS 70	306.	The fan relay can be purchased with a stepdown transformer attached "fan center." (True or False)
V-TECS 71	307.	When twisting electrical wires to be placed in a wire nut, should the wire splice, "pig tail," be twisted clockwise or counterclockwise?
V-TECS 71	308.	Does the heat pump reversing valve use a solenoid or a heater as the activator for position changing?
V-TECS 71	309.	What color equipment grounding wire is usually used on heat pumps?
V-TECS 71	310.	What electrical power supply is used for most residential heat pumps?
V-TECS 72	311.	What voltage is used with most home heating and cooling thermostats?
V-TECS 72	312.	On a multistage thermostat subbase, which terminal is usually used for 1st stage heating?
V-TECS 72	313.	Which thermostat subbase terminal is normally wired to the fan relay coil?
V-TECS 72	314.	Name the two positions that the thermostat fan switch may be set in.
V-TECS 73	315.	Name two windings located in a split-phase motor.
V-TECS 73	316.	Which winding in a split phase motor is constructed of the larger diameter wire?
V-TECS 73	317.	How many hot wires are wired to a 208 volt split-phase, single phase motor?
V-TECS 73	318.	A split phase motor should be grounded for safety. (True or False)
V-TECS 74	319.	Is the start capacitor wired in series or in parallel with the start winding of the motor?
V-TECS 74	320.	Should the start capacitor be wired to "S" or "M" terminal of the current relay?
V-TECS 74	321.	It is possible for a start capacitor to store an electrical charge. (True or False)
V-TECS 74	322.	Is the start capacitor wired in series with the current relay coil or in parallel with the coil?
V-TECS 75	323.	When testing a start capacitor with an ohmmeter, the meter reading is zero, what does this indicate?
V-TECS 75	324.	Are the potential relay contacts normally open or normally closed?
V-TECS 75	325.	The start capacitor is connected to which terminal of the potential relay?
V-TECS 75	326.	A start capacitor has an open circuit. (True or False)
V-TECS 76	327.	Does a PSC motor use a start capacitor or a run capacitor?
V-TECS 76	328.	Is the run capacitor identified terminal wired to the motor "R" terminal or "S" terminal?

V-TECS 76	9.	It is possible for a disconnected run capacitor to shock the mechanic. (True or False)
V-TECS 76	330.	Which terminals on the compressor motor are the run capacitor wires electrically wired to?
V-TECS 77	331.	When the CSR compressor motor reaches running speed, is the run capacitor or the start capacitor electrically removed from the circuit?
V-TECS 77	332.	When the refrigeration unit is "off," receiving no power, are the potential relay contacts open or closed?
V-TECS 77	333.	What setting should be selected on the ohmmeter for use in testing a run capacitor?
V-TECS 77	334.	Does a CSR motor use a start capacitor or a run capacitor?

IV. INSTALLING AND SERVICING COMPRESSORS, CONDENSERS, EVAPORATORS AND WATER TOWERS

V-TECS 78	335.	How do you add oil to the system if the system cannot be made to produce a vacuum?
V-TECS 78	336.	What safety steps must be taken when adding oil to a system which has service valves and the vacuum method is used?
V-TECS 78	337.	The primary purpose of oil in a refrigeration system is __________.
V-TECS 78	338.	One of the chief properties required of a good refrigerant oil is ____ _________.
V-TECS 78	339.	The meaning of "pour point" of oil is ____________.
V-TECS 79	340.	The most common indication of a shortage of refrigerant in a hermetic system is ____________.
V-TECS 79	341.	The most important thing to do if a shortage of refrigerant is discovered is ______________.
V-TECS 79	342.	The best way to heat a service cylinder is ___________.
V-TECS 79	343.	One may determine when the unit has been charged with the correct amount of refrigerant _____________.
V-TECS 79	344.	The best leak testing method is ______________.
V-TECS 80	345.	When the load on a refrigeration system decreases, how does this effect the suction pressure? a. Stays the same. b. It drops. c. It increases.
V-TECS 80	346.	The evaporator pressure regulator valve is installed in which refrigerant line? a. Liquid line. b. Hot gas line. c. Suction line.
V-TECS 80	347.	Until the suction pressure is pumped down to the setting of the valve, how does the system operate? a. As though the valve didn't exist. b. With high suction pressure. c. With low suction pressure.

V-TECS 81 348. Before attempting to start the unit, the service valves should be in which position?
a. Mid position.
b. Back seated.
c. Front seated.

V-TECS 81 349. When the valve is adjusted to the correct setting, where will the frost line be?
a. Almost covering the cooperator.
b. The first 10% of the cooperator.
c. Half way across the evaporator.

V-TECS 81 350. When service valves are in the back seated position and the unit is started, what may result?
a. Damage to the compressor.
b. Nothing.
c. Evaporator frosting.

V-TECS 82 351. Reciprocating compressors with unloaders generally start at which size below?
a. 3 HP.
b. 5 HP.
c. 10 HP.

V-TECS 82 352. What is one advantage of cylinder unloading?
a. Prevents fequent starting and stopping.
b. Keeps compressors cool.
c. Prevents oil foaming.

V-TECS 82 353. It is estimated that compressor wear occurs most during start up. What percent of wear below would be correct?
a. 10%
b. 60%
c. 90%

V-TECS 83 354. What does an anemometer measure?
a. Feet.
b. Cubic feet.
c. Temperature.

V-TECS 83 355. What is wrong if the anemometer registers backwards?
a. Nothing.
b. The air flow is too slow.
c. The anemometer is facing the wrong way.

V-TECS 83 356. How is the anemometer held in reference to the air stream?
a. At an angle.
b. Square to the air stream.
c. At a 45 degree angle.

V-TECS 84 357. Where will noncondensable gas move toward and collect?
a. Evaporator.
b. Condenser.
c. Compressor.

