Air-Conditioning, Heating, and Refrigeration Institute

Third Edition

Curriculum Guide

For HVACR Instructors Training Entry-Level Service, Installation and Maintenance Technicians in Heating, Ventilation, Air-Conditioning And Refrigeration

By

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PREFACEPREFACE

The Air-Conditioning and Refrigeration Institute (ARI) developed this Curriculum Guide in collaboration with HVACR instructors, manufacturers' training experts, and other technical professionals and industry representatives. It was created for use in all school programs that educate and train students to become competent, entry-level heating, ventilation, air-conditioning, and refrigeration (HVACR) technicians.

This Guide has been developed for use by schools nationwide that offer programs in HVACR technology. These institutions include vocational/technical schools, trade schools and junior or community colleges. They are privately funded and publicly funded; they offer certificates, diplomas, or degrees. They are adult-ed, evening, apprenticeship, secondary or post-secondary programs. Some run six months; others run two years. They vary from state-to-state, locality to locality.

Because of the great diversity among programs, this Guide was designed, first and foremost, to be a flexible document that allows for differences in instructor methodology, lab resources, and length or complexity of program, among other variables. While allowing for this diversity, this Guide does suggest that all content areas and competencies cited be integrated into the school's HVACR curricula to the degree necessary so that the students become competent in those areas for entry-level work in residential and light commercial air-conditioning and heating and commercial refrigeration.

OVERVIEW OF THE ARI CURRICULUM GUIDE IN HVACROVERVIEW OF THE ARI CURRICULUM GUIDE IN HVACR

The Curriculum Guide provides instructors with the necessary ingredients for a complete HVACR program. Its purpose is to establish a common language of proficiency standards so that both education and industry have a universal set of standards for HVACR programs to train entry-level technicians for residential or light commercial heating and air-conditioning equipment or commercial refrigeration systems.

The competencies and topic areas outlined in this Guide parallel those competencies targeted by the ARI/GAMA Competency Exams. Instructors can use this Guide as another checklist against which preparation for the ARI/GAMA Competency Exams can be measured.

The Guide is not a "how-to" for starting an HVACR course of study. It does not offer a prescriptive set of lesson plans nor a step-by-step formula for teaching an HVACR course. It does not give contact hours, credit hours, nor will it declare one length of program better than another.

It is designed to facilitate the classroom work of HVACR instructors without replacing individual program needs such as level of program, community needs and training program mission. It is designed to assist in curricular decisions but not to replace the decision-maker. Excellence in classrooms will always depend on the instructor. It is the instructor who selects appropriate instructional objectives in light of his or her students' needs. It is the instructor who organizes instructional materials for effective and efficient learning. And it is the instructor who integrates the latest teaching technologies into his or her classroom. It is in support of such responsible educational professionals and of their students that this Guide has been developed.

To The Instructor ....

HOW TO USE THE ARI CURRICULUM GUIDEHOW TO USE THE ARI CURRICULUM GUIDE

This Guide is for you to use in whatever way fits your teaching methods. Use pieces of it at different times or follow the order presented here. The first step is to familiarize yourself with each part of the Guide.

ARI Suggested Lists of Tools and Equipment

ARI's Curriculum Guide Committee suggest that these lists be used as a guidepost to determine needed tools and equipment. We recognize that your school may not have every piece of equipment or every tool on these lists. However, ideally, this is what an exemplary HVACR program would have.

The Curriculum Guide Outline

Twenty-four areas of training are listed. All 24 areas of training should be included in your curricula to whatever degree is necessary for your students to demonstrate understanding of each topic. The organization of the Outline is our way of presenting these topics. How they appear in your course is up to you and your school. ARI recommends that all these areas of training be covered.

Competency Objective Sheets

Each subtopic area has its own list of concrete knowledge and task statements that the student should master after having gone through related classroom training and practice in a laboratory setting. Sheets can be switched or intermingled depending upon the organization of your curricula.

Selected References

References have been added to the bibliography. It is included here for you to use to supplement your textbooks and other classroom materials.

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ENTRY-LEVEL JOB DESCRIPTIONSENTRY-LEVEL JOB DESCRIPTIONS

ENTRY-LEVEL
RESIDENTIAL AIR-CONDITIONING AND HEATING TECHNICIAN

The entry-level technician performs start-up and preventive maintenance, service and repair, and/or installation of residential heating and air-conditioning equipment. Residential equipment has been considered to be five ton systems or smaller.

The technician will perform unsupervised or with minor, occasional supervision those tasks involved in installation and start-up and preventive maintenance. Although the degree of supervision varies with the hiring contractor and the individual's abilities, the entry-level technician will be supervised to some extent when servicing or repairing residential equipment.

ENTRY-LEVEL
LIGHT COMMERCIAL AIR-CONDITIONING AND HEATING TECHNICIAN

The entry-level technician performs start-up preventive maintenance, service and repair, and/or installation of light commercial heating and air-conditioning systems. Light commercial equipment is considered here to be six to twenty ton systems.

The technician is relatively unsupervised when performing start-up and preventive maintenance and installing equipment. However, he/she is somewhat supervised when servicing and repairing light commercial equipment.

ENTRY-LEVEL
COMMERCIAL REFRIGERATION TECHNICIAN

The entry-level commercial refrigeration technician is one who performs installation and start-up, preventive maintenance, and/or service and repair. The technician understands system design principles. He/she can do installation, start-up and preventive maintenance with relatively minor supervision, if any. The entry-level technician is supervised when servicing equipment.

Commercial refrigeration equipment includes display cases, walk-in boxes, reach-in boxes, coolers, ice-cream machines, ice machines, air conditioners, etc.

ARI SUGGESTED LIST OF TOOLSARI SUGGESTED LIST OF TOOLS

Acetylene B-tank
Acetylene Regulator-Hose & Tips (Turbo)
Bar Holder
Bench/Wood Top with Vise
C Clamps
Conduit Pipe Bender - Thin Wall
Divider Set
Drills 3/8", 1/2 Elect.
Folding Ruler - 6ft.
Gear Puller Set
110V Bench Grinder
Hand Formers
220V Kit Quick Start
110V Kit Quick Start
Leak Detector
20 Gauge Capacity Lockformer
Wooden Mallet
3ft. Width 16 Gauge Pan Brake
Pop Rivet Gun
Reamers
Service Valve Kit
Shear
Tin Snips - Right/Left/Straight
Pipe /12" Compound
Soldering Gun
Squares - Combination
Tap and Die Set
Tape Measure
Pipe Threading Dies
Pipe Vise
Three Foot Metal Rule
Universal Appliance Truck
Vacuum Cleaner
Portable Spot Welder
Oxy-Acetylene Welding Unit
Wheel Puller set
Pipe Wrench Set
Torque Wrench
Chisels Set
Combination Wrench Set
Diagonal Cutters

ARI SUGGESTED LIST OF TOOLS ARI SUGGESTED LIST OF TOOLS (cont'd)

File Set
Flare/Swage Set
Nitrogen Tank & Recyling Regulator and Relief Valve
First Aid Kit
Dial Indicator
Schrader Valve Core Removal Tool
Low Loss Fittings
Industrial Flashlight
Fuse Pullers
Hack Saw
Ballpeen Hammer
Hand Tool Set - Refrigeration
Nut Driver Set
Pinch Off Tool
Pliers (Slip Joint/Needle Nose/Linesman Locking)
Rivet Set
Scratch Awl
Screwdriver Set (Straight & Philips)
Sockets & Ratchet Set - 1/2" & 3/8 Drive, 1/4" Drive
Torch Tip - Propane
Tubing Bender Set
Tubing Cutter Kit
Tubing/Wrench Set
Wire Strippers
Allen Wrenches
Wire End Crimpers
Safety Glasses
Gloves
Fire Extinguisher

ARI SUGGESTED EQUIPMENT LISTARI SUGGESTED EQUIPMENT LIST

A/C EQUIPMENT:

A/C Split
A/C Window
Commercial Package Heating*
Elec. Condensing Unit with Economizer
Condensate Pump
Electronic Air Cleaner*
Dehumidifier*
Humidifier
Reciprocating Chiller
Air-to-Air Heat Pump*
Water-to-Air Heat Pump*
Cooling Tower-Water Pump
Evaporative Cooler
Absorption Unit

HEATING EQUIPMENT:

Boiler Hydronic System Water/Steam
Forced Air Gas Furnace
Forced Air Oil Furnace
Forced Air Electric Furnace
Forced Air Condensing Gas Furnace
Forced Air Condensing Oil Furnace
Unit Heater

COMMERICAL REFRIGERATION:

Walk-in-Cooler
Reach-in-Cooler
Ice Maker
Drinking Fountain
Condensing Unit - Med/Low Temperature
Domestic Refrigerator
Evaporating Coil Med-Temperature & Freezer
Dual Compressor Rack
Evaporative Condensers
Supermarket Display Cases
Assoc. Electrical & Refrigeration Components
Air-Cooled & Water-Cooled Condensing Unit

* Dual purpose - for both heating and cooling instruction

ARI SUGGESTED EQUIPMENT LISTARI SUGGESTED EQUIPMENT LIST (cont'd)

ELECTRICAL TEST EQUIPMENT:

Clamp-on Ammeter
Hermetic Analyzer
Capacitor Analyzer
VOM (Multimeter)
Megohmmeter
Millivolt Meter
Microamp Meter
Wattmeter
Recording Ammeter
Recording Voltmeter

REFRIGERATION SERVICING & TESTING EQUIPMENT:

Charging Cylinder
Electronic Thermometer
Electronic Charging Scale
Micron Vacuum Gauge
Electronic Leak Detector
Manifold Gauge Set
Bimetal and Glass Stem Thermometers
Temperature Recorder
Acid Test Kit
Psychrometer (dry and wet bulb)
Vacuum Pump
Refrigerant Identifier
Recovery/Recycling Equipment
Storage Tank
Refractometer
Hand Oil Pump

HEATING-SERVICING & TESTING EQUIPMENT:

Combustion Test Kit
U-tube Manometer*
Carbon Monoxide Tester
Vacuum Gauge
Oil Pressure Gauge

* Dual purpose - for both heating and cooling instruction

ARI SUGGESTED EQUIPMENT LISTARI SUGGESTED EQUIPMENT LIST (cont'd)

AIR FLOW-MEASURING & TESTING EQUIPMENT:

Magnehelic*
Velometer*
Pitot Tube
Flow Hood
Inclined Manometer
Tachometer
Hot Wire Anemometer
Vane-Type Anemometer
Indoor Air Quality Instruments

* Dual purpose - for both heating and cooling instruction

I. INTRODUCTIONI. INTRODUCTION

SUBTOPIC TITLE: ***I.A. Introduction to Refrigeration I.A. Introduction to Refrigeration***

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain the history of air-conditioning and refrigeration.
2. Define air-conditioning and refrigeration.
3. Explain the differences between air-conditioning and refrigeration.
4. Determine career opportunities in the HVACR industry.
5. Describe the role of Trade Associations.

