

**Correlation of
Modern Refrigeration and Air Conditioning, 21st edition**

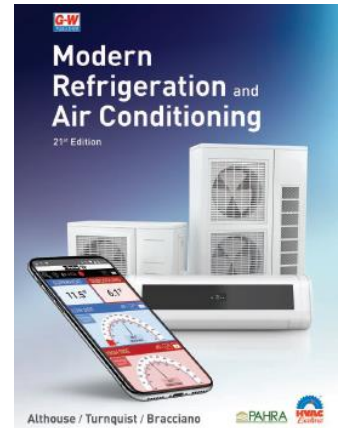
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to

HBI Residential Heating, Ventilation, and Air Conditioning Standards

Goodheart-Willcox is pleased to partner with the Home Builder's Institute by correlating *Modern Refrigeration and Air Conditioning* to the Residential Heating, Ventilation, and Air Conditioning Standards.

The correlation chart below lists the Standards and Objectives for the Residential, Heating, Ventilation, and Air Conditioning exam in the left column. Corresponding content from *Modern Refrigeration and Air Conditioning* that can be used by a student to help achieve the standard and objective is listed in the right column.



Standards / Objectives	Textbook Pages
Standard 1: Applied Academic Skills	
Theory of Heat	
Objective 1 Understand and apply the theory of heat and heat transfer.	pgs. 953-954
Objective 2 Understand and apply principles of matter and energy.	pgs. 53-54
Objective 3 Understand and apply refrigeration cycle and refrigerants used in residential and light commercial installations.	pgs. 85-86
Mathematics	
Objective 1 Perform simple arithmetic functions including addition, subtraction, multiplication, and division of whole numbers, decimals, fractions and mixed numbers both with and without calculators.	pgs. 54-55, 57-59, 66-67, 71-77, 119
Objective 2 Measure and calculate linear distances, circles, angles, and radii in English and metric measurement systems.	pgs. 119, 961-962
Objective 3 Identify common geometric shapes and compute area and volume using basic geometry.	pgs. 71, 78-79
Objective 4 Measure temperature, weight, volume, and pressure in English and metric measurement systems.	pgs. 54-55, 57-59, 66-67

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Standards / Objectives	Textbook Pages
Objective 5 Understand and interpret job specification and manufacturers' tables, graphs and charts.	pgs. 397
Objective 6 Take accurate readings from and interpret different types of scales including volume and pressure gauges, airflow measurements and electrical meters.	pgs. 71-77, 375, 379-383
Objective 7 Solve multi-step problems using basic formulas.	pgs. 54-55, 57-59, 66-67, 71-77
Communication Skills	
Objective 1 Follow verbal directions.	pgs. 10, 14
Objective 2 Follow written directions including reading and understanding technical manuals, schematics, tables, graphs, and charts.	pgs. 384, 1489-1501
Objective 3 Give one- or two-step directions to associates and clients.	pgs. 978
Objective 4 Give multiple-step directions to associates and clients using diagnostic and technical data and information.	pgs. 42-46
Science	
Objective 1 Understand and apply basic principles of temperature, pressure and temperature conversion.	pgs. 57-59, 71-78
Objective 2 Understand and apply basic principles of alternating and direct current, series, parallel, and series parallel circuits, circuit overload protection, single- and three-phase voltage systems, transformers, grounding and bonding principles and electrical measurement.	pgs. 264-274, 283, 288-289
Objective 3 Understand and apply basic principles of heat transfer and combustion.	pgs. 953-954, 1082-1087
Objective 4 Understand and apply basic principles of matter, mass and weight.	pgs. 53-54
Objective 5 Understand and apply basic principles of energy.	pgs. 53-54
Objective 6 Understand and apply basic principles of gas laws including the physical and chemical properties of refrigerants and hydrocarbons and their effects on the environment.	pgs. 78-80
Objective 7 Understand and apply the basic principles of airflow, velocity and pressure measurements.	pgs. 55, 75-78
Objective 8 Understand and apply the basic principles of temperature and humidity.	pgs. 777-779