V-TECS 84 358. How can noncondensable gases effect head pressure?
a. Lower it.
b. Raise it.
c. They have no effect.

V-TECS 84 359. Which of the following is a noncondensable gas?

a. Freon 22.
b. Air.
c. Freon 12.

V-TECS 85 360. How are the coils cooled in an evaporative condenser?

V-TECS 85 361. The most likely cause of poor water flow through an evaporative condenser is ______________.

V-TECS 85 362. Define calibrating a float.

V-TECS 85 363. Water is added when using an evaporative condenser because ______________.

V-TECS 85 364. The static head of a cooling tower system is ______________.

V-TECS 86 365. What should be done with the oil after removing it from the compressor?

a. It is redistilled.
b. It is saved.
c. It is measured and tested for acid.
d. Nothing.

V-TECS 86 366. How may one best clean the compressor before assembly?

a. Cloth.
b. Brush.
c. With water.
d. With mineral spirits.

V-TECS 86 367. Why must one be careful when handling the old oil?

a. It may be hot.
b. It may spill.
c. It may be acidic.
d. To keep it clean.

V-TECS 86 368. What action should be taken when removing the refrigerant from the system?

a. Save the refrigerant.
b. Purge it into a sewer.
c. Purge it into a special purge line into a ventilated hood.

V-TCS 86 369. Where is the most common place to install a drier in the system?

a. In the liquid line.
b. Anywhere.
c. Between compressor and condenser.

V-TECS 87 370. Where is heat rejected from the refrigerant system?

a. The evaporator.
b. The compressor.
c. The condenser.
d. The metering device.

V-TECS 87 371. Pressure drop means which of the following statements:

a. Pressure difference needed to push the refrigerant through a component.
b. The difference in water pressure in tower basin.
c. The cooling effect caused by the evaporation of water.
d. The difference in refrigerant pressure in the crankcase.

V-TECS 87 372. What happens to the refrigerant in the condenser?

a. It boils.
b. It condenses.
c. It evaporates.
d. It absorbs heat.

V-TECS 87 373. Why should care be taken when cleaning tubes with abrasives?

a. They may be weakened.
b. They may transfer too much heat.
c. To keep system from oxidation.
d. To prevent water pressure difference in condenser.

V-TECS 87 374. What is the common fault with condensers?

a. Clogged
b. Undersize
c. Oil bound
d. Overcharged.

V-TECS 88 375. What limits the degree of vacuum that it will develop in a compressor?

V-TECS 88 376. Which service operations may best be performed with the aid of a high vacuum pump?

V-TECS 88 377. What instrument is often combined with the high vacuum pump as an assembly?

V-TECS 88 378. Measured in millimeters of mercury column, what is a good vacuum?

V-TECS 88 379. The micron equivalent of one inch of vacuum is ______________.

V-TECS 89 380. What is the main purpose of an accumulator?

a. To prevent liquid from entering the compresor
b. To prevent oil from leaving the compressor
c. To help increase refrigerant flow.

V-TECS 89 381. The accumulator is usually between which two components?

a. Compressor and condenser
b. Evaporator and condenser
c. Evaporator and compressor
d. Metering device and evaporator.

V-TECS 89 382. If liquid refrigerant enters the compressor, what would result?

a. Considerable knocking and damage to the compressor
b. Nothing
c. Compression ratio will be lowered.

V-TECS 89 383. What happens to liquid refrigerant that enters the accumlator?

a. It is pumped to the condenser.
b. It evaporates.
c. It returns to the compressor.

V-TECS 89 384. The accumulator will allow only vapor to enter which refrigerant line?

a. The hot gas line
b. The suction line
c. The liquid line.

V-TECS 90 385. The most common fault with condensers is _______________.

V-TECS 90 386. A condenser fan should operate only _______________.

V-TECS 90 387. The most frequent service operation performed on a condenser is _______________.

V-TECS 90 388. Avoid bending a condenser fan blade because the fan will _______________.

V-TECS 90 389. One knows there is air in the system when the head pressure will be ___________ normal.

V-TECS 91 390. How are the coils cooled in an evaporative condenser?

V-TECS 91 391. The most likely cause of poor water flow through an evaporative condenser is _______________.

V-TECS 91 392. Define calibrating a float?

V-TECS 91 393. Water must be added when using an evaporative condenser because _______________.

V-TECS 91 394. The static head of a cooling tower system is _______________.

V-TECS 92 395. The liquid receiver is a storage tank for which of the following:

- a. Hot gas.
- b. Liquid refrigerant.
- c. Cold gas.
- d. Compressor oil.

V-TECS 92 396. Where is the liquid receiver usually located?

- a. On the entering side of the condenser.
- b. On the leaving side of the condenser.
- c. Between the evaporator and compressor.
- d. Between the compressor and condenser.

V-TECS 92 397. Which of the following is correct?

- a. Liquid receivers above a certain size are equipped with safety release valves.
- b. Large liquid receivers do not need safety release valves.
- c. All small liquid receivers have safety release valves.

V-TECS 92 398. When a liquid receiver does not work properly, what is the best way to make it operational?

- a. It is usually cheaper to replace it.
- b. Cut it open and check for obstructions.
- c. Blow system out with air.

V-TECS 92 399. Liquid receivers in commercial systems usually have which of the following shell seams?

- a. Bolted with steel plates.
- b. Welded seams.
- c. They have no seams.

V-TECS 93 400. The oil separator located in the system is usually located between the ___________ and ___________.

V-TECS 93 401. Most oil separators are insulated because _______________.

V-TECS 93 402. If the oil separator float collapses, the valve will _______________.

V-TECS 93 403. The one advantage of an oil separator is ______________.

V-TECS 93 404. An oil separator must be mounted ______________.

V-TECS 94 405. If possible the condenser is always purged after charging to:
- a. Remove excess refrigerant.
- b. Help the unit pump down.
- c. Remove non-condensable gases.