I. INTRODUCTION

SUBTOPIC TITLE: ***I.B. Introduction to Air-Conditioning I.B. Introduction to Air-Conditioning***

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Understand the historical development of air-conditioning.

2. Define "air-conditioning" and relate to human comfort conditions.

3. Discuss the differences between air-conditioning and heating.

4. Discuss the various systems of air-conditioning:

    a. mechanical compression cycle
    b. evaporative cooling
    c. desiccant dehumidification
    d. absorption cycle

5. Explain why ventilation is often inadequate.

I. INTRODUCTION

SUBTOPIC TITLE: *I.C. Introduction to HeatingI.C. Introduction to Heating*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Understand the historical development of heating.

2. Define "heating."

3. Discuss the differences between air-conditioning and heating.

4. Explain the various heating systems:

    a. gas
    b. oil
    c. heat pump
    d. electric resistance
    e. hydronics
    f. solar

II. PRINCIPLES OF THERMODYNAMICS AND HEAT TRANSFER

II. PRINCIPLES OF THERMODYNAMICS AND HEAT TRANSFER

SUBTOPIC TITLE: *II.A. Matter and Heat BehaviorII.A. Matter and Heat Behavior*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Define matter and heat.
2. Explain the direction and rate of heat flow.
3. Describe the three methods of heat transfer.
4. Identify the reference points of temperature:
   a. boiling point
   b. freezing point
   c. critical temperature
   d. absolute zero
5. Explain the difference between heat and temperature.
6. Explain the difference between latent and sensible heat.
7. Explain the change of state of matter.
8. Explain heat/cool storage.
9. Define specific heat.
10. Define sensible heat.
11. Define latent heat of fusion.

II. PRINCIPLES OF THERMODYNAMICS AND HEAT TRANSFER

SUBTOPIC TITLE: *II.A. Matter and Heat Behavior II.A. Matter and Heat Behavior (cont'd)*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

12. Define latent heat of vaporization.
13. Define enthalpy.
14. Define saturation temperature (dew point temperature).
15. Define water vapor pressure.
16. Explain the direction and rate of moisture transfer.

TASK:

1. Calculate total heat (in BTU's) a pound of any substance contains.

II. PRINCIPLES OF THERMODYNAMICS AND HEAT TRANSFER

SUBTOPIC TITLE: *II.B. Fluids and PressuresII.B. Fluids and Pressures*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain the relationship of pressures and fluids at saturation temperatures.
2. Identify the relationship between temperature and pressure using the P/T Chart.
3. Define pressure.
4. Explain atmospheric pressure.
5. Explain compound gauges.
6. Explain bourdon tubes.
7. Explain barometric pressure.
8. Explain absolute pressure.
9. Explain gauge pressure.
10. Explain inches of mercury absolute.
11. Explain micron.

TASKS:

1. Calculate absolute and gauge pressures.
2. Measure absolute and gauge pressures.
3. Relate temperature and pressure using the P/T Chart.
4. Measure a vacuum using a micron gauge.

II. PRINCIPLES OF THERMODYNAMICS AND HEAT TRANSFER

SUBTOPIC TITLE: *II.C. Refrigeration Cycle/Diagrams**II.C. Refrigeration Cycle/Diagrams*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Identify the four major components of the vapor compression refrigeration system.
2. Describe the state and conditions of the refrigerant during a cycle.
3. Explain the effects of:
   a. superheating the suction gases
   b. increasing the condensing pressure
   c. subcooling the liquid
4. Explain the importance of superheat and subcooling.
5. Define refrigeration.
6. Explain the functions of the four major components of a refrigeration system:
   a. compressor
   b. condenser
   c. metering device
   d. evaporator
7. List the components which separate the high side from the low side of the system.
8. Describe the Temperature/Enthalpy (T-H) Diagram.

II. PRINCIPLES OF THERMODYNAMICS AND HEAT TRANSFER

SUBTOPIC TITLE: *II.C. Refrigeration Cycle/Diagrams/I.C. Refrigeration Cycle/Diagrams (cont'd)*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

1. Draw a refrigeration cycle on a pressure-enthalpy chart:

    a. diagram a simple refrigeration cycle
    b. state the unit of measurement for heat (BTU/h)
    c. define enthalpy and entropy
    d. show arrows for direction of cycle flow
    e. place accumulator, receiver and oil separator correctly on refrigeration cycle drawing

2. Draw a simple refrigerant cycle diagram and label each of the basic components as well as the refrigerant lines. Place arrows on the diagram to show the direction of refrigerant flow.

3. Calculate problems using Temperature/Enthalpy (T-H) Diagram.

4. Calculate problems using Pressure/Enthalpy (P-H) Diagram.

5. Label the line which represents each of the four basic components on a Pressure/Enthalpy (P-H) Diagram.

II. PRINCIPLES OF THERMODYNAMICS AND HEAT TRANSFER

SUBTOPIC TITLE: *II.D. Measurement Systems* *II.D. Measurement Systems*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain units of heat, power, velocity, mass and length.

2. Identify U.S. and S.I. units.

TASKS:

1. Convert from U.S. to metric units for the following:

    a. Length
    b. Area
    c. Volume
    d. Mass
    e. Force
    f. Velocity
    g. Density
    h. Pressure
    i. Temperature
    j. Energy
    k. Power
    l. Specific Heat
    m. Volume Flow Rate
    n. Capacity

2. Convert pounds to ounces.

3. Convert cooling capacity from tons of refrigeration to kW and Btu/h to kW.

III. SAFETIII. SAFETY

SUBTOPIC TITLE: *III.A. Personal Safety and Work PracticesIII.A. Personal Safety and Work Practices*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain clothing and safety equipment.
2. Review OSHA standards.
3. Explain the effects of substance abuse on safety.
4. Review safe driving practices.
5. Identify, handle, use, and dispose of hardware material.

TASKS:

1. Wear appropriate clothing.
2. Use safety equipment (e.g., footwear, hearing protection, hardhat, goggles, gloves).
3. Demonstrate good housekeeping practices in the lab.
4. Demonstrate proper ladder safety:
    a. wooden
    b. aluminum
    c. fiberglass
    d. scaffolding
5. Demonstrate proper lifting procedures.
6. Pass safe driving course.
7. Use appropriate fire extinguishers.
8. Conduct routine safety inspections.

III. SAFETY

SUBTOPIC TITLE: *III.B. Handling of Pressurized FluidsIII.B. Handling of Pressurized Fluids*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. List safety requirements.
2. Explain application of pressure relief devices.
3. Explain proper storage and handling of refrigerants.
4. Explain effect of temperature and hydraulic expansion.
5. Explain proper storage and handling of oxygen, nitrogen and acetylene bottles.
6. Explain the effects of mixing oxygen and oil.
7. Follow procedures specified on the Material Safety Data Sheet (MSDS).
8. Store and dispose of hazardous material according to EPA specifications.
9. Explain ASHRAE Refrigerant Safety Classification of Refrigerants for Toxicity and Flammability.

TASKS:

1. Properly fill and label a refrigerant cylinder.
2. Determine if a refrigerant cylinder needs retesting.

III. SAFETY

SUBTOPIC TITLE: *III.C. Handling Hazardous SubstancesIII.C. Handling Hazardous Substances*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain use of Material Safety Data Sheets (MSDS).
2. Define difference between hazardous materials, substances and wastes.
3. Explain use of hazardous material manifest.

TASKS:

1. Locate MSDS and identify particular effect.
2. Demonstrate use of proper clothing and equipment.
3. Demonstrate basic first aid procedures.

III. SAFETY

SUBTOPIC TITLE: *III. D. Electrical Safety* *III. D. Electrical Safety*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain importance of ground fault circuit interrupters.
2. Explain the use of power tools and accessories.
3. Discuss work habits.
4. Explain environmental safety practices.
5. Explain proper procedures when working with hands on live equipment.

TASKS:

1. "Fault" a ground fault interrupter.
2. Demonstrate the use of lockout/tagout equipment.

IV. TOOLS AND EQUIPMENTIV. TOOLS AND EQUIPMENT

SUBTOPIC TITLE: *IV.A. Hand Tools and AccessoriesIV.A. Hand Tools and Accessories*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Identify basic tools:

    a. adjustable wrenches
    b. Allen (hex) wrenches
    c. crimpers
    d. diagonal cutting pliers (dikes)
    e. flare nut wrenches
    f. general-use pliers
    g. hack saw
    h. hand saw
    i. lineman pliers (sidecutters)
    j. nutdrivers
    k. open & box end wrenches
    l. pipe wrenches
    m. pulley & gear pullers
    n. punches
    o. scratch awl
    p. sheet metal snips
    q. socket wrenches
    r. torque wrenches
    s. various hammers
    t. various screwdrivers
    u. wire strippers
    v. tape measure
    w. solder gun
    x. Schrader valve

IV. TOOLS AND EQUIPMENT

SUBTOPIC TITLE: *IV.A. Hand Tools and Accessories IV.A. Hand Tools and Accessories (cont'd)*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

2. Identify power tools:

    a. general-purpose drills
    b. hammer drill
    c. power screwdriver
    d. reciprocating saws
    e. screwgun

3. Identify fasteners:

    a. bolts
    b. conduit, pipe & cable clamps
    c. masonry anchors
    d. nails
    e. screws
    f. various electrical connectors
    g. pop rivets

4. Identify pipe and tubing tools:

    a. benders
    b. flaring tools
    c. pipe cutters, reamers and threaders
    d. pipe vises
    e. swaging tools
    f. tubing cutters and reamers

5. Describe lubrication methods using different types of circuits:

    a. grease guns
    b. oilers
    c. sprays

IV. TOOLS AND EQUIPMENT

SUBTOPIC TITLE: *IV.A. Hand Tools and Accessories IV.A. Hand Tools and Accessories (cont'd)*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

1. Show the proper use of a pipe cutter.
2. Show the proper use of a threader.
3. Demonstrate how to make a flared tubing joint.

IV. TOOLS AND EQUIPMENTIV. TOOLS AND EQUIPMENT

SUBTOPIC TITLE: *IV.B. Electrical Testing Devices/MetersIV.B. Electrical Testing Devices/Meters*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Define amps, volts, ohms and watts.
2. Demonstrate understanding of the basic types of electrical measurement.