**Correlation of *Modern Refrigeration and Air Conditioning* to HBI's Residential Heating,
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Standard 2: Basic Occupational Skills	
General Safety Procedures	
Objective 1 Understand and apply proper general safety procedures when working with pressurized systems, electrical energy, heat, cold, and chemicals, rotating machinery, moving heavy objects.	pgs. 21-30
Safety Rules	
Objective 1 Understand and apply Occupational Safety and Health Administration (OSHA) regulations that cover HVAC practices.	pgs. 21
Objective 2 Understand and apply Department of Transportation (DOT) regulations that cover the transportation and handling of hazardous materials, including refrigerants.	pgs. 28-30, 187
Objective 3 Understand and apply Environmental Protection Agency (EPA) regulations that cover air quality as well as venting, recovery, reclaiming, and recycling of refrigerants.	pgs. 16, 160-161, 1526-1532
Objective 4 Apply basic fall protection safety procedures.	pg. 35
Objective 5 Apply all OSHA, EPA and DOT hazardous materials safety requirements.	pgs. 22-30
Objective 6 Apply electrical safety procedures in NEC and local codes and regulations.	pgs. 283-284, 356, 1164, 1166, 1169
Objective 6 Apply safety and maintenance procedures for power tools and cords.	pgs. 23, 36
Objective 7 Apply OSHA rigging safety procedures.	pgs. 21, 35
Objective 8 Apply OSHA ladder and scaffold safety and maintenance procedures.	pgs. 34-35
Objective 9 Use personal protective equipment (PPE) such as safety glasses, electrical protection, shoes, and hardhat.	pgs. 30-34
Objective 10 Use safe methods and tools for lifting and moving materials and equipment to prevent personal injury and property damage.	pgs. 34-35
Objective 11 Use proper procedures to prevent and respond to fire and other hazardous risks.	pgs. 22-30
Objective 12 Use proper procedures for reporting fire and safety incidents.	pgs. 22
Objective 13 Apply brazing and soldering safety procedures to prevent fires and personal injury.	pgs. 22-30
Objective 14 Apply OSHA, EPA, DOT and local safety procedures and codes for safe handling and storage of refrigerant containers.	pgs. 26-29

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Objective 15 Apply proper safety precautions to prevent dangerous chemical reactions, fires and other hazards.	pgs. 22-30
Standard 3: Tools and Equipment	
Basic Safety Tools and Equipment	
Objective 1 Describe the safe use of tools, including power tools used by heating and air conditioning technician.	pgs. 99-124
Objective 2 Describe the safe use of specialized service and installation equipment used to install and service air conditioning, heating and air conditioning systems.	pgs. 99-124
Fasteners and Adhesives	
Objective 1 Describe, select and install the proper fasteners, adhesives and solvents used with wood, sheet metal, fiberglass, plastics and insulation.	pgs. 100, 106, 120, 122-123
Objective 2 Describe, select and install the proper machine screw and masonry anchors and fasteners.	pgs. 100, 106, 120-121
Objective 3 Describe, select and install hanging devices and supports.	pgs. 203
Objective 4 Describe, select and install solderless terminals and screw-on wire connectors.	pgs. 285
Tubing and Piping	
Objective 1 Identify, select, measure and install the proper type of pipe and tubing used in heating, air conditioning applications.	pgs. 129-154
Objective 2 Describe and apply proper procedures for measuring and fabricating copper pipe, including brazing, soldering, cutting, cleaning reaming, bending, flaring and swaging.	pgs. 129-131, 133-152
Objective 3 Fabricate and install plastic piping including cutting, cleaning, solvent welding, connecting, and hanging, so that pipe does not leak.	pgs. 132-136, 138-142
Objective 4 Describe and apply the proper procedures for measuring, cutting, cleaning, reaming and threading steel pipe joined with thread sealant properly applied so that it does not contaminate interior of piping and piping does not leak.	pgs. 131, 133, 136, 138-139
Objective 5 Understand and install piping design for proper oil return in AC systems.	pgs. 445, 457-459, 1305
Objective 6 Understand and install proper long-line refrigerant piping design.	pgs. 843-844, 136-1369
Objective 7 Explain the various factors that affect the selection of proper fittings or valves for specific installations including globe valves, gate valves, ball valves, check valves, elbows, and tees union.	pgs. 144-145, 436, 477-478, 490, 557-558, 843, 1012