V-TECS 94 406. Does the heat loss from the condenser equal the heat gain to the evaporator?
- a. It is more.
- b. It is less.
- c. They are equal.
- d. The heat gain is 5 times the heat loss.

V-TECS 94 407. What should be the approximate water rate of flow through a water-cooled condenser?
- a. As rapid as possible.
- b. Rate not important.
- c. 5 FPM.
- d. 200 FPM.

V-TECS 94 408. How is a shell and tube condenser constructed?
- a. Straight tubes inside receiver with a manifold on both ends.
- b. A coil within a tank.
- c. Tubes soldered together.

V-TECS 94 409. What is the rate of heat removal in a water-cooled condenser?
- a. Same as air-cooled.
- b. 10 times more rapidly than air.
- c. 15 times more rapid than air.
- d. Depends on the barometer reading.

V-TECS 95 410. When purging a refrigerant system, how much of the air is removed?
- a. All of it.
- b. Some of the air remains.
- c. None of the air is removed.

V-TECS 95 411. What instrument is often combined with the high vacuum pump as an assembly?
- a. A high vacuum gauge.
- b. A drier.
- c. A filter.
- d. An acid indicator.

V-TECS 95 412. What is a good vacuum, measured in millimeters of mercury column?
- a. 5-10.
- b. 25-35.
- c. 40-50.
- d. 70-80.

V-TECS 95	413.	Why is purging not the most desirable method of removing non-condensable gases? a. Some of the non-condensable gases remain. b. It is too expensive. c. It is too dangerous.
V-TECS 95	414.	What is the micron equivalent of one inch of vacuum? a. 500 b. 2,000 c. 2,500 d. 25,400.
V-TECS 96	415.	What is the primary purpose of oil in a refrigerant system? a. Lubricating and cooling. b. Removing heat. c. Quietness.
V-TECS 96	416.	What does the term "Pour point" mean? a. The temperature at which it will pour the fastest. b. Its lubricating ability at high speed. c. The lowest temperature at which the oil will pour.
V-TECS 96	417.	How may one determine when the unit has been charged with the correct amount of refrigerant? a. By the head pressure. b. By the low side pressure. c. By the frost line on the evaporator.
V-TECS 96	418.	What is a good vacuum, measured in a micron equivalent of one inch? a. 500 b. 2,500 c. 25,400.
V-TECS 96	419.	What is the best method for removing non-condensables from the oil crank case? a. Purge the system. b. Evacuate the system. c. Blow air through it.
V-TECS 97	420.	Many troubles in refrigerating systems can be traced to which of the following? a. Not enough oil. b. Too much oil. c. Moisture in system.
V-TECS 97	421.	When moisture is in a system, where does it usually freeze and clog? a. Condenser. b. Metering device. c. Compressor.
V-TECS 97	422.	Moisture causes which of the following problems? a. Too much cooling. b. Chemical break down between the oil and refrigerants. c. Oil foaming.

V-TECS 97	423.	Acid is created by moisture and may ruin which of the following? a. The evaporator. b. The condenser. c. The motor winding.
V-TECS 97	424.	Why do some service technicians install large driers on a temporary basis? a. To filter the oil. b. To quickly clean a system. c. To improve refrigerant flow.
V-TECS 98	425.	What does the thermostatic expansion valve control? a. The amount of refrigerant in the evaporator. b. The vacuum. c. The pressure in the evaporator.
V-TECS 98	426.	What will happen to the evaporator if the expansion valve is restricted? a. Flooded b. Starve c. Nothing.
V-TECS 98	427.	How may the needle and seat be tested for leaks? a. Cooling the power bulb and using air pressure. b. With water. c. By turning the adjustment all the way out.
V-TECS 99	428.	How can one tell when a drier without an indicator is absorbing moisture?
V-TECS 99	429.	A strainer screen is supposed to remove ____________.
V-TECS 99	430.	Moisture in an R-12 system will ____________ at the refrigerant control.
V-TECS 99	431.	The most common place to install a drier in the system is ____________.
V-TECS 99	432.	A popular drier chemical is ____________.
V-TECS 100	433.	Which of the following is correct? a. The automatic expansion valves controls super heat. b. The automatic expansion valve maintains a constant evaporator pressure. c. The automatic expansion valve throttles in response to super heat.
V-TECS 100	434.	The automatic expansion valve does which of the following: a. Permits flow in response to pressure in the evaporator. b. Strives to maintain a constant super-heat. c. Reacts to super heat in the evaporator.
V-TECS 100	435.	The automatic expansion valve is used with which of the following? a. Where the heat load frequently changes. b. When a constant evaporator pressure is required. c. When a constant evaporator pressure is not required.

V-TECS 100 436. By holding the suction pressure constant, how does this affect the compressor?
- a. The compressor load changes.
- b. The compressor load stops the same.
- c. The compressor current draws changes.

V-TECS 100 437. The automatic expansion valve is not suited for use:
- a. When compressors run constantly.
- b. When evaporator load changes frequently.
- c. When contstant evaporator pressure is needed.

V-TECS 101 438. Does the service valve attachment have threads on it?
- a. Yes
- b. No
- c. On some models.
- d. Only if it is a high pressure unit.
- e. No valve steam is used.

V-TECS 101 439. How is maximum refrigerant flow obtained through a Shrader or Dill valve core?
- a. Core all the way out.
- b. Core depressed half way.
- c. Core removed.
- d. Core all the way in.

V-TECS 101 440. What permits the service valve attachment to be swiveled to any position?
- a. Tapered threads.
- b. A swivel nut on the attachment.
- c. A compressible gasket.

V-TECS 101 441. Which compressor service valve can be changed after pump down?
- a. Both
- b. The suction
- c. The high pressure.

V-TECS 102 442. The most common fault with condensers?

V-TECS 102 443. A condenser fan operates only when the ____________ is running.