TASKS:

1. Measure voltage with digital and analog voltmeters.
2. Measure AC current with a clamp-on ammeter.
3. Measure resistance with an ohmmeter.
4. Check winding insulation with megohmmeter.
5. Check voltage with a voltage tester.
6. Use a continuity tester to determine whether an open circuit or dead short exists.
7. Use a capacitance meter to measure capacitance of run and start capacitors.
8. Calculate capacitance.
9. Wire and measure resistance of different types of circuits:
    a. series
    b. parallel
    c. unequal
    d. series - parallel

IV. TOOLS AND EQUIPMENT

SUBTOPIC TITLE: *IV.C. Refrigeration: Servicing and Testing EquipmentIV.C. Refrigeration Servicing and Testing Equipment*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

1. Measure pressures with the refrigeration gauge manifold.
2. Evacuate systems with a two-stage vacuum pump.
3. Measure vacuums with a thermistor vacuum gauge.
4. Measure temperatures with electronic thermometers.
5. Measure temperatures with bimetal, thermocouple or glass stem thermometer.
6. Charge a system with a charging cylinder.
7. Charge a system with an electronic charging scale.
8. Check for leaks with electronic leak detector and halide torch.
9. Use nitrogen with trace of R-22 for leak detection.
10. Compare readings to manufacturers' specifications.
11. Determine refrigerant amount and type.
12. Charge a system to manufacturers' specifications.

IV. TOOLS AND EQUIPMENT

SUBTOPIC TITLE: *IV.D. Heating: Servicing and Testing Equipment/ V.D. Heating Servicing and Testing Equipment*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

1. Measure chimney draft with a gauge:
    a. Measure draft over fire
    b. Measure draft at the chimney breaching
2. Perform an efficiency test on an oil-gas burner:
    a. smoke test
    b. CO_2 test
    c. O_2 test
    d. check draft
    e. check stack temperature
3. Determine effectiveness of an oil pump using:
    a. vacuum gauge
    b. pressure gauge
4. Determine relative humidity using a sling psychrometer:
    a. Find the relative humidity and dew point using psychrometric chart
5. Measure gas pressure with the following equipment:
    a. U-tube manometer
    b. pressure gauge
6. Calculate proper size of chimney for both 80 and 90+ furnaces.

IV. TOOLS AND EQUIPMENT

SUBTOPIC TITLE: *IV.D. Heating: Servicing and Testing Equipment/V.D. Heating Servicing and Testing Equipment (cont'd)*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

7. Determine what to do with an "orphaned" water heater.

8. Check wall thermostat and anticipator:

   a. cooling system (fan on-automatic)
   b. heating system (fan on-automatic)

9. Check electronic pilot system.

10. Check and adjust blower system.

11. Check and adjust fan control.

12. Check limit and safety controls.

IV. TOOLS AND EQUIPMENT

SUBTOPIC TITLE: *IV.E. Air Flow: Measuring and Testing EquipmentIV.E. Air Flow Measuring and Testing Equipment*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

1. Determine air velocity within a duct via:
    a. pitot tube
    b. inclined manometer
    c. electronic velometer
    d. U-tube manometer
2. Determine air velocity at grilles and diffusers via:
    a. deflecting vane anemometer
    b. velometer
    c. hot wire anemometer
    d. pitot tube
    e. rotating vane anemometer
3. Measure pressure drop with a magnahelic gauge.
4. Determine Cubic Feet Per Minute (CFM).
5. Use manufacturers' airflow data sheet.
6. Solve problems using friction loss chart.

V. PIPING AND PIPING PRACTICESV. PIPING AND PIPING PRACTICES

SUBTOPIC TITLE: *V.A. Piping Material and FabricationV.A. Piping Material and Fabrication*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Identify types of pipe and tubing used in refrigeration work.
2. Identify various types of fittings.
3. Describe methods of insulating pipe and tubing.
4. Identify soldering and brazing alloys used in HVACR.
5. Explain applications of soldering and brazing alloys.
6. Describe heat sink methods.
7. Describe heat exchange techniques.
8. Describe the applications and installation of vibration eliminators.
9. Identify types of torches.

TASKS:

1. Flare copper tubing.
2. Swage copper tubing.
3. Bend copper tubing.
4. Solder and braze copper tubing.
5. Cut and thread steel/iron pipe.
6. Solder aluminum tubing.

V. PIPING AND PIPING PRACTICES

SUBTOPIC TITLE: *V.B. Pipe Sizing and Troubleshooting V.B. Pipe Sizing and Troubleshooting*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain capacities of refrigerant lines.
2. Explain effects of refrigerant velocity in lines.
3. Explain equivalent lengths of piping for fittings.
4. Explain use of traps in vapor risers.
5. Explain the effects of pressure drop in the refrigeration system.
6. Explain gas piping.

TASKS:

1. Calculate total effective length of pipe runs.
2. Calculate amount of refrigerant in lines.
3. Size piping using manufacturers' installation instructions.
4. Calculate pressure drop in liquid line risers.
5. Size liquid and vapor lines.
6. Calculate gas piping sizes to multiple units, fed from a single meter.

V. PIPING AND PIPING PRACTICES

SUBTOPIC TITLE: *V.C. SheetmetalV.C. Sheetmetal*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain use of bending tools.
2. Explain use of cutting tools.
3. Explain the types of ductwork and fittings.

TASKS:

1. Demonstrate use of tin snips left, right and straight.
2. Identify the different pressures of ductwork.
3. Identify the different types of connections.

VI. ELECTRICITYVI. ELECTRICITY

SUBTOPIC TITLE: *VI.A. Basic Electricity VI.A. Basic Electricity*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Define watts, ohms, volts, and amps.
2. Define and compare single- and three-phase voltage and current.
3. Identify types of electrical loads (i.e., capacitive, inductive and resistive).
4. Analyze applications of magnetism in electricity.
5. Apply magnetic principles to electrical theory.
6. Compare conducting and insulating materials.
7. Identify principles of solid-state switching devices.

TASKS:

1. Demonstrate proper use of ammeter, ohmmeter, voltmeter and wattmeter.
2. Use Ohms Law to solve circuit problems and calculate circuit loads.
3. Use appropriate meters to check basic electrical components.
4. Determine the electrical characteristics of both series and parallel circuits.
5. Demonstrate algebra/math skills.

VI. ELECTRICITY

SUBTOPIC TITLE: *VI.A. Basic ElectricityVI.A. Basic Electricity (cont'd)*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

6. Determine the equivalent resistance in a parallel and series circuit.

7. Determine the equivalent capacitance in a parallel and series circuit.

8. Construct and analyze:

   a. series circuit
   b. parallel circuit
   c. series-parallel circuit

VI. ELECTRICITY

SUBTOPIC TITLE: *VI.B. Electrical Generation and DistributionVI.B. Electrical Generation and Distribution*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain basic generator principle.
2. Explain how electricity is produced and distributed.
3. Define Wye (Y) and Delta ($\in$) distribution systems.

TASKS:

1. Draw and identify power transformer types.
2. Use electrical meters appropriately to test and identify voltages in both single- and three-phase systems.
3. Size/test fuses/breakers and safely replace them.
4. Use National Electrical Code (NEC) tables (i.e., NEC 310-16) to check wire size and conduit size for connected equipment.
5. Determine correct wire size and voltage drops for electrical circuits.
6. Determine whether existing load centers are adequate to supply desired load additions.

VI. ELECTRICITY

SUBTOPIC TITLE: *VI.C. Electrical Components VI.C. Electrical Components*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Define magnetic theory.

2. Define and explain the use or function of:

   a. Aquastats
   b. Capacitors
   c. Contactor/Starters
   d. Crankcase Heaters
   e. Current relays
   f. Damper Actuators
   g. Defrost Timers
   h. Fan/Limit Controls
   i. Oil pressure safety
   j. Overloads
   k. Positive Temperature Co-efficient (PTC)
   l. Potentiometers
   m. Pressure Controls
   n. Relays
   o. Rheostats
   p. Sail Switches
   q. Sequencers
   r. Solenoids
   s. Solid state time delays
   t. Thermostats
   u. Water Valves
   v. Zone Valves

TASK:

1. Demonstrate proper use of test equipment for testing the above items.

VI. ELECTRICITY

SUBTOPIC TITLE: *VI.D. Electric Motors VI.D. Electric Motors*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain electric motor theory (i.e., magnetism, electromotive force, etc.).

2. Explain operation and application of:

    a. Capacitor start induction run motor (CSIR)
    b. Capacitor start capacitor run motor (CSCR)
    c. Electronically controlled motor (ECM)
    d. Modulating motor (economizers)
    e. Multi-speed motor
    f. Permanent split capacitor (PSC)
    g. Shaded pole
    h. Split-phase motor (RSIR)
    i. Three-phase motor
    j. Variable-speed motor

3. Describe starting components associated with single-phase and three-phase motors.

4. Explain the significance of power factor.

TASKS:

1. Demonstrate proper use of testing equipment for motors.

2. Determine physical conditions of motor bearings and rotors.

VI. ELECTRICITY

SUBTOPIC TITLE: *VI.D. Electric MotorsVI.D. Electric Motors (cont'd)*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

3. Build a basic motor-using a piece of wood, copper wire, and a coat hanger.

4. Draw and explain the starting and run circuit for a single-phase CSIR compressor using a current type starting relay.

5. Draw and explain the starting and run circuit for a single-phase CSCR compressor using a potential (metage) starting relay.

6. Draw and explain the circuit for a PSC compressor.

VI. ELECTRICITY

SUBTOPIC TITLE: *VI.E. Electrical Circuits and Controls VI.E. Electrical Circuits and Controls*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Interpret detailed instructions for wiring circuits.

TASKS:

1. Draw electrical circuits that conform to standard industry logic and symbols using appropriate loads and controls.
2. Wire actual electrical circuits from wiring diagrams.
3. Demonstrate use and understanding of basic electrical meters in actual wiring and testing of circuits.
4. Identify and draw all electrical symbols used by the HVACR industry in diagrams.
5. Size an electric motor circuit, single and multiple, including overcurrent protection in accordance with National Electrical Code (NEC).