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Objective 8 Explain the various factors that affect the selection of flanges, hangers, supports, and insulation.	pgs. 409-412, 1349, 1368
Condensate Piping	
Objective 1 Identify, select, measure and install the proper condensate piping used in heating and air conditioning applications.	pgs. 517, 812
Objective 2 Identify, select, locate and install drain lines to provide for proper discharge of condensate.	pgs. 131-132, 517, 766, 943, 1252
Objective 3 Identify, select, locate and install proper traps and vents for condensate piping.	pgs. 517, 594, 766, 793
Objective 4 Identify, select, locate and install proper auxiliary drain pans and secondary drains.	pgs. 131-133, 142, 145, 851
System Evacuation	
Objective 1 Understand and apply vacuum and evacuation procedures.	pgs. 242-243
Objective 2 Describe and apply the proper selection of a vacuum pump and the measurement of vacuum pressure.	pgs. 212-213
Objective 3 Describe and apply single and multiple vacuum evacuation procedures.	pgs. 242-243
Objective 4 List and apply proper safety procedures used in evacuation.	pgs. 242-243
Refrigerant & Oil Management	
Objective 1 Understand the relationship between potential for ozone depletion and global warming.	pgs. 160-161
Objective 2 Describe how to recover, reclaim and recycle refrigerants.	pgs. 160-161, 189, 213-218
Objective 3 Differentiate between blended and azeotropic refrigerants.	pg. 163
Objective 4 Differentiate among CFCs, HCFs, HFCs, and HCs.	pgs. 161-165
Objective 5 Understand and apply EPA regulations that apply to refrigerants and oils.	pgs. 160-161
Objective 6 Identify DOT-approved recovery cylinders.	pgs. 165, 167
System Charging	
Objective 1 Describe and apply the proper procedures for system charging.	pgs. 244-253
Objective 2 Describe how and when refrigerant is charged into the system in liquid or vapor states.	pgs. 247-249
Objective 3 Read, understand and interpret manufacturers' charging charts properly.	pgs. 224-225

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Checking Instruments	
Objective 1 Test and verify calibration of thermometers at low and high-temperature ranges.	pgs. 116-118
Objective 2 Test and verify ohmmeters and voltmeters for accuracy.	pgs. 115, 119
Objective 3 Verify settings on multimeter before use.	pgs. 116, 119-120
Objective 4 Describe and apply proper procedures for checking pressure and airflow instruments.	pgs. 116, 118-119
Objective 5 Check operation of flue gas instruments.	pgs. 992-993
Standard 4: Basic Automatic Controls	
Basic Electricity & Magnetism	
Objective 1 Understand the principles of electron flow and parts of the atom.	pgs. 57, 259-260, 264-265, 301-302
Objective 2 Understand the difference between alternating current and direct current.	pgs. 264, 272
Objective 3 Explain the basic measurement principles of amperage, voltage, wattage and ohms.	pgs. 260-262, 327-328, 351, 381
Objective 4 Apply Ohms' and Watts' Laws to calculate electrical values.	pgs. 262-263, 279-281
Objective 5 Understand the principles of magnetism and electromagnetic induction.	pgs. 270-271
Objective 6 Explain the basic principles for series, parallel and series-parallel circuits.	pgs. 266-269
Objective 7 Determine voltage and current values for 120/240-volt single-phase service, wye connected (high-leg) three-phase service and delta-connected three-phase service.	pgs. 283, 324, 401
Objective 8 Determine voltage drop in a circuit.	pgs. 269-270
Objective 9 Read, interpret and properly apply manufacturers' electrical specifications.	pgs. 373, 1373
Objective 10 Understand the relationship between resistance, inductive reactance, and capacitive reactance.	pgs. 261, 281-282
Objective 11 Read and interpret volt-ohm-milliamper meter (VOM).	pg. 379
Objective 12 Understand and apply the principles of electrical circuit protection including fuses, circuit breakers, and ground fault interrupters (GFCI).	pgs. 286-289
Objective 13 Understand the principles of sine waves.	pgs. 264, 272, 302
Objective 14 Describe and apply NEC and local codes.	pgs. 283-284, 356, 1164, 1166, 1169