V-TECS 102 444. The most frequent service operation performed on a condenser is ________________.

V-TECS 102 445. One should avoid bending a condenser fan blade because the fan will ________________.

V-TECS 102 446. One knows there is air in the system when the head pressure will be ______________ normal.

V-TECS 102 447. The type of evaporator used with a capillary tube is ________________.

V-TECS 103 448. The service valve attachment installation should be checked for leaks in order ____________________.

V-TECS 103 449. The tubing is cut with a tube cutter instead of being cut with a hacksaw ___________________________.

V-TECS 103 450. Which tubing lines are cut?

V-TECS 103 451. The action that should be taken when removing the refrigerant from the system is ___________________.

V-TECS 104 452. Heat exchangers are frequently installed between which two lines in the R-12 systems?

a. Suction and hot gas.
b. Suction and liquid.
c. Liquid and hot gas.

V-TECS 104 453. Heat exchangers help prevent which problem below?

a. Flash gas in the liquid line.
b. Oil foaming.
c. Acid build up.

V-TECS 104 454. Increasing the heat of the suction gas helps prevent which problem below?

a. Liquid in the suction line.
b. Liquid in the hot gas line.
c. Proper expansion valve control.

V-TECS 105 455. The valve that controls the hot gas flow to the evaporator is the ________________.

V-TECS 105 456. The hot gas valve is closed (end of defrost cycle) by the ________________.

V-TECS 105 457. "Hot gas" comes from the ________________.

V-TECS 105 458. Rapping the body of the valve to open it will be a good repair. (True or False)

V-TECS 105 459. The compressor runs during the "hot gas" defrost operation. (True or False)

V-TECS 106 460. The part of a solenoid that moves is ________________.

V-TECS 106 461. The two popular types of solenoid valves are ________________ and ________________.

V-TECS 106 462. There are three different voltages that are popular for solenoids. (True or False)

V-TECS 106 463. The fluid presssure helps operate the solenoid valve by ________________ the valve.

V-TECS 106 464. Some solenoid valves must be plumbed vertically in c. .. ________________.

V-TECS 107 465. The power bulb is located on ________________ when controlling an air-cooling evaporator.

V-TECS 107 466. The thermostatic expansion valve controls ________________.

V-TECS 107 467. The needle and seat may be tested for leaks by ________________.

V-TECS 107 468. If the TEV adjustment screw is turned out the evaporator will ________________.

V-TECS 107 469. If the power element is located in a warm air stream the evaporator will ________________.

V-TECS 108 470. How should you select the correct fin comb?

a. Any comb will work.
b. By determining how many fins to the inch.
c. By condenser appearance.

V-TECS 108 471. Damaged fins could cause which problems below?

a. High head pressure.
b. Low head pressure.
c. Low suction pressure.

V-TECS 108 472. How should a fin comb be used?
a. Push the comb
b. By working comb back and forth
c. By pulling comb.

V. INSTALLING AND SERVICING REFRIGERATION SYSTEMS AND DOMESTIC REFRIGERATORS

V-TECS 109 473. Shims can be used to raise the door. (True or False)

V-TECS 109 474. The type screw that is used to hold the hinges in place is the ________________.

V-TECS 109 475. The purpose of shims used under the hinge and the hinge bolt is to ______________.

V-TECS 109 476. How is the bottom of the door adjusted if it is too far away from the frame?

V-TECS 109 477. The kind of bushings used in modern hinges are ______________.

V-TECS 110 478. During the freezing cycle, the temperature in the freezing compartment is:
a. 20F. to 18F.
b. 32F. to 26F.
c. 8F. or lower.

V-TECS 110 479. Water flows into the ice tray for how many seconds?
a. 30 seconds
b. 50 seconds
c. 7.5 seconds.

V-TECS 110 480. The cold cut in thermostat starts which process below:
a. The harvest cycle
b. The water fill cycle
c. The cold cycle.

V-TECS 111 481. A capillary tube is made of ________________.

V-TECS 111 482. The effect of internal moisture on a capillary tube system will ________________.

V-TECS 111 483. The most popular refrigerant control in domestic refrigerators is ________________.

V-TECS 111 484. A filter is put at the inlet of the capillary tube to ________________.

V-TECS 111 485. When a capillary tube system is overcharged, it will ________________.

V-TECS 112 486. In addition to the tubing connection, the ________________ must be removed from the dome.

V-TECS 112 487. After removing oil from the dome, the next step is to ________________.

V-TECS 112 488. The unit should be run before the dome is put in place in order to ________________.

V-TECS 112 489. The best way to clean the mechanism before assembly is ________________.

V-TECS 112 490. The service recommended for compressor valves is ________________.

V-TECS 113 491. If water flow is too little, which answer below could be true?

a. Too much water pressure.
b. Clogged screen.
c. Valve adjustment turned in too far.

V-TECS 113 492. Some of the trouble caused by water valves could be which of the answers below?

a. Too little water.
b. Too mu :h water.
c. Water flow does not stop when unit is idle.
d. All of the above.

V-TECS 113 493. What may cause too great a water flow?

a. Water pressure too high.
b. Leaking water valve.
c. All of the above.

V-TECS 114 494. The most common indication of a shortage of refrigerant in a hermetic system is the ________________.

V-TECS 114 495. The most important thing to do if a shortage of refrigerant is discovered is to ________________.

V-TECS 114 496. The best way to heat a service cylinder is ____________.

V-TECS 114 497. To determine when the unit has been charged with the correct amount of refrigerant you check ____________.

V-TECS 114 498. The best leak testing method is ________________.

V-TECS 115 499. The material usually used for compressor cylinders is ________________.

V-TECS 115 500. A good compressor should be capable of creating ________ inches of vacuum.

V-TECS 115 501. The type of piston crankshaft arrangement which does not use a connecting rod is a ________________.

V-TECS 115 502. The type of compressor which has the cylinders parallel to the crankshaft is the ________________.