VII. CONTROLSVII. CONTROLS

SUBTOPIC TITLE: *VII.A. Gas ValvesVII.A. Gas Valves*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Identify types of gas valves:

    a. low voltage
    b. line voltage
    c. redundant
    d. two-stage
    e. modulating

2. Explain the operation of solenoid valves used to control gas flow.

3. Describe function and application of regulators.

4. Describe the methods of pilot/burner ignition:

    a. Standing pilot thermocouple
    b. Glow coil pilot ignition
    c. Intermittent spark pilot ignition
    d. Direct spark burner ignition
    e. Hot surface burner ignition

5. Describe methods of fan control for the three categories of gas furnaces:

    a. Low-efficiency - 60-70% efficient
    b. Mid-efficiency - 78-80% efficient
    c. High-efficiency - 90%+ efficient

VII. CONTROLS

SUBTOPIC TITLE: *VII.A. Gas ValvesVII.A. Gas Valves (cont'd)*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

6. Describe the sequence of operation for 78-80% efficient gas furnaces.

7. Identify the components used in all types of gas furnaces:

   a. Low-efficiency - 60-70% efficient
   b. Mid-efficiency - 78-80% efficient
   c. High-efficiency - 90%+ efficient

8. Explain the operation of a redundant gas valve.

TASKS:

1. Check gas valve operation.

2. Check flame sensing current of flame sensing device.

3. Check and adjust inlet and outlet pressure of a gas valve.

4. Perform conversion on gas valve from natural gas to liquified petroleum (LP) or reverse.

5. Check the operation of an induced draft blower by blocking flue outlet.

VII. CONTROLS

SUBTOPIC TITLE: *VII.B. Fuel ControlVII.B. Fuel Controls*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain the operation of ignition and pilot proving devices.
2. Explain operation of an oil delay valve.

TASKS:

1. Test and change a thermocouple flame sensor.
2. Test spark ignition modules.
3. Perform safety lockout procedures for burners.
4. Measure resistance of cad cell.

VII. CONTROLSVII. CONTROLS

SUBTOPIC TITLE: *VII.C. Residential Control Systems - Heating/CoolingVII.C. Residential Control Systems - Heating/Cooling*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Identify residential heating and cooling thermostats.
2. Identify controls for heating and cooling.
3. Explain heat and cooling anticipators.

TASKS:

1. Install and test a fan/limit control to identify set point of control.
2. Wire a complete heating system - line and low voltage.
3. Wire a humidistat into electrical circuit.
4. Wire an electronic air cleaner into an electrical circuit.
5. Program a programmable thermostat for heating, cooling and heat pump operation including set-up and set back.
6. Set heat anticipator on system thermostat.
7. Install residential heating and cooling thermostats.

VII. CONTROLS

SUBTOPIC TITLE: *VII.D. Commercial Control Systems VII.D. Commercial Control Systems*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Identify types of control systems:

    a. electromechanical
    b. pneumatic
    c. electronic
    d. programmable
    e. building management

2. Identify control system components.

3. Describe electrical/mechanical sequences of operation of control systems.

TASKS:

1. Draw a schematic diagram using all components necessary to safely operate an air conditioner, heat pump, furnace or chiller system.

2. Wire the control circuit of an air-conditioning heating or chiller system.

VII. CONTROLS

SUBTOPIC TITLE: *VII.E. Heat Pump Controls VII.E. Heat Pump Controls*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain the operation and function of a reversing valve.
2. Identify the main types of defrost controls.
3. Identify and explain the operation of each type of defrost control.
4. Identify and explain the operation of flow and safety control for geothermal system.
5. Describe the purpose and function of outdoor thermostats.
6. Describe the sequence and purpose of emergency heat controls.
7. Identify and explain the operation of check valves in heat pumps.
8. Describe the sequence between first stage and second stage heating thermostat.
9. Describe the auxiliary heat controls.

TASKS:

1. Select and install appropriate system thermostat.
2. Wire the control circuit of a heat pump system.
3. Install or replace a heat sequencing relay.
4. Perform tests on reversing valve to determine if mechanical or electrical failure.

VII. CONTROLS

SUBTOPIC TITLE: ***VII.F. Direct Digital Controls (DDC)VII.F. Direct Digital Controls (DDC)***

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain the history of DDC systems.
2. Discuss the definition of DDC systems.
3. Explain wiring methods.
4. Explain peripheral devices.
5. Explain input and output.
6. Explain central processors.
7. Explain the difference between DDC and Energy Management Systems (EMS).
8. Discuss remote communications, monitoring and alarming.
9. Describe a programmable thermostat.
10. Describe several applications for electronic controls.
11. Describe why electronic controls are more applicable to some situations than are electromechanical controls.

TASKS:

1. Troubleshoot a basic electronic control circuit board.
2. Program different types of thermostats.

VII. CONTROLS

SUBTOPIC TITLE: ***VII.G.*** **Energy Management Systems (EMS) (Computer Controls)*VII.G.* Energy Management Systems (EMS) (Computer Controls)**

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain the definition of EMS.
2. Explain the difference between EMS and Direct Digital Controls (DDC).
3. Discuss the uses for EMS.
4. Discuss utility rebates regarding EMS.
5. Explain wiring methods.
6. Explain peripheral devices.
7. Explain input and output.
8. Discuss remote communications, monitoring and alarming.
9. Discuss energy accounting.
10. List the principal parts of a programmable controller.

TASKS:

1. Draw basic diagrams of how input and output modules function.
2. Enter a program into a programmable controller.

VIII. SOLID STATE ELECTRONICSVIII. SOLID STATE ELECTRONICS

SUBTOPIC TITLE: *VIII.A. Solid State ComponentsVIII.A. Solid State Components*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain the function and/or application in HVACR circuits and controls of:

    a. Amplifiers
    b. Bilateral switches
    c. Capacitors
    d. Diodes
    e. Direct Digital Control/System (DDC/DDS)
    f. Effects of heat and moisture
    g. Photoelectric Cell
    h. Rectifiers
    i. Resistors
    j. Semiconductors
    k. Shielded wiring
    l. Sensors
    m. Silicon Controlled Rectifiers (SCR)
    n. Thermistors
    o. Transducers
    p. Transistors
    q. Triacs

2. Explain the role computers are now playing in the HVACR industry.

TASKS:

1. Measure resistive value of various sensors.

2. Measure operability of various boards.

3. Test electronic air cleaners.

IX. LOAD CALCULATIONSIX. LOAD CALCULATIONS

SUBTOPIC TITLE: *IX.A. Refrigeration LoadsIX.A. Refrigeration Loads*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Define "U" value: (Btu/hrAft^{2}A°F).
2. Define "K" value: (Btu/hrAft^{2}A°F).
3. Define "C" value: (Btu/hrAft^{2}A°F).
4. Define "R" value: (hrAft^{2}A°F/Btu).
5. Interpret heat transfer tables ("U," "K," "C," "R").
6. Explain the heat load sources:
    a. conduction
    b. infiltration (sensible and latent)
    c. product
    d. miscellaneous loads (people, motors, equipment, sensible and latent)
    e. radiation
7. Explain the purpose of vapor barriers.
8. Interpret tables of specific heat values, latent heat, and heat of respiration.

TASK:

1. Calculate total heating transfer value of any surface (R) - (U).

IX. LOAD CALCULATIONS

SUBTOPIC TITLE: *IX.B. Psychrometrics IX.B. Psychrometrics*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Identify the following on a psychrometric chart:

    a. dry bulb line (DB)
    b. wet bulb line (WB)
    c. relative humidity (RH)
    d. dew point (DP)
    e. enthalpy (h)
    f. specific humidity (grains of moisture) or (lbw/lbda)
    g. apparatus dew point

2. Explain:

    a. specific humidity
    b. apparatus dew point
    c. contact factor
    d. relative humidity
    e. dry bulb
    f. wet bulb
    g. dew point
    h. enthalpy
    g. specific volume

TASKS:

1. Calculate:

    a. refrigeration sensible heat ratio
    b. latent heat ratio
    c. contact factor
    d. latent heat
    e. sensible heat
    f. total heat
    g. water removal
    h. mixed air condition

IX. LOAD CALCULATIONS

SUBTOPIC TITLE: *IX.B. Psychrometrics/X.B. Psychrometrics (cont'd)*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

2. On a psychrometric chart, plot the following:

    a. sensible heating
    b. sensible cooling
    c. heating and humidifying
    d. heating and dehumidifying
    e. cooling and humidifying
    f. cooling and dehumidifying
    g. humidifying
    h. dehumidifying
    i. cooling cycle
    j. mixed air process
    k. cooling and reheat

IX. LOAD CALCULATIONS

SUBTOPIC TITLE: *IX.C. Heating Loads IX.C. Heating Loads*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Interpret structure design data.

2. Interpret building prints - size of rooms, etc.

TASKS:

1. Determine total resistance to heat flow ("R"), ("U").

2. Calculate conduction loss:

    a. walls
    b. roofs
    c. floors
    d. windows
    e. basement (walls, floor)
    f. unconditioned space

3. Calculate infiltration:

    a. doors
    b. windows

4. Calculate ventilation load.

5. Calculate duct loss.

6. Calculate effects of bath and kitchen exhaust.

7. Calculate effects of power roof ventilators.

8. Calculate total heating load.

IX. LOAD CALCULATIONS

SUBTOPIC TITLE: *IX.D. Cooling Loads IX.D. Cooling Loads*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Interpret structure design data.

TASKS:

1. Calculate "U" values for building material.
2. Calculate Cooling Load Temperature Difference (CLTD).
3. Make corrections for CLTD.
4. Calculate conduction loads:
   a. walls
   b. roofs
   c. windows
   d. doors
   e. unconditioned space
   f. floors
5. Calculate lighting load.
6. Calculate equipment load.
7. Calculate infiltration and ventilation load:
   a. heat load
   b. moisture loads
8. Calculate duct gain.

IX. LOAD CALCULATIONS

SUBTOPIC TITLE: *IX.D. Cooling Load IX.D. Cooling Load (cont'd)*

COMPETENCY OBJECTIVES:

TASKS:

9. Calculate refrigeration sensible heat ratio.

10. Calculate storage factor.

11. Calculate effects of bath and kitchen exhaust.

12. Calculate effects of power roof ventilators.

13. Calculate total cooling load:

    a. sensible loads
    b. latent loads

X. REFRIGERANT SYSTEM COMPONENTSX. REFRIGERANT SYSTEM COMPONENTS

SUBTOPIC TITLE: *X.A. Metering DevicesX.A. Metering Devices*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Define types of metering devices:

    a. capillary tubes
    b. thermal expansion valve
    c. automatic expansion valve
    d. low side float
    e. high side float
    f. hand expansion valve
    g. restrictor orifices
    h. electronic expansion valve
    i. solid state expansion valve

2. Evaluate system performance when using different types of flow control devices.

3. Explain how to size expansion valves.

4. Explain how to size a thermal expansion valve.

5. Explain how to size an automatic expansion valve.

TASKS:

1. Adjust and size metering devices when and where appropriate.

2. Check and adjust superheat and/or subcooling to manufacturers' specifications.

3. Install capillary tube.

X. REFRIGERANT SYSTEM COMPONENTS

SUBTOPIC TITLE: *X.B. EvaporatorsX.B. Evaporators*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Identify types of evaporators:
    a. bare-tube
    b. finned
        - internal
        - external
    c. plate
    d. unit coolers
    e. chillers
2. Determine the Mean Effective Temperature Difference (METD).