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Automatic Control Circuits	
Objective 1 Read and draw a simple schematic of an electrical control circuit, properly interpreting and using proper NEMA control symbols.	pgs. 286, 328-329
Objective 2 Understand basic principles of semiconductors including diodes, rectifiers, transistors, thermistors, diacs, triacs and heat sinks.	pgs. 298-299, 300-303
Objective 3 Describe different types of automatic controls and explain principles of operation.	pgs. 305
Objective 4 Understand the operation of devices that use bimetal sensors to detect thermal change.	pgs. 344-345
Objective 5 Understand the principles of fluid expansion to detect thermal change.	pg. 914
Objective 6 Understand the principles of thermocouples and thermistors and how they react to thermal change.	pgs. 287, 303, 306-308
Automatic Control Components	
Objective 1 Explain the differences and application of low and high-voltage controls.	pgs. 305, 375, 384, 387
Objective 2 Explain how electrical motors are protected from high temperature and over-loading.	pgs. 330, 347
Objective 3 Describe the uses of pressure-sensing devices, including low- and high-pressure controls and pressure relief valves.	pgs. 305, 375, 384, 387
Objective 4 Describe the functions of mechanical and electromechanical controls.	pgs. 338, 592, 928
Objective 5 Explain the function of solid-state relays in circuits.	pgs. 356-357
Objective 6 Explain the basic principles of control transformers.	pg. 877
Objective 7 Explain the basic principles of operation for variable-speed motor controls.	pgs. 846, 1058
Objective 8 Explain the basic principles of operation for defrost systems.	pgs. 517-526
Objective 9 Explain the basic principles of operation for flow switches.	pgs. 1028-1029
Objective 10 Explain the basic principles of operation for humidistats and dehumidistats.	pgs. 721, 799, 901-902
Objective 11 Explain the basic principles of operation for fan limit switches.	pgs. 918
Objective 12 Explain the basic principles of operation for oil pressure failure switches.	pgs. 349-350
Objective 13 Explain the basic principles of operation for solenoid valves.	pgs. 558-561, 1450

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Objective 14 Explain the basic principles of the operation for short-cycle timers.	pg. 515
Objective 15 Understand the application of electronic controls.	pgs. 338, 344, 892
Objective 16 Understand functions and operation of programmable and non-programmable thermostats.	pgs. 926-931
Objective 17 Describe the differences between electronic and electromechanical controls.	pgs. 592-593
Objective 18 Describe the operation of electronic control boards for use in air conditioning, heat pump, oil burner and gas furnace circuits.	pgs. 268, 344, 592-593, 840, 892
Objective 19 Identify and troubleshoot a basic electronic control circuit board.	pgs. 385, 392
Troubleshoot Automatic Controls	
Objective 1 Troubleshoot mechanical, electromechanical, and electronic control devices.	pgs. 385-392, 397-401, 1489-1501
Objective 2 Recognize the control components in a heat cool circuit.	pgs. 384, 387, 779-780, 790, 799-800
Objective 3 Troubleshoot control devices using pictorial and line-type electrical wiring diagrams.	pgs. 266, 357, 384-385
Objective 4 Conduct systematic and comprehensive diagnostic practices consistent with manufacturer specifications.	pgs. 406, 413, 935-938, 945, 1223-1225
Objective 5 Follow all safety electrical safety practices.	pgs. 22-23
Objective 6 Record electrical voltage and other electrical readings.	pgs. 260-263
Objective 7 Prepare repair plan that meets applicable manufacturer and job specifications.	pgs. 41-43
Integrated Circuit Control Boards	
Objective 1 Understand the principles of the operation of integrated circuit control boards.	pgs. 268, 303-304
Objective 2 Identify and troubleshoot integrated circuit control boards.	pgs. 270, 304, 397-401
Standard 5: Electric Motors	
Types and Characteristics of Electric Motors	
Objective 1 Understand and explain the characteristics of single-phase, three-phase and split-phase motors.	pgs. 318-325
Objective 2 Understand the principle of torque and applications for low- and high-torque motors.	pgs. 317, 353, 409
Objective 3 Identify different types of motors and motor specifications including variable speed and multi-speed fan motors.	pgs. 313-314, 318-325