V-TECS 115 503. Compressor valves are usually located on open type compressors in a ________________.

V-TECS 116 504. To what part of the system is the compound gauge connected?

V-TECS 116 505. To what part of the system is the high-pressure gauge connected?

V-TECS 116 506. How much warmer is the air at the condensing unit than the room air?

V-TECS 116 507. What do you use to determine the relation between pressure and temperature?

V-TECS 117 508. What service operation may best be performed with the aid of a high vacuum pump?

V-TECS 117 509. What instrument is often combined with the high vacuum pump as an assembly?

V-TECS 117 510. What is a good vacuum, measured in millimeters of inches of mercury?

V-TECS 117 511. What is the micron equivalent of one inch of vacuum?

V-TECS 118 512. You leave the core in a core type valve for pulling a vacuum. (True or False)

V-TECS 118	513.	The core type valve is a piercing valve. (True or False)
V-TECS 118	514.	You can charge a system and read head pressure with a core type valve. (True or False)
V-TECS 119	515.	Name two methods of installing a filter.
V-TECS 119	516.	What is the largest particle that can enter a compressor?
V-TECS 120	517.	What is the first thing you do to prepare a line for a line service valve?
V-TECS 120	518.	You install a service valve to ________________________ on system.
V-TECS 121	519.	Name two ways of installing a sight glass.
V-TECS 121	520.	A sight glass indicates the shortage of refrigerant. (True or False)
V-TECS 121	521.	How does the sight glass indicate a shortage of refrigerant?
V-TECS 121	522.	A sight glass indicates the presence of moisture. (True or False)
V-TECS 122	523.	What do you install in a suction line to pick up particles, acid sludge and moisture?
V-TECS 122	524.	What is the screen made of in a filter which is installed before the service stub?
V-TECS 123	525.	How is a leak indicated using a soap solution?
V-TECS 123	526.	What indicates the presence of refrigerant on the halide torch?
V-TECS 123	527.	What indicates a presence of refrigerant to the electronic leak detector?
V-TECS 123	528.	Which method is the most used?
V-TECS 123	529.	The contents in a refrigerator have a relationship with leveling. (True or False)
V-TECS 124	530.	The refrigerator comes from the factory with a need to be leveled. (True or False)
V-TECS 124	531.	You level a refrigerator that has rollers. (True or False)
V-TECS 124	532.	You level a refrigerator that does not have rollers. (True or False)
V-TECS 125	533.	It is a good practice to charge on liquid side. (True or False)
V-TECS 125	534.	The compressor should be running when charging. (True or False)
V-TECS 125	535.	You use a disposable refrigerant cylinder to charge on high side. (True or False)
V-TECS 125	536.	When is it practical to charge from high side?
V-TECS 126	537.	It is proper to use freon to purge system. (True or False)
V-TECS 126	538.	Purging removes moisture and vapor from the system. (True or False)
V-TECS 126	539.	You install a gauge manifold on the high and low side. (True or False)
V-TECS 127	540.	One capillary tube fits all systems. (True or False)
V-TECS 127	541.	What happens to head pressure if cap tube is too long, is it too high or too low?
V-TECS 127	542.	What happens to suction pressure if cap tube is too long, is it too high or too low?
V-TECS 127	543.	What do you cut a cap tube with?
V-TECS 128	544.	Where do you find size replacement information?

V-TECS 128	545.	What happens if the low side tubing on compressor is not the same size as low side tubing on the unit?
V-TECS 128	546.	What type refrigerant is used to clean out system?
V-TECS 129	547.	Where do you find size of door gasket seal?
V-TECS 129	548.	Why would a door gasket seal be replaced?
V-TECS 129	549.	What is the last thing you do prior to putting unit back into service?
V-TECS 130	550.	Name electrical device used to check drain heater?
V-TECS 130	551.	Where is the drain heater located?
V-TECS 130	552.	Why do you use mastic sealer?
V-TECS 131	553.	Why is alumilastic used between the heat and the mold?
V-TECS 131	554.	What is the mold heater watt rating?
V-TECS 131	555.	What determines the type mold heater?
V-TECS 132	556.	The mullion heater circuit opens when __________.
V-TECS 132	557.	The mullion heater rather than the butter heater uses more electricity. (True or False)
V-TECS 132	558.	Some cabinets have two mullion heaters located in the same place in order to __________.
V-TECS 132	559.	A mullion heater prevents condensation by __________.
V-TECS 132	560.	Single door refrigerators have mullion heaters. (True or False)

VI. INSTALLING AND SERVICING RESIDENTIAL AIR CONDITIONING AND HEATING SYSTEMS

V-TECS 133	561.	It is important that the squirrel cage be __________ on the shaft.
V-TECS 133	562.	You position the motor so that the belt runs __________.
V-TECS 133	563.	What is the first thing you do before inspecting fan system?
V-TECS 133	564.	What do you do to make the squirrel cage run?
V-TECS 134	565.	What meter is used to adjust a regulator?
V-TECS 134	566.	Where is the manometer connected on gas line?
V-TECS 134	567.	You move the __________ __________ on top of the regulator.
V-TECS 134	568.	Which way is the adjustment nut turned to increase pressure?
V-TECS 135	569.	What must be mixed before ignition?
V-TECS 135	570.	What air surrounds the flame?
V-TECS 135	571.	The __________ must be removed prior to adjusting shutter.
V-TECS 136	572.	The draft __________ provides a fixed rate of diluted air.
V-TECS 136	573.	Where does the fixed rate of diluted air come from?
V-TECS 137	574.	What does the excess air and diluted air carry away?
V-TECS 137	575.	At what degree must the anemometer be placed?
V-TECS 138	576.	The anemometer must be in place for a minimum of __________.