TASKS:

1. Adjust for proper coil air flow.
2. Check coil performance.
3. Select and size evaporator based on compressor capacities.

X. REFRIGERANT SYSTEM COMPONENTS

SUBTOPIC TITLE: *X.C. CompressorsX.C. Compressors*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Identify types of compressors:
    a. hermetic
    b. semi-hermetic
    c. open type
2. Identify methods of compression:
    a. centrifugal
    b. rotary
    c. screw
    d. scroll
    e. reciprocating
3. Explain the methods of compression.
4. Explain methods of capacity control:
    a. cylinder unloading
    b. multiple compressors
    c. hot gas bypass
    d. variable speed compressors

TASKS:

1. Select the compressor based on cooling load.
2. Determine the system balance based on the selected components.

X. REFRIGERANT SYSTEM COMPONENTS

SUBTOPIC TITLE: *X.D. CondensersX.D. Condensers*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Define the types of condensers:
   a. air-cooled
   b. water-cooled
   c. evaporative-cooled
2. Determine proper air and water flow.
3. Describe maintenance of a condenser and a cooling tower.
4. Explain the operation and performance of a condenser.
5. Explain the terms "range" and "approach" related to cooling towers.
6. Explain purpose of heat reclaim.

TASKS:

1. Adjust the air flow for proper temperature difference.
2. Adjust water flow for proper gallons per minute (GPM) and temperature difference.
3. Size a cooling tower.
4. Select and size an air-cooled condenser.

X. REFRIGERANT SYSTEM COMPONENTS

SUBTOPIC TITLE: *X.E. AccessoriesX.E. Accessories*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Identify the proper location of all accessories:

    a. accumulators
    b. crankcase heaters
    c. crankcase pressure regulating valves
    d. defrost timers
    e. driers/filters
    f. evaporator pressure regulating valves
    g. head pressure controls
    h heat exchangers
    i. hot gas bypass
    j. low pressure controls
    k. low ambient controls
    l. mufflers
    m. oil separators
    n. receivers
    o. solenoid valves
    p. suction filters
    q. unloaders
    r. vibration eliminators
    s. check valves
    t. water regulating valve
    u. liquid sight valve-refrigerant and oil
    v. relief valve

2. Determine appropriate accessories for systems application.

3. Explain the operation of the above listed accessories (Item #1).

X. REFRIGERANT SYSTEM COMPONENTS

SUBTOPIC TITLE: ***X.E. AccessoriesX.E. Accessories (cont'd)***

COMPETENCY OBJECTIVES:

The student will:

TASKS:

1. Replace a drier/filter.
2. Adjust a crankcase pressure regulating valve.

X. REFRIGERANT SYSTEM COMPONENTS

SUBTOPIC TITLE: *X.F. Access ValvesX.F. Access Valves*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Identify front and back seat valves in the:

    a. Operation and use of the suction and discharge service valves that service the compressor.

    b. Application and operation of the king valve at the outlet of the receiver.

    c. Application and operation of the queen valve where present, near the receiver.

    d. Small system high side and low side service ports.

    e. Front seating and Schrader valves, OEM and field installed.

TASKS:

1. Identify Schrader Type OEM and field installed in the:

    a. Installation and use of clamp on valves.

    b. Installation and use of solder (in) or (on) stem valves.

    c. Use of A/C front seating/Schrader OEM service valves.

    d. Use of quick disconnects with Schrader-Based Valves.

XI. AIR-CONDITIONING SYSTEMSXI. AIR-CONDITIONING SYSTEMS

SUBTOPIC TITLE: *XI.A. Unitary Cooling XI.A. Unitary Cooling*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Describe the sequence of the basic refrigeration cycle and operation of the various types of air-conditioning systems.

TASK:

1. Use and read various tools and instrumentation needed for checking, testing, and operating air-conditioning systems.

XI. AIR-CONDITIONING SYSTEMS

SUBTOPIC TITLE: *XI.B. Central Station SystemsXI.B. Central Station Systems*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain the basic function of the following components of central station systems:

    a. air distribution systems
    b. expansion tanks
    c. heat recovery systems
    d. water chiller
    e. water cooling tower

2. Explain the operation of a central station system.

3. Understand the requirements for system control:

    a. electronic DDC
    b. pneumatic
    c. building systems

TASK:

1. Draw a piping diagram of a chilled water system:

    a. Two-way control valves
    b. Three-way control valves

XI. AIR-CONDITIONING SYSTEMS

SUBTOPIC TITLE: *XI.C. Service and Problem Analysis XI.C. Service and Problem Analysis*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain the causes of electrical problems.
2. Explain the causes of mechanical problems.
3. Explain the causes of hydronic problems.

TASK:

1. Analyze air-conditioning systems and appropriately diagnose the electrical and/or mechanical and/or hydronic problems.

XI. AIR-CONDITIONING SYSTEMS

SUBTOPIC TITLE: *XI.D. Absorption RefrigerationXI.D. Absorption Refrigeration*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain the basic function of the components of the absorption system.
2. Describe the sequence of operation of the absorption system.
3. Understand which components of an absorption system can be field-serviced.

TASK:

1. Check all "external" components of system for proper operation.

XI. AIR-CONDITIONING SYSTEMS

SUBTOPIC TITLE: ***XI.E. Desiccant Cooling and DehumidificationXI.E. Desiccant Cooling and Dehumidification***

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. List the applications of dehumidification.

2. Describe the methods of desiccant dehumidification.

3. Describe the benefits of using desiccant dehumidification versus cooling coil dehumidification.

4. Explain how a desiccant wheel works.

5. Understand and describe how the four primary variables influence the performance of a desiccant dehumidifier:

    a. air flow
    b. entering humidity level
    c. entering dry bulb temperature
    d. regeneration temperature

6. Understand basic troubleshooting methods for desiccant systems:

    a. air flow readings
    b. temperature verification
    c. humidity level readings
    d. mass balance calculation

7. Describe the operation and maintenance of desiccant cooling and dehumidification systems. (Desiccant cycle and physical components)

8. List the various types of desiccant cooling and dehumidification systems in use today.

9. Describe how desiccant dehumifiers are integrated into conventional refrigeration and air-conditioning systems and identify, the function of each component in an integrated system.

XI. AIR-CONDITIONING SYSTEMS

SUBTOPIC TITLE: *XI.E. Desiccant Cooling and Dehumidification XI.E. Desiccant Cooling and Dehumidification (cont'd)*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

1. Read and use the various tools/instruments needed for checking, testing and operating a desiccant dehumidifier:

    a. airflow measurement
    b. humidity measurements
        - ☐ wet/dry bulb
        - ☐ dewpoint
        - ☐ relative humidity
    c. moisture balance calculation

2. Analyze a desiccant system and determine:

    a. if meeting manufacturers' specifications
    b. potential for improving moisture removal rate

XII. HEAT PUMP SYSTEMSXII. HEAT PUMP SYSTEMS

SUBTOPIC TITLE: *XII.A. Basic Principles and ComponentsXII.A. Basic Principles and Components*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Review the history of heat pumps.
2. Explain the basic theory of the air source heat pump system.
3. Explain the basic theory of the water source heat pump system.
4. Explain the basic theory of geothermal source heat pump system.
5. Identify and explain the function of the electrical and mechanical components of the heat pump systems.
6. Explain terms typically used for heat pumps:
   a. Seasonal Energy Efficiency Ratio (SEER)
   b. Coefficient of Performance (COP)
   c. Heating Seasonal Performance Factor (HSPF)
   d. Balance Points
   e. Outdoor Design Temperature (ODT)
   f. Optimizer
7. Analyze and explain the refrigerant cycle in both cooling and heating -- identifying the pressure and state of the refrigerant at any point in the refrigerant circuit.
8. Explain the different types of defrost methods.
9. Describe the operation of the time clock in a defrost control.
10. Identify which three components of a heat pump system are controlled directly during a defrost cycle.
11. Describe a heat pump thermostat function.

XII. HEAT PUMP SYSTEMS

SUBTOPIC TITLE: *XII.A. Basic Principles and ComponentsXII.A. Basic Principles and Components (cont'd)*

COMPETENCY OBJECTIVES:

TASKS:

1. Check reversing valve for proper temperatures.
2. Calculate both economic and thermal balance points.
3. Calculate temperature settings for multiple outdoor thermostats.
4. Check refrigerant charge using charging chart.
5. Check sequence of operation of an air-to-air split system heat pump for cooling, heating, and defrost modes.

XII. HEAT PUMP SYSTEMS

SUBTOPIC TITLE: *XII.B. ApplicationsXII.B. Applications*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Identify and describe different types of heat pump systems:

    a. Air-cooled
    b. Water-source
        - open loop
        - closed loop
        - air-to-water
        - water-to-water
        - geothermal

2. Analyze and compare the operation and performance of the different types of Heat Pump Systems:

    a. Explain the integration and operation of the air-to-air heat pump with electric resistance heat.

    b. Explain the integration and operation of the water-to-air heat pump with electric resistance heat.

    c. Explain the integration and operation of the air-to-air heat pump with a fossil fuel unit.

    d. Explain applications for open vs. closed loop geothermal heat pump systems.

TASK:

1. Mechanically and electrically connect and check out:

    a. Air-to-air heat pump
    b. Water-to-water heat pump

XIII. HEATING SYSTEMSXIII. HEATING SYSTEMS

SUBTOPIC TITLE: *XIII.A. Forced Warm Air SystemsXIII.A. Forced Warm Air Systems*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

1. Check the operation of the ignition system.
2. Derate or change over a gas burner.
3. Adjust burner flame for proper fuel/air ratio.
4. Check for proper temperature rise through the furnace.
5. Test all safety controls.
6. Remove, install and adjust blower motor and/or belt.
7. Clean pilot assembly.
8. Oil motor(s) and bearings.
9. Check and adjust heat anticipator of thermostat.
10. Use orifice sizing charts.
11. Test induced draft pressure switches.
12. Check all safety controls.
13. Check operation of sequence.

XIII. HEATING SYSTEMS

SUBTOPIC TITLE: *XIII.B. Hydronic SystemsXIII.B. Hydronic Systems*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Identify types of hydronic piping systems.
2. Identify types of boilers.

TASKS:

1. Check circulator for alignment and lubrication.
2. Set aquastat.
3. Check water pressure regulating valve (PRV).
4. Check the zone valve operation.
5. Remove air from system.
6. Check backflow preventer.
7. Check compression/expansion tank.
8. Check water temperature rise across the boiler.
9. Check and adjust water level in pressure tanks.
10. Check automatic air vent operation.
11. Wire multizone/multipump hydronic systems.