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Objective 4 Describe the use of motors in hermetic compressors.	pgs. 321-322, 325, 331, 398, 402-404
Objective 5 Describe electric motor protection devices, including low- and high-voltage, heat and single-phasing.	pgs. 320, 359-363
Objective 6 Describe the principles of operation of different types of motors.	pgs. 313-314, 318-325
Application of Motors	
Objective 1 Understand the design features that influence the selection of motors: power supply, work requirements, motor insulation, bearing types, mounting characteristics/frame size, and cooling requirements.	pgs. 314, 316, 322, 324, 327-328, 345
Objective 2 Describe the applications of three-phase and single-phase motors.	pgs. 318-325
Motor Controls	
Objective 1 Understand the principles and differences among a relay, contactor, and magnetic starter.	pgs. 305, 319-322, 354-356
Objective 2 Understand different types of external motor overload protection.	pgs. 354, 361-362
Objective 3 Describe the proper procedures when resetting safety devices to start electric motors.	pgs. 345, 362, 368
Troubleshoot Electric Motors	
Objective 1 Identify and describe the various types of electric motor problems.	pgs. 385-392, 397-401
Objective 2 Distinguish the difference between mechanical or electrical malfunctions.	pgs. 387, 413
Objective 3 Describe a capacitor checkout procedure.	pgs. 348-349, 399-400
Objective 4 Describe troubleshooting an electric motor.	pgs. 389-392
Standard 6: Refrigeration	
Principles of Evaporators & Refrigerant Systems	
Objective 1 Understand the differences between air conditioning and refrigeration systems.	pgs. 585-593, 777-793
Objective 2 Describe different types of evaporators.	pgs. 503-526
Objective 3 Understand the principles of multiple- and single-circuit evaporators.	pgs. 505, 521-522
Refrigerant Metering Devices (Expansion Devices)	
Objective 1 Understand and apply the operating principles and selection of appropriate refrigerant metering devices.	pgs. 467-498
Objective 2 Understand the operating characteristics of expansion devices and how they respond to load changes.	pgs. 467-498

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Condensers	
Objective 1 Understand the principles of heat exchange as applied to condensers.	pgs. 526-535
Objective 2 Describe the operating characteristics and differences between water-cooled and air-cooled condensers.	pgs. 527-529
Objective 3 Explain the operation of and differences between open-loop and closed-loop water condenser systems.	pgs. 527-529
Objective 4 Explain the differences among a tube and fin condenser coil, a coaxial tube condenser, a tube and shell condenser, and a serviceable-tube condenser.	pgs. 506, 509-510, 527-528
Objective 5 Understand the relationship between condensing refrigerant and condensing medium.	pgs. 504-505
Compressors	
Objective 1 Understand the function of a refrigerant compressor.	pgs. 419-420
Objective 2 Explain the differences between hermetic and semi-hermetic compressor.	pgs. 421-422
Objective 3 Identify and describe the various components and parts of compressors.	pgs. 440-448
Accessories and Minor Components	
Objective 1 Understand the principles of refrigeration system components, including mechanical, electrical and electromechanical controls, as well as accessories such as receivers, accumulators, filter-driers, and high- and low pressure switches, time delays, reversing valves and solenoid valves.	pgs. 456, 551, 558-560, 585-593
Troubleshoot Refrigeration Systems	
Objective 1 Understand the operating conditions for air cooled, open-loop and closed-loop water-cooled systems.	pgs. 527-529
Objective 2 Describe and diagnosis problems in a refrigeration system such as low or excessive refrigerant charge, low or high-pressures, unsatisfactory compressor performance, and restrictions in refrigerant systems.	pgs. 620-640
Standard 7: Electric Heat	
Principles of Electric Heat	
Objective 1 Understand and explain principles of electric heat elements installed in air handlers, electric furnaces and duct heaters.	pgs. 1159-1161
Objective 2 Understand and explain principles of electric heat elements installed in air handlers.	pgs. 1160-1163

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Objective 3 Install proper electric heat elements in air handlers according to manufacturer specifications and applicable NEC and other local codes.	pgs. 1160, 1162-1163, 1168-1169
Objective 4 Provide required voltage and safety controls for electrical and control circuits.	pgs. 1169-1174
Objective 5 Follow applicable safety procedures.	pgs. 1161, 1173-1174, 1177
Install Electric Furnace	
Objective 1 Install electric furnaces according to manufacturer specifications.	pgs. 1161-1162
Objective 2 Comply with applicable NEC and local codes.	pgs. 1164, 1166, 1168
Objective 3 Provide required voltage and safety controls as specified.	pgs. 1173-1174
Objective 4 Follow all applicable safety procedures.	pgs. 1161-1162, 1173-1174
Install Electric Duct Heaters	
Objective 1 Install duct heaters according to manufacturer specifications.	pgs. 1163-1164
Objective 2 Comply with applicable NEC and other local codes.	pgs. 1164, 1170
Objective 3 Size duct heaters properly to the duct and airflow requirements.	pgs. 1163-1164
Objective 4 Install control circuits to provide required voltage and safety controls as specified.	pgs. 1170-1171
Objective 5 Follow all applicable safety procedures.	pgs. 1173-1174
Troubleshoot Electric Heating System	
Objective 1 Follow systematic and comprehensive diagnostic practices consistent with manufacturer's specifications.	pgs. 413, 935-936
Objective 2 Follow all appropriate safety regulations and procedures.	pgs. 1173-1174
Objective 3 Record electrical measurements and temperatures not meeting specified operating parameters.	pgs. 376, 1160
Standard 8: Gas Heat	
Principles of Gas Heat	
Objective 1 Understand and explain principles of gas-fired forced-air heating systems, such as combustion and operation of heat exchangers.	pgs. 1081-1087
Objective 2 Describe the major components of gas-fired furnaces and types of fuel.	pgs. 1082-1087
Objective 3 Explain the basic principles of operation for gas burner controls.	pgs. 1088-1090