V-TECS 138	577.	At what rate is the air rate considered comfortable?
V-TECS 139	578.	______________ air flow is the first indication of a dirty filter.
V-TECS 139	579.	____________ and ____________ solution is used to clean a filter.
V-TECS 139	580.	A ____________ ____________ is an instrument used to determine if a filter is dirty.
V-TECS 139	581.	How much dirt would a filter collect if it does not become loaded.
V-TECS 140	582.	The first thing you do before removing valve is to cut off the ______________.
V-TECS 140	583.	What is the last thing you do before putting a gas valve into service?
V-TECS 140	584.	What type meter do you use to adjust the gas valve?
V-TECS 140	585.	With what do you clean the valve body?
V-TECS 141	586.	How often do you clean the main burner?
V-TECS 141	587.	____________ and ____________ must be removed from the burner when cleaning.
V-TECS 141	588.	First ____________ flame parts when cleaning the main burner.
V-TECS 141	589.	You observe the ____________ and adjust primary air when cleaning main burner.
V-TECS 141	590.	After ____________ ____________ air, you get proper flame.
V-TECS 142	591.	A ____________ or ____________ pilot office will not light.
V-TECS 142	592.	How do you clean a pilot orifice?
V-TECS 142	593.	A pilot has to be adjusted. (True or False)
V-TECS 142	594.	What does the pilot orifice control?
V-TECS 143	595.	Cubic gas measurement is measured by ____________.
V-TECS 143	596.	Heat is determined by the amount of gas released. (True or False)
V-TECS 144	597.	Dew point is the ____________ humidity.
V-TECS 144	598.	What instrument is used to determine the dew point?
V-TECS 144	599.	The ____________ on a window pane is a good example of dew point.
V-TECS 145	600.	When first starting a gas furnace, first ____________ the air from the installed gas piping.
V-TECS 145	601.	What do you use to check for leaks?
V-TECS 145	602.	The regulator and valve housing are usually made of a ____________ die casting.
V-TECS 145	603.	The drip leg is installed to keep ____________ and ____________ from entering the pressure regulators.
V-TECS 146	604.	The first thing you do is ____________ ____________ and ____________ when servicing a heat exchanger.
V-TECS 146	605.	Does one heat exchanger fit all?
V-TECS 146	606.	Name one way of checking an installed heat exchanger to make sure it is sealed.
V-TECS 146	607.	What does a wavering flame mean?
V-TECS 147	608.	The threads are made self sealing by pressing together of the sharp ____________ as they are assembled.

V-TECS 147	609.	What is used to help seal the threads?
V-TECS 147	610.	What is used to keep pipe dies from being abused?
V-TECS 147	611.	The external pipe threads are cut with a ___________.
V-TECS 147	612.	Are pipe threads NF or NC?
V-TECS 148	613.	List two ways smaller vents may be used to distribute air and maintain good heating season temperature.
V-TECS 148	614.	List three uses for an air duct.
V-TECS 148	615.	What is the purpose of a grill?
V-TECS 148	616.	Name three places air vents are placed.
V-TECS 149	617.	How much overlap do you cut?
V-TECS 149	618.	What forms on duct if insulation is not tight?
V-TECS 149	619.	When a comfort cooling air duct has condensation on its outer surface, does the air become warmer or cooler?
V-TECS 149	620.	How do you seal the insulation?
V-TECS 150	621.	The pilot flame only touches the last ___________ of thermal couple.
V-TECS 150	622.	How long do you wait between lighting the pilot if it fails the first time?
V TECS 150	623.	A pilot flame that stays on all the time is called a ___________.
V-TECS 150	624.	A pilot has a safety device. (True or False)
V-TECS 151	625.	What method do you use for installing a four way valve?
V-TECS 151	626.	What do you use to absorb heat from the valve?
V-TECS 151	627.	Which way do you direct heat when brazing a four way valve?
V-TECS 151	628.	What happens if the valve is over heated during installation?
V-TECS 152	629.	The first thing done to change a gas valve is to ___________.
V-TECS 152	630.	How many functions does the gas valve perform?
V-TECS 152	631.	What voltage is usually on a gas valve?
V-TECS 152	632.	How many millivolts does it take to open a pilot solenoid?
V-TECS 153	633.	Do you replace the whole valve?
V-TECS 153	634.	You should ___________ both coils when replacing pilot solenoid valve coil.
V-TECS 153	635.	How do you check voltage on pilot solenoid?
V-TECS 154	636.	The power generating source of a millivolt system is the ___________.
V-TECS 154	637.	What increases as heat is applied?
V-TECS 154	638.	How do you check the closed circuit voltage?
V-TECS 154	639.	What is the main gas valves safety device?

ANSWERS FOR EVALUATION QUESTIONS

I. BRAZING, CUTTING, FITTING, SOLDERING, AND WELDING PIPING AND TUBING

1. b
2. Hard
3. 3
4. c
5. 3/8 inch
6. Spring and lever type benders
7. So not to crimp the tubing
8. Mechanical
9. By applying heat
10. When copper tubing has become hard and brittle.
11. For safety
12. Clockwise
13. So as not to bend or collapse the tubing.
14. To insure a proper fit and a good connection.
15. To keep the tubing dry and clean
16. Right-handed threads — oxygen
    Left-handed threads — acetylene
17. From 7 — 10 lbs. of pressure
18. The thickness of the metal
19. To initiate rapid oxidation.
20. Soapy water solution
21. Gauges
22. Frost
23. By cutting the lines.
24. Pressurize the system.
25. b
26. b
27. e
28. c
29. b
30. b
31. c
32. d
33. d
34. b
35. b
36. a
37. a
38. d
39. a
40. To insure a proper bond
41. 7 — 10 lbs.
42. Thickness of the metal
43. A circular motion
44. Chip off excess metal and clean with wire brush:
45. a. Right-handed threads
    b. Left-handed threads
46. With soapy water solution
47. To initiate rapid oxidation.