XIII. HEATING SYSTEMS

SUBTOPIC TITLE: *XIII.C. Testing and Balancing EquipmentXIII.C. Testing and Balancing Equipment*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

1. Perform pressure checks on air distribution system.

2. Perform pressure checks on fuel system.

3. Perform efficiency test and adjust to recommended rate:

    a. check draft
    b. check smoke (if applicable)
    c. check stack temp
    d. check CO_2
    e. check O_2
    f. check CO

4. Perform balance method for an air distribution system.

5. Perform balance method for a hydronic system.

XIII. HEATING SYSTEMS

SUBTOPIC TITLE: *XIII.D. HumidificationXIII.D. Humidification*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain importance of humidification.
2. Describe different types of humidifiers.
3. Explain factors affecting humidity in business and residence.

TASKS:

1. Select proper humidification equipment.
2. Check operation of humidification equipment.
3. Perform maintenance on humidification equipment.
4. Determine relative humidity using a psychrometer.
5. Determine dew point using a psychrometer.

XIII. HEATING SYSTEMS

SUBTOPIC TITLE: *XIII.E. Unitary Combination Heating and Cooling Equipment XIII.E. Unitary Combination Heating and CoolingEquipment*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Describe the sequence of operation of a heating system.

TASK:

1. Use and read various tools and instruments needed for checking and testing combination air-conditioning and heating systems.

XIII. HEATING SYSTEMS

SUBTOPIC TITLE: *XIII.F. Oil FurnacesXIII.F. Oil Furnaces*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain and check the sequence of operation of oil stack switches.
2. Explain and check the sequence of operation of Electronic Primary Controls.
3. Understand how to replace oil filters.
4. Understand how to purge water from oil storage tanks.
5. Understand how to oil motors.

TASKS:

1. Replace oil nozzle and adjust electrodes.
2. Perform combustion test and adjust to optimum efficiency.
3. Perform safety shutdown check.
4. Replace oil nozzles with proper size replacements.
5. Inspect and adjust electrodes replacing when necessary.
6. Test and adjust oil pumps and couplers.

XIII. HEATING SYSTEMS

SUBTOPIC TITLE: *XIII.G. Electric FurnacesXIII.G. Electric Furnaces*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Understand the use of sequencers in electric furnaces.
2. Understand the effects of air flow on temperature rise.

TASKS:

1. Inspect heating elements and insulators.
2. Test thermal fuses.
3. Inspect all electrical connections.
4. Check for proper temperature.
5. Oil motors.
6. Test sequence of operation of electric furnaces.

XIV. COMMERCIAL REFRIGERATIONXIV. COMMERCIAL REFRIGERATION

SUBTOPIC TITLE: *XIV.A. Single CompressorXIV.A. Single Compressor*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain the importance of compressor/evaporator balance.

2. Describe the differences in compressor displacement between the various temperature ranges.

3. Explain basic low and high pressure control theory and operation.

4. Explain the operation of a vapor compression system and its effects on temperature and volume.

5. Explain the operation and components used for the pump down cycle.

6. Explain the evaporator and the condenser side of a system.

7. Explain application and operation of evaporator pressure regulating valves.

8. Discuss the problems associated with compressors operating at lower evaporator temperatures:

    a. decreased volumetric efficiency
    b. higher discharge gas temperatures
    c. potential overloading during initial temperature pull-down

9. Discuss the use of different compressor designs for increased efficiency and capacity.

10. Describe the methods used for cycling the compressor on and off.

11. Explain methods of defrost.

12. Explain methods of head pressure control system.

13. Explain heat reclaim.

14. Explain the lubrication methods for a compressor.

XIV. COMMERCIAL REFRIGERATION

SUBTOPIC TITLE: *XIV.A. Single CompressorXIV.A. Single Compressor (cont'd)*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

15. Determine the terminal identification of a single-phase compressor.

16. Explain how to measure the compressor lubrication oil pressure.

17. Explain several manufacturers' model numbering system.

18. Define compression ratio and the effect suction and discharge pressure have on compression ratio.

19. Determine compressor capacity using the compressor's curve.

20. Determine the correct operating amps using the compressor's curve.

21. Describe the different types and designs of compressors:

Type:	Design:
a. hermetic	a. reciprocating
b. semi-hermetic	b. scroll
c. open drive	c. screw

22. Explain requirements of food preservation:

    a. medium temperature
    b. low temperature

23. Describe supermarket display cases.

24. Explain the difference between an across-the-line start and a part-winding start.

XIV. COMMERCIAL REFRIGERATION

SUBTOPIC TITLE: *XIV.A. Single CompressorXIV.A. Single Compressor (cont'd)*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

1. Identify the different types of compressors.
2. Select a compressor for a particular capacity and temperature range.
3. Check the operation of a compressor in a particular system.
4. Compute the compression ratio for a particular system.
5. Adjust Evaporator Pressure Regulating (EPR) valve.
6. Check control circuits per manufacturers' specifications.
7. Check system charge, superheat and subcooling.
8. Check display case temperatures and determine if operating properly.
9. Set cut-in and cut-out for a special product.
10. Draw the wiring diagrams for an across-the-line start and a part-winding start.
11. Draw a ladder diagram of a system equipped with a pump down cycle.
12. Draw the schematic of a single-phase and a three-phase compressor motor.
13. Draw a ladder diagram of a system using a defrost time clock and defrost termination fan delay switch.
14. Measure the compressor windings and determine if they are correct.

XIV. COMMERCIAL REFRIGERATION

SUBTOPIC TITLE: *XIV.A. Single CompressorXIV.A. Single Compressor (cont'd)*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

15. Measure the operating amps and determine if it is correct.

16. Check operation of defrost cycle and adjust time clock.

17. Adjust head pressure controls for proper operation.

18. Check operation of equipment equipped for automatic pump down.

XIV. COMMERCIAL REFRIGERATION

SUBTOPIC TITLE: *XIV.B. Multiplexed Evaporator Systems XIV.B. Multiplexed Evaporator Systems*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Define the different types of multiplexed systems.
2. Explain the application of multiplexed systems.
3. Describe how compressors are connected.
4. Describe the physical construction of a common rack system.
5. Describe the advantages of controlling capacity using the multiplexed system.
6. Describe how compressors are cycled on and off.
7. Explain the problems associated with multiplexed systems:
   a. oil level control
   b. crankcase pressure balance
   c. contamination due to a compressor burnout
8. Explain the cascade system.
9. Explain operation of Evaporator Pressure Regulating (EPR) valves.
10. Explain function and placement of check and hot gas valves.
11. Explain advantages of multiple evaporator systems.
12. Explain the difference in compressor requirements for a multiplexed system.
13. Define the different types of multiplexed systems.
14. Explain the difference between even and uneven parallel systems.
15. Explain operation of defrost cycle.

XIV. COMMERCIAL REFRIGERATION

SUBTOPIC TITLE: *XIV.B. Multiplexed Evaporator Systems XIV.B. Multiplexed Evaporator Systems (cont'd)*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

1. Check staging of compressors with changes in system load.
2. Check individual evaporator temperatures and adjust Evaporator Pressure Regulating (EPR) valves accordingly.
3. Identify capacity of compressors used on multiplexed system by referring to manufacturers' specifications.
4. Set superheat on multiplex system.
5. Check control circuits per manufacturers' specifications.
6. Adjust Evaporator Pressure Regulating valves, for established (assigned) multiple temperature cases.
7. Adjust pressure control to lowest temperature case.
8. Layout piping diagram of multiple evaporator system showing placement of required low side components (TXVs, EPRs, CK valves, etc.) and high side required components.

XIV. COMMERCIAL REFRIGERATION

SUBTOPIC TITLE: *XIV.C. Refrigerated StorageXIV.C. Refrigerated Storage*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain the difference between medium temperature, low temperature, and ultra low temperature storage systems.

2. Explain the difference between service and self-service cases.

3. Identify service cases and self-service cases.

4. Explain the operation of:

   a. air screen freezer
   b. glass door freezer
   c. display/coffin cases

5. Explain the different methods of defrost:

   a. electric resistance
   b. hot gas
   c. cool gas
   d. natural shut-down
   e. ambient air

TASKS:

1. Replace anti-sweat heaters.

2. Replace fan motors and fans.

3. Find and repair leaks.

4. Verify operation of unit.

XIV. COMMERCIAL REFRIGERATION

SUBTOPIC TITLE: *XIV.C. Refrigerated StorageXIV.C. Refrigerated Storage (cont'd)*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

5. Check and/or replace fan relay.
6. Verify air flow.
7. Clean drain line.
8. Check all electrical components for voltage and current.
9. Adjust operating and safety controls.
10. Clean condenser coil surface (air-cooled/water-cooled).
11. Perform all aspects of preventive maintenance.
12. Check operation of defrost cycle.
13. Identify defrost components on a given system.

XIV. COMMERCIAL REFRIGERATION

SUBTOPIC TITLE: *XIV.D. Ice Makers XIV.D. Ice Makers*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain the operation of ice making for both cubed and flaked ice.
2. Explain water spray system for ice making.
3. Identify styles of icemakers and explain the sequence of operation of each.

TASKS:

1. Follow manufacturers' instructions for cleaning the evaporator.
2. Clean the condenser.
3. Check the harvest cycle.
4. Adjust cube size.
5. Check for and repair leaks.
6. Inspect the electrical circuit.
7. Check and adjust the metering device for proper operation.
8. Measure grid heater current when applicable.
9. Clean ice storage bin.
10. Inspect and clean drains as necessary.
11. Replace bearings and seals in flake-type machine.
12. Replace auger motor in a flaker.

XIV. COMMERCIAL REFRIGERATION

SUBTOPIC TITLE: *XIV.D. Ice Makers XIV.D. Ice Makers (cont'd)*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

13. Check and adjust water pressure.
14. Level the machine.
15. Check water pump.
16. Check water treatment equipment.
17. Adjust float valve assembly.
18. Change float valve assembly.
19. Check production capacity of a given ice machine.

XIV. COMMERCIAL REFRIGERATION

SUBTOPIC TITLE: *XIV.E. Dispensing Freezers* *XIV.E. Dispensing Freezers*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Describe the application of dispensing freezers.
2. Describe the types of dispensing freezers.
3. Describe the design and construction of dispensing freezers.
4. Describe the maintenance requirements of a dispensing freezer including sanitary requirements.