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Objective 4 Describe the procedures for taking flue-gas carbon dioxide readings and temperatures.	pgs. 1085-1086
Install Gas Furnaces	
Objective 1 Install gas-fired forced-air heating systems according to manufacturer's specifications.	pgs. 1092-1097, 1100
Objective 2 Comply with applicable AGA standards, local codes and regulations, including combustion air and venting.	pgs. 1083, 1095-1096
Objective 3 Install furnace with all electrical and control circuits as specified.	pgs. 1097-1099
Objective 4 Ensure that system operates within manufacturer specifications.	pgs. 1097-1099
Install Gas Piping	
Objective 1 Ensure that system operates within manufacturer specifications.	pgs. 1101-1102
Objective 2 Perform tests to determine that piping and joints do not leak.	pgs. 1101-1102
Install Gas Venting	
Objective 1 Install vents according to manufacturer specifications and applicable local codes.	pg. 1099
Objective 2 Perform tests to determine that all seams and joints do not leak.	pgs. 1099-1100
Provide Combustion Air for Gas-Fired System	
Objective 1 Provide combustion air to meet local code and manufacturer specifications.	pgs. 1082-1087
Gas Safety Tests and Start-Up	
Objective 1 Perform all applicable safety tests to meet manufacturer specifications and applicable codes at start-up.	pgs. 1085, 1096-1097, 1102, 1103
Objective 2 Follow all applicable safety procedures.	pgs. 1083, 1095-1096
Troubleshoot Gas Heat Systems	
Objective 1 Follow systematic and comprehensive diagnostic practices consistent with manufacturer's recommendations.	pgs. 1100, 1104-1108
Objective 2 Record electrical measurements, pressures and temperatures not meeting specified operating parameters, including measurements of gas valves, pilot lights, blower fans, and other system components and safety devices operating outside manufacturer specifications.	pgs. 1085-1086, 1091-1092, 1097, 1104
Objective 3 Prepare repair plan that meets applicable manufacturer's specifications and local codes.	pgs. 1100, 1104, 1108

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Standard 9: Oil Heat	
Principles of Oil Heat	
Objective 1 Understand and apply the principles of oil-fired forced air-heating systems.	pgs. 1115-1117
Objective 2 Describe the major components of oil heating systems.	pgs. 1123-1126
Objective 3 Explain the basic principles of operation for oil burner controls.	pgs. 1127-1134
Objective 4 Describe basic service and preventive maintenance procedures.	pgs. 1142-1153
Objective 5 Describe basic diagnostic procedures to determine burner efficiency, basic malfunctions, and corrective procedures.	pgs. 1118-1122
Install Oil Furnaces	
Objective 1 Install oil-fired forced-air heating system according to manufacturer's specifications.	pgs. 1141-1142, 1146-1149
Objective 2 Comply with applicable NEC, National Fuel Gas Code, and local codes.	pgs. 1142
Objective 3 Install all electrical and control circuits, voltage and safety controls as specified.	pgs. 1121, 1123-1127, 1141-1142, 1146-1149
Objective 4 Follow all applicable safety procedures.	pgs. 1136, 1138
Install Oil Piping and Tanks	
Objective 1 Install steel piping according to manufacturer specifications and applicable codes.	pgs. 1123-1124, 1141-1142, 1146
Objective 2 Measure, cut and install piping correctly with thread sealant properly applied at joints.	pgs. 1123-1124, 1142, 1144, 1146
Objective 3 Install joints without leaks.	pgs. 1144
Objective 4 Properly support all piping using clamps and supports spaced with adjustments to ensure adequate flow of oil without sagging between supports.	pgs. 1123-1124, 1142, 1144, 1146
Objective 5 Follow all applicable safety procedures.	pgs. 1123-1124, 1142, 1144
Objective 6 Install oil tanks according to manufacturer specifications and applicable codes.	pgs. 1117-1118, 1123-1124
Objective 7 Install below-ground tanks level and compacted with approved materials to prevent movement.	pgs. 1144
Objective 8 Install above-ground tanks slightly pitched towards the outlet.	pgs. 1143, 1145
Objective 9 Follow all applicable safety procedures.	pgs. 1123-1124, 1141-1142, 1144