48. Cleaning
49. To insure a proper bond.

II. INSTALLING AND SERVICING CONTROLS

50. b
51. e
52. a
53. d
54. a
55. Cut-in, cut-out
56. To prevent ice build up on the evaporator.
57. 40 to 60 minutes
58. d
59. e
60. b
61. b
62. a
63. a
64. b
65. b
66. a
67. a
68. b
69. e
70. b
71. c
72. e
73. Setting, room
74. The greatest
75. 50%
76. Solid state
77. A bimetal strip
78. True
79. Air temperatures
80. d
81. e
82. b
83. b
84. a
85. d
86. e
87. b
88. b
89. a
90. c
91. c
92. e
93. a
94. c
95. Heating and cooling

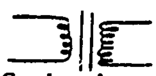
96. Using a relay
97. b
98. e
99. a
100. b
101. e
102. d
103. d
104. a
105. d
106. d
107. c
108. d
109. d
110. b
111. e
112. a
113. d
114. a

III. INSTALLING AND SERVICING ELECTRICAL CIRCUITS, COMPONENTS AND MOTORS

115. 1/2
116. Parallel
117. Inside length
118. e
119. c
120. Air temperatures
121. High temperature
122. 40°F/50°F
123. Line
124. c
125. a
126. e
127. e
128. d
129. a
130. c
131. b
132. Rotor, starter
133. Amperage load
134. National electric codes
135. 3
136. 2
137. Available power
138. Gage or size
139. A tubing cutter
140. For electrical safety
141. c
142. d

143. b
144. d
145. A circuit failure.
146. 120V
147. No
148. Replace it.
149. Five feet
150. Ten feet
151. Mast
152. Three feet
153. Shorted
154. Mast
155. To prevent water leaks.
156. The head, the wire divider, and the base.
157. To determine the motor speed.
158. To the motor shaft.
159. Manufacturer's rating.
160. Resistance
161. Black bus, red bus
162. One
163. 120 volts
164. Two or both
165. An ohmmeter
166. Meter base
167. Eye level or five feet
168. To make sure the meter does not drag.
169. Water proof
170. e
171. a
172. a
173. V-belts
174. Shorten
175. 1/2 inch
176. Between the pulley and the flywheel.
177. 1/2 inch, 5/8 inch, 15/16 inch
178. Belt drive and direct drive
179. Red
180. Black
181. Two
182. Armature
183. Magnetic field
184. Silver and aluminum
185. Zero
186. Infinity
187. "L"
188. Run
189. Large
190. The coil

191. 50°F. or 10°C.
192. The evaporator
193. Infinity
194. Series
195. Series
196. Zero
197. 30°F. or -1.1°C.
198. Automatic reset
199. 115
200. Series
201. Series
202. Compressor motor or freezer blower motor.
203. False
204. Belts up to 17/32 inches in width.
205. As much as 30 percent.
206. A bushing
207. National course threads.
208. Ohmmeter
209. Voltmeter
210. True
211. Lint and dirt
212. Every six months.
213. Direct drive and belt drive.
214. True
215. Axial flow
216. Two
217. High
218. Low
219. False
220. Cooling
221. Amperage
222. Dual element time delay.
223. Renewable
224. Voltmeter
225. Zero
226. C terminal
227. Excessive heat
228. Infinite
229. True
230. Stretch
231. Closed
232. Run winding contacts.
233. Soon as the motor reaches its operating speed.
234. Cooling
235. Normally open
236. Normally open
237. False
238. Stop
239. Normally closed
240. Excessive heat
241. True
242. True

243. Energized
244. Voltage
245. False
246. Zero
247. False
248. True
249. Three
250. Bimetal relay and thermal relay or molten alloy relay.
251. True
252. Three phase equipment.
253. Increase in voltage.
254. Closed
255. There is no arcing.
256. Terminals 2-5
257. False
258. 24 volts, 115 volts or 230 volts.
259. Time delay relay.
260. True
261. Voltmeter
262. 
263. Squirrel cage induction type.
264. False
265. Stator
266. True
267. Ohmmeter
268. True
269. One or two seconds.
270. Series
271. Three
272. Closed
273. True
274. Ohmmeter
275. Opened
276. Both hot gas and electrical defrost.
277. True
278. False
279. Off
280. Bimetal overload with a heater.
281. The bimetal warps.
282. False
283. The number of windings -- compared to the primary winding.
284. 24 volts
285. False
286. "L-M" Terminals
287. "L-M" Contact
288. Open
289. Closed
290. Moving parts
291. Motor starter
292. Silver cadmium alloy
293. Three

294. "S"
295. Normally closed
296. Voltage relay
297. Terminal 5
298. Terminals 2 and 5
299. Normally open
300. Terminal "R"
301. Terminal "S"
302. Terminal "L" and "M"
303. False
304. True
305. True
306. True
307. Clockwise
308. Solenoid
309. Green
310. 230 volts, 1 60 cycle power
311. 24 volts
312. "YI" Terminal
313. "G" Terminal
314. "On" and "auto"
315. Start winding and mainwinding.
316. Main or run winding
317. Two hot wires
318. True
319. Series
320. "S" Terminal
321. True
322. Parallel
323. Shorted capacitor
324. Normally closed
325. Terminal one
326. True
327. Run capacitor
328. "R" Terminal
329. True
330. "R" and "S" Terminals
331. Start capacitor
332. Closed
333. R x 10,000 ohms
334. Both are used. The start capacitor and the run capacitor.
335. Build up a pressure in an oil charged cylinder.
336. Always keep the end of the hose submerged in oil.
337. Cooling and lubricating.
338. It should flow at low temperatures.
339. The lowest temperature at which the oil will flow.
340. Lowering of frost line on evaporator.
341. Find the leak
342. Use hot water
343. By the frost line on the evaporator.
344. Electronic sniffer.