TASKS:

1. Check the operation of a dispensing freezer.
2. Clean and set-up a dispensing freezer.

XIV. COMMERCIAL REFRIGERATION

SUBTOPIC TITLE: *XIV.F. Packaged Liquid ChillersXIV.F. Packaged Liquid Chillers*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Discuss the application of liquid chillers.
2. Describe the differences in design and construction between direct expansion versus indirect expansion evaporators.
3. Explain the operation of liquid chillers.
4. Discuss the problems associated with liquid chillers:
   a. insufficient water flow problems
   b. considerations when operation below 32EF is required
   c. added maintenance

TASKS:

1. Measure the temperature drop through the chiller.
2. Check the operation of the liquid chiller.
3. Identify the components of a liquid chiller.
4. Determine Btu/h capacity of water chillers using flow and Delta ($\in$)T method.

XIV. COMMERCIAL REFRIGERATION

SUBTOPIC TITLE: *XIV.G. System ApplicationsXIV.G. System Applications*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain the operation of a single compressor/evaporator system.
2. Explain the fundamental two-stage (multi-stage) system.
3. Explain the fundamental cascade system used for specialty ultra-low temperature application.
4. Explain operation of low ambient head pressure control systems (fan cycling, dampers and flooding of condenser).
5. Explain the heat reclaim cycle (three-way valve).
6. Explain function operation of oil separation and return to compressor crankcase.
7. Explain oil level (balance) of multi-parallel compressor applications.
8. Explain the defrost cycle.
9. Establish the pressure control settings.
10. Describe electrical/mechanical sequence from electrical schematic.

XIV. COMMERCIAL REFRIGERATION

SUBTOPIC TITLE: *XIV.G. System ApplicationsXIV.G. System Applications (cont'd)*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

1. Adjust evaporator pressure regulating valve (EPR).
2. Check control circuits as per manufacturers' specifications.
3. Check the suction stop valve.
4. Check system for proper refrigerant charge.
5. Charge system with refrigerant on liquid side as well as suction side.
6. Test and adjust all operating and safety controls.
7. Replace filter driers.
8. Check compressor oil.
9. Change oil in compressor crankcase.
10. Check for and repair refrigerant leaks.
11. Inspect electrical circuit for defective connections.
12. Repair defective connections.
13. Troubleshoot from electrical schematic.
14. Check oil separator operation and return.
15. Draw a ladder diagram of a given system.

XV. AIR HANDLINGXV. AIR HANDLING

SUBTOPIC TITLE: *XV.A Air Flow Principles/Duct DesignXV.A Air Flow Principles/Duct Design*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

1. Draw layout of return and supply runs.
2. Calculate equivalent length of trunk and branch ducts.
3. Calculate total effective length of duct runs.
4. Calculate total available static pressure.
5. Size trunk and branch ducts by equal friction method.
6. Use duct calculator to find duct size, velocity, cfm, and friction loss.
7. Calculate air flow factors for heating and cooling.
8. Size registers, grilles, and diffusers.
9. Fabricate fittings.
10. Fabricate a "HAND" pittsburg.
11. Fabricate "HAND" slips and drives.
12. Identify and use all basic hand-held sheet metal tools.
13. Identify and use all basic hand-held tools for duct board.

XV. AIR HANDLING

SUBTOPIC TITLE: *XV.B. Mechanical and Electronic Filtration XV.B. Mechanical and Electronic Filtration*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Identify types of mechanical filters:

    a. disposable
    b. permanent foam, mesh, and fiber
    c. high efficiency
    d. HEPA
    e. electrostatic

2. Describe operation of electronic air cleaners.

TASKS:

1. Install air cleaner system into existing ductwork.

2. Remove and clear prefilter and cells:

    a. check ionizer wires
    b. test power pack

XV. AIR HANDLING

SUBTOPIC TITLE: *XV.C. Fans/BlowersXV.C. Fans/Blowers*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Identify different types of fans/blowers:

   a. centrifugal
   b. axial

2. Determine the proper direction of rotation.

3. Explain the difference between tubeaxial and vaneaxial.

4. Identify the types of centrifugal fans/blowers:

   a. forward curved
   b. backward curved
   c. air foil
   d. radial tip

TASKS:

1. Check for proper rotation.

2. Interpret the fans/blowers curve.

3. Select the fans/blowers via the curve.

4. Check fans/blowers performance via curves.

5. Check amp draws.

XVI. SYSTEM INSTALLATION AND START-UPXVI. SYSTEM INSTALLATION AND START-UP

SUBTOPIC TITLE: *XVI.A. Heating Start-up, Checkout, and OperationXVI.A. Heating Start-up, Checkout, and Operation*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Understand the importance of manufacturers' installation and operation requirements.

TASKS:

1. Demonstrate use of tools and instruments.
2. Determine equipment electrical, mechanical and code requirements.
3. Verify equipment air flow and distribution requirements.
4. Check operation of all electrical control components.
5. Check operation of gas train components and measurements.
6. Check oil burner components and measurements.
7. Check ignition systems.
8. Evaluate fuel supply systems.
9. Test for proper combustion.
10. Check electrical components for operation and wiring connections.
11. Check for correct heating input and adjust to manufacturers' specifications.

XVI. SYSTEM INSTALLATION AND START-UP

SUBTOPIC TITLE: *XVI.B. Heat Pump Start-up, Checkout, and Operation XVI.B. Heat Pump Start-up, Checkout, and Operation*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Understand the importance of manufacturers' installation and operation requirements.
2. Understand alternative fuel methods.

TASKS:

1. Demonstrate use of tools and test equipment.
2. Determine equipment electrical requirements.
3. Verify equipment air flow and distribution.
4. Check operation of all electrical and mechanical components.
5. Check system operation in the heating, cooling and defrost modes.
6. Check supplementary and emergency heat.
7. Instruct customer on operation and maintenance of system.

XVI. SYSTEM INSTALLATION AND START-UP

SUBTOPIC TITLE: *XVI.C. Air-Conditioning Start-up, Checkout, and Operation**XVI.C. Air-Conditioning Start-up, Checkout, and Operation*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Understand the importance of manufacturers' installation and operation requirements.

TASKS:

1. Demonstrate use of tools and test equipment.
2. Determine equipment electrical requirements.
3. Verify equipment air flow and distribution requirements.
4. Check operation of all electrical and mechanical components.
5. Check system operation while following all safety procedures.
6. Pull and verify deep vacuum.
7. Perform leak check and make repairs.
8. Conform to all applicable governmental regulations.

XVII. SYSTEM SERVICING AND TROUBLESHOOTINGXVII. SYSTEM SERVICING AND TROUBLESHOOTING

SUBTOPIC TITLE: *XVII.A Mechanical System ProblemsXVII.A Mechanical System Problems*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Develop systematic way to diagnose system problems and demonstrate method.
2. Identify and describe possible causes of failure and how to eliminate causes.

TASKS:

1. Demonstrate use of tools and test equipment following safety practices.
2. Record system data for the mechanical system operation.
3. Verify mechanical system operation is acceptable.
4. Determine cause of failure in system components.
5. Determine actual system air flow using the appropriate test equipment.
6. Determine system air flow requirements.

XVII. SYSTEM SERVICING AND TROUBLESHOOTING

SUBTOPIC TITLE: *XVII.B. Electrical Troubleshooting XVII.B. Electrical Troubleshooting*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Interpret electrical diagrams into sequence of operation.
2. Describe electrical mechanical sequence from electrical schematic.
3. Develop a methodical routine for electrical troubleshooting.

TASKS:

1. Analyze electrical performance of each component.
2. Rewire an HVACR unit using an electrical diagram:
   a. air conditioner
   b. heat pump
   c. furnace
3. Record electrical system data.
4. Use electrical test instruments to diagnose electrical troubles and correct electrical system performance.
5. Troubleshoot a faulty compressor overload protector.
6. Change a schematic diagram to a "ladder" diagram in a drawing.

XVII. SYSTEM SERVICE AND TROUBLESHOOTING

SUBTOPIC TITLE: *XVII.C. Heating: Service and Problem Analysis XVII.C. Heating Service and Problem Analysis*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain combustion theory for gas combustion and oil combustion.
2. Identify and describe possible causes of failure and how to correct problems.

TASKS:

1. Determine and measure combustion air, ventilation air and unit/system air requirements.
2. Develop systematic method(s) to diagnose system problems and demonstrate method.
3. Determine the cause of failure in a heating system.
4. Record data and verify system operation.

XVII. SYSTEM SERVICE AND TROUBLESHOOTING

SUBTOPIC TITLE: *XVII.D. Heat Pump: Service and Problem Analysis XVII.D. Heat Pump Service and Problem Analysis*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

1. Test and evaluate the operation of the refrigeration cycle in cooling and heating modes.
2. Test the operation of the supplementary heat component(s).
3. Test the operation of the emergency heat status for the heat pump system.
4. Record appropriate data to evaluate complete system operation.
5. Test proper operation of reversing valve.
6. Check operation of defrost controls.
7. Inspect wiring and tighten connections.

XVII. SYSTEM SERVICE AND TROUBLESHOOTING

SUBTOPIC TITLE: ***XVII.E. Air-Conditioning: Service and Problem AnalysisXVII.E. Air-Conditioning Service and Problem Analysis***

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain proper temperatures and pressures at various system locations.
2. Explain proper fan/blower operation.
3. Explain heat exchanger inspection.
4. Explain thermostat setting and operation.
5. Explain sounds that could indicate a problem.
6. Explain how electrical measurements could indicate a problem.
7. Explain value of nameplate data and service records.
8. Discuss the required performance checks.
9. Discuss the method of measuring superheat, subcooling, evaporator and condenser splits.
10. Discuss the proper procedures for using a voltmeter and an ammeter.
11. Explain normal operation of air-conditioning systems.
12. Explain the effects of overcharge and undercharge of refrigerant.
13. Explain the effects of improper airflow.
14. Develop a systematic approach to diagnose mechanical or electrical problems.

XVII. SYSTEM SERVICE AND TROUBLESHOOTING

SUBTOPIC TITLE: ***XVII.E. Air-Conditioning: Service and Problem Analysis XVII.E. Air-Conditioning Service and Problem Analysis (cont'd)***

COMPETENCY OBJECTIVES:

The student will:

TASKS:

1. Check system for system leaks.
2. Check and clean heat exchangers.
3. Check for proper refrigerant charge.
4. Check for proper thermostat and electrical controls.
5. Check oil sample for acidity.
6. Check and replace filter/driers.
7. Check available voltage and install high and low side manifold gauges.
8. Compare static pressure on a P/T Chart to determine unit refrigerant.
9. Start unit and allow to stabilize.
10. Measure superheat and subcooling.
11. Check evaporator and condenser splits.
12. Check amperage of each motor.
13. Analyze performance using manufacturers' specifications.
14. Check electrical component operation.

XVII. SYSTEM SERVICE AND TROUBLESHOOTING

SUBTOPIC TITLE: ***XVII.E. Air-Conditioning: Service and Problem AnalysisXVII.E. Air-Conditioning Service and Problem Analysis (cont'd)***

COMPETENCY OBJECTIVES:

The student will:

TASKS:

15. Check air flow from furnace of air handler.

16. Inspect electrical connections.

17. Troubleshoot A/C systems from electrical schematics.

XVIII. INDOOR AIR QUALITYXVIII. INDOOR AIR QUALITY

SUBTOPIC TITLE: ***XVIII.A. Requirement and Maintenance of Air QualityXVIII.A. Requirement and Maintenance of Air Quality***

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Define Indoor Air Quality (IAQ) as defined by ASHRAE Std. 62.

2. Explain Sick Building Syndrome (SBS) and Building Related Illness (BRI).

3. Explain the different factors that make up acceptable indoor air quality.

    a. pollutant levels
    b. ventilation air quantities
    c. air distribution effectiveness
    d. occupant comfort

XIX. PREVENTATIVE MAINTENANCEXIX. PREVENTATIVE MAINTENANCE

SUBTOPIC TITLE: *XIX.A. Basic Maintenance XIX.A. Basic Maintenance*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain the various types of maintenance programs.
2. Explain broad tasks and frequencies for a quality maintenance program.
3. Explain why each step of the Preventative Maintenance Program is necessary.
4. Explain the benefits associated with proper equipment maintenance.

TASKS:

1. Demonstrate various maintenance tasks.
2. Develop a Preventative Maintenance Program for:
    a. Absorption cooling unit
    b. Electric heat system
    c. Gas heat system
    d. Heat pump system
    e. Hydronic systems
    f. Ice makers
    g. Oil heat system
    h. Package heat and cooling unit
    i. Refrigeration systems
    j. Split system condensing unit and evaporator
    k. Walk-in boxes
    l. Water-cooled centrifugal chiller
    m. Water-cooled reciprocating chiller
3. Develop a list of tools needed to perform the Preventative Maintenance Program.
4. Develop a Preventative Maintenance Check Sheet.

XX. REFRIGERANT RECOVERYXX. REFRIGERANT RECOVERY

SUBTOPIC TITLE: *XX.A. IntroductionXX.A. Introduction*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Describe the environmental issues regarding refrigerant, including legislation, protocol, laws, and regulations.

2. Describe the basic refrigerant cycle.

3. Determine proper evacuation levels and leak rates.

4. Identify three different types of technician certification.

XX. REFRIGERANT RECOVERY

SUBTOPIC TITLE: *XX.B. SafetyXX.B. Safety*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Describe the problems associated with mixing of refrigerants.

2. Describe the methods of determining when a recovery cylinder is full.

3. Describe the problems associated with component isolation where unsafe hydrostatic pressures can occur.

4. Describe the problems associated with contaminants left in a refrigerant system after recovery.

XX. REFRIGERANT RECOVERY

SUBTOPIC TITLE: *XX.C. Refrigerant Recovery, Recycling, and Reclamation Methods**XX.C. Refrigerant Recovery, Recycling, and Reclamation Methods*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Describe how to manually pump down a system.
2. Describe how to isolate system components.
3. Describe system dependent and self-contained recovery equipment.
4. Describe the push-pull method.
5. Describe difference between recycled and reclaimed refrigerant.
6. Explain options in Industry Recycling Guideline (IRG-2).

TASKS:

1. List the advantages/disadvantages, and application of liquid and vapor recovery.
2. List methods for decreasing recovery time.

XX. REFRIGERANT RECOVERY

SUBTOPIC TITLE: *XX.D. Refrigerant Recovery, Recycling and Reclamation EquipmentXX.D. Refrigerant Recovery, Recycling and ReclamationEquipment*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Identify proper equipment for a particular job.
2. Describe procedures for recovering multiple refrigerants with the same recovery unit.
3. Describe maintenance and efficiency testing procedures for recovery units.
4. Describe maintenance and testing for refrigerant recovery cylinders.
5. Identify recovery cylinders.
6. Explain when to change filter-driers in recycling equipment.
7. Explain methods of purging non-condensables when recycling.
8. Identify type of refrigerant in a given recovery cycle.

TASKS:

1. Perform procedures for recovery.
2. Perform procedures for recycling.
3. Perform maintenance on recovery machine.
4. Connect and operate recovery equipment.

XXI. REFRIGERANT RETROFITSXXI. REFRIGERANT RETROFITS

SUBTOPIC TITLE: ***XXI.A Alternative Refrigerant RetrofitsXXI.A Alternative Refrigerant Retrofits***

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Determine if the Alternative Refrigerant and/or Lubricant:

   a. is applicable for retrofitting specific system
   b. is on the EPA SNAP list
   c. is U.L. listed
   d. meets the equipment manufacturers' approval

2. Determine the lubricant required for the alternate refrigerants.

TASKS:

1. Procure the Manufacturers' Changeover Guidelines and follow the retrofit procedures.

2. Measure the residual mineral oil in a system being changed from a CFC to an HFC refrigerant.

XXII. REFRIGERANTS AND LUBRICANTSXXII. REFRIGERANTS AND LUBRICANTS

SUBTOPIC TITLE: *XXII.A. RefrigerantsXXII.A. Refrigerants*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain the different classes of refrigerants:

    a. CFC Refrigerants
    b. HCFC Refrigerants
    c. HFC Refrigerants
    d. HC Refrigerants
    e. Other Refrigerants
    f. Azeotropic mixtures (ASHRAE 500 series)
    g. Zeotropic blends (ASHRAE 400 series)

2. Explain physical and chemical properties:

    a. Flammability and toxicity
    b. Materials compatibility
    c. Miscibility and oil return
    d. Pressure and temperature data
    e. Refrigerant temperature glide
    f. Environmental properties (ODP, GWP and TEWI)
    g. Bubble point
    h. Dew point

3. Define pure refrigerants and azeotropic mixtures.

4. Define zeotropic mixtures.

5. Define zeotropic blends.

6. Identify the color and classification of refrigerants by Pantone Matching System (PMS) color number.

7. Explain fractionization of blends.

XXII. REFRIGERANTS AND LUBRICANTS

SUBTOPIC TITLE: *XXII.A. RefrigerantsXXII.A. Refrigerants (cont'd)*

COMPETENCY OBJECTIVES:

The student will:

TASKS:

1. Look up saturation pressure and temperature:

    a. single element refrigerant
    b. azeotropic
    c. zeotropic
    d. blends

2. Identify when saturation pressure and temperature do not match the refrigerant.

3. Calculate superheat and subcooling.

4. Calculate superheat and subcooling glide.

XXII. REFRIGERANTS AND LUBRICANTS

SUBTOPIC TITLE: ***XXII.B. LubricantsXXII.B. Lubricants***

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain the function of lubricants in systems.

2. Explain the different types and applications of lubricants:

   a. Alkylbenzenes (AB)
   b. Mineral oils
   c Polyolesters (POE)
   d. Polyglocols (PAG)

3. Explain properties of lubricants:

   a. Materials compatibility
   b. Miscibility and oil return
   c. Pour point and flash point
   d. Viscosity
   e. Water absorption
   f. Rust and oxidation inhibitors

4. Describe proper oil disposal.

TASKS:

1. Draw oil sample from system.

2. Demonstrate proper handling of POE's.

3. Use acid test kit for mineral oil and AB.

4. Demonstrate proper use of a refractometer or oil sample test.

XXIII. REGULATIONSXXIII. REGULATIONS

SUBTOPIC TITLE: ***XXIII.A. Codes and Standards XXIII.A. Codes and Standards***

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Describe the reasons for codes.

2. Describe the three model codes:

   a. Building Officials and Code Administrators (BOCA), National Mechanical Code
   b. Southern Building Code Congress International (SBCCI), Standard Mechanical Code
   c. International Conference of Building Officials (ICBO), Uniform Mechanical Code

3. Identify the codes and standards for the applicable area, locality and state.

4. Discuss the relationship between codes and manufacturers' installation instructions.

5. Identify pertinent standards published by the following organizations:

   a. AGA
   b. AMCA
   c. ANSI
   d. ARI
   e. ASHRAE
   f. IEC
   g. ISO
   h. SMACNA
   i. UL

XXIII. REGULATIONS

SUBTOPIC TITLE: ***XXIII.B. Regulations Affecting Ozone DepletionXXIII.B. Regulations Affecting Ozone Depletion***

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain ozone depletion.

2. Explain significance of the Montreal Protocol.

3. Explain significance of the Clean Air Act.

4. Explain EPA requirements:

   a. Technician certification
   b. Refrigerant recover, recycle, and reclaim
   c. Disposal of systems
   d. Labeling
   e. Shipping
   f. Leak detection
   g. Significant New Alternatives Policy Program (SNAP)
   h. Recordkeeping

5. Know Department of Transportation (DOT) requirements concerning transportation of refrigerants.

6. Determine if refrigerant container is DOT-approved and whether it needs to be retested.

7. Determine if recovery/recycle equipment is certified and meets requirements.

TASKS:

1. Dispose of empty non-refillable cylinders.

2. Use recovery equipment and prepare system for disposal.

3. Obtain federal EPA technician certification.

XXIII. REGULATIONS

SUBTOPIC TITLE: ***XXIII.C. Other RegulationsXXIII.C. Other Regulations***

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Explain global warming.
2. Know OSHA Work Rules.
3. Explain Indoor Air Quality (IAQ) standards (ASHRAE Std.62).
4. Explain impact of state and local codes on system application and retrofit.
5. Explain proper disposal of oil, components, and other materials.
6. Explain state and local licensing requirements.
7. Explain DOT regulations.

XXIV. PROFESSIONAL SERVICEXXIV. PROFESSIONAL SERVICE

SUBTOPIC TITLE: *XXIV.A. Customer Relations/CommunicationXXIV.A. Customer Relations/Communication*

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Describe methods of dealing with irate customers.
2. Describe methods of dealing with technician delays and scheduling realities.
3. Describe methods of selling service agreements and replacement equipment.
4. Explain service(s) performed in layman's terms.
5. Explain how to obtain customer satisfaction.
6. Explain service contracts.

TASKS:

1. Demonstrate professional/personal appearance and attitude.
2. Discuss customer telephone etiquette.
3. Describe, list, calculate and present a typical billing invoice.
4. Demonstrate good customer relations.

XXIV. PROFESSIONAL SERVICE

SUBTOPIC TITLE: ***XXIV.B. Character EducationXXIV.B. Character Education***

COMPETENCY OBJECTIVES:

The student will:

KNOWLEDGE:

1. Discuss the following personal traits:

    a. honesty
    b. integrity
    c. reliability
    d. responsibility
    e. accountability
    f character
    g. conflict resolution
    h. teamwork
    i ethics
    j. pride
    k. initiative
    l. time management

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