345. b
346. c
347. a
348. b
349. a
350. a
351. c
352. a
353. c
354. a
355. c
356. b
357. b
358. b
359. b
360. Sprayed with water
361. Screen clogged
362. Adjusting to provide with proper water head.
363. Some is evaporated.
364. The vertical height of the piping.
365. c
366. d
367. c
368. c
369. a
370. c
371. a
372. b
373. a
374. a
375. The clearance volume of the compressor.
376. Dehydration of a system.
377. A high vacuum gauge .
378. 5-10
379. 25,400
380. a
381. c
382. a
383. b
384. b
385. Leaks
386. When the compressor is running.
387. Cleaning it,
388. Fan will vibrate.
389. The head pressure will be above normal.
390. Sprayed with water.
391. Screen clogged
392. Adjusting to provide the proper water level.
393. Some is evaporated.

394. The vertical height of the piping.
395. b
396. b
397. a
398. a
399. b
400. Between the compressor and the condenser.
401. To keep the refrigerant from condensing in the separator.
402. Stay closed.
403. Keeps the oil in the compressor.
404. Level
405. d
406. c
407. d
408. a
409. c
410. b
411. a
412. b
413. a
414. d
415. a
416. c
417. c
418. c
419. b
420. c
421. b
422. b
423. c
424. b
425. a
426. b
427. a
428. The drier becomes warm while the unit is operating.
429. Solid impurities
430. Freezes at the refrigerant control.
431. In the liquid line.
432. Silica gel
433. b
434. a
435. b
436. b
437. a
438. a
439. c
440. b
441. b
442. Leaks
443. Only when the compressor is running.
444. Cleaning it.
445. Fan will vibrate.

446. The head pressure will be above normal.
447. Dry
448. To save needed refrigerant.
449. To keep copper chips out of the refrigerant lines.
450. Capillary tubing and suction tubing.
451. Purge it into a special purge line into a ventilation hood.
452. b
453. a
454. a
455. Solenoid valve
456. Timer or thermostat
457. Compressor
458. False
459. True
460. Core
461. Two-way and three-way
462. False
463. Helping close the valve.
464. To permit core to move freely.
465. On the suction line near the evaporator.
466. The quantity of refrigerant in the evaporator.
467. Cooling the power bulb and using air pressure.
468. Flood
469. Flood
470. b
471. a
472. c
473. True
474. Flat head machine screws
475. To adjust the distance between the door and the frame.
476. Adjust the door liner screws.
477. Nylon
478. c
479. c
480. a
481. Copper
482. Make it defrost.
483. Capillary tube
484. Remove solid foreign particles.
485. Sweat and frost back.
486. The electrical connections.
487. Measure and test for acid.
488. See if the assembly operates correctly.
489. Wash with mineral spirits.
490. Replacing
491. b
492. d
493. c
494. Lowering of frost line on the evaporator.
495. Find the leak.
496. Use hot water.

497. The frost line on the evaporator.
498. Electronic sniffer
499. Cast iron
500. 28
501. Scotch yoke
502. Swash plate
503. Valve plate
504. Suction on low side
505. Discharge on high side
506. 30F to 35F
507. Pressure temperature chart
508. Dehydrate system
509. A high vacuum gauge
510. 5-10
511. 25,400
512. False
513. False
514. True
515. Brazing and flaring
516. 5 microns
517. Sand tubing
518. Read pressure
519. Brazing and flaring
520. True
521. By bubbles
522. True
523. Filter
524. Monel metal
525. Bubbles
526. Light green color
527. Squealing noise
528. Soap solution
529. True
530. True
531. True
532. True
533. False
534. False
535. False
536. After vacuuming
537. True
538. True
539. True
540. False
541. High
542. Low
543. File
544. Data plate
545. Wrong size compressor
546. R-11
547. Manufacturer's design specification

548. Gasket worn.
549. Adjust door.
550. Ohmmeter
551. Drain trough
552. To form positive air seal.
553. Good thermo contact
554. 165 watts
555. Manufacturer's design
556. Ambient air is over 80°F.
557. False
558. Allow adjustment for different climates.
559. Heating the air above the dew point temperature.
560. True
561. Centered
562. Straight
563. Power off
564. Center it
565. Manometer
566. Demonstrate of pressure tap.
567. Seal tap.
568. Clockwise
569. Air fuel
570. Secondary
571. Panel
572. Diverter
573. Ceiling vent
574. Water vapor
575. 90°
576. One minute
577. 15-20 FPM
578. Poor
579. Soap and water
580. Water manometer
581. 90°
582. Gas
583. Leak test
584. Manometer
585. Cleaning solution
586. Once a year
587. Dust rust
588. Clean
589. Flame
590. Adjusting primary
591. Dirty or clogged
592. Blow it out.
593. True
594. Pilot light
595. BTU
596. True
597. 100%
598. Aspiring psychomotor
599. Moisture
600. Purge

601. Soap solution
602. Zinc
603. Dirt, moisture
604. Disconnect gas and electricity.
605. You have to inspect, because one heat exchange does not fit all.
606. Wavering flame
607. Heat exchange is not sealed.
608. V-threads
609. Pipe compound
610. Cutting compound
611. Pipe die
612. Both
613. a. Increase rate of flow.
     b. Increase temperature.
614. a. Carry warm air.
     b. Carry cool air.
     c. Return air.
615. To spread air.
616. Ceiling, wall, floor
617. 3 inches
618. Condensation
619. Warmer
620. Tape or glue
621. 3/8 to 1/2 inch
622. 5 minutes
623. Standing pilot
624. True
625. Brazing
626. Soaked wet ray
627. Away from the valve
628. Prevents it from operating properly.
629. Cut off the gas.
630. 3
631. 24V
632. 7 million
633. Not necessary
634. Compare
635. Millivolt meter
636. Thermocouple
637. Voltage
638. Millivoltmeter
639. Thermocouple

"END OF DOCUMENT"