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Install Oil Venting	
Objective 1 Install vents according to manufacturer specifications and applicable codes.	pgs. 1142, 1144
Objective 2 Perform tests to determine that all seams and joints do not leak.	pgs. 1144
Objective 3 Follow all applicable safety procedures.	pgs. 1142, 1144
Provide Combustion Air Oil-Fired System	
Objective 1 Provide combustion air to meet all applicable local codes as well as heating system and manufacturer specifications.	pgs. 1116-1117, 1120-1121
Oil Safety Tests and Start-Up	
Objective 1 Perform all applicable safety tests at start-up to meet manufacturer specifications and applicable local codes at.	pgs. 1118-1122, 1152-1153
Objective 2 Follow all applicable safety procedures.	pgs. 1118-1122, 1152-1153
Troubleshoot Oil Heat Systems	
Objective 1 Follow systematic and comprehensive diagnostic practices consistent with manufacturer specifications.	pgs. 1135, 1147-1153
Objective 2 Record draft and combustion efficiency measurements and stack temperatures.	pgs. 1118-1122
Objective 3 Record measures of other component parts not meeting specified operating parameters including pumps, burner motor, blower fan, nozzles and other system components and safety devices operating outside manufacturer specifications.	pgs. 1118-1122
Objective 4 Prepare repair plan that meets applicable manufacturer specifications and local codes.	pgs. 1123-1124, 1142-1145, 1147
Boilers	
Objective 1 Understand and apply principles of electric, gas and oil boilers.	pgs. 1042-1043
Standard 10: Hydronic Heat	
Principles of Hydronic Heat	
Objective 1 Understand and apply principles of gas-fired, electric or oil-fired hot water and radiant panel hydronic heating systems.	pgs. 1006-1007, 1025-1029
Objective 2 Describe the major components of hydronic heating systems including pressure relief valve, zone control valve, balancing valve, limit controls, expansion tank, boiler, backflow prevention device and air elimination device.	pgs. 1006-1017

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Objective 3 Understand and apply principles of centrifugal pumps.	pgs. 1009, 1034
Install Hydronic Heating Systems	
Objective 1 Install gas-fired, electric or oil-fired hot water and radiant panel hydronic heating systems according to manufacturer specifications.	pgs. 1032-1033
Objective 2 Comply with applicable NEC and other codes and regulations.	pgs. 1008, 1021, 1032-1033
Objective 3 Install boiler, pumps, piping, makeup water supply and other components properly for the correct water flow to meet building's heating and domestic hot-water requirements.	pgs. 1008, 1012-1014, 1032-1033
Objective 4 Fill and bleed the system according to manufacturer specifications.	pgs. 1032-1033, 1035
Objective 5 Install all safety devices properly as required by local codes.	pgs. 1008, 1021, 1032-1033
Objective 6 Follow all applicable safety procedures.	pgs. 1008, 1021, 1032-1033
Test Integrity of Hydronic Heating Water Circuits	
Objective 1 Test hydronic heating piping system, including heating and hot-water circuits for leaks and air entrapment.	pgs. 1032-1043
Objective 2 Make adjustments as required.	pgs. 1011-1012
Objective 3 Test that system does not leak.	pgs. 1032-1043
Objective 4 Follow all applicable safety procedures.	pgs. 1032-1043
Hydronic Heating Systems Start-Up	
Objective 1 Perform all applicable safety tests that meet manufacturer specifications and applicable codes at start-up.	pgs. 1032-1034
Objective 2 Follow all applicable safety procedures.	pgs. 1032-1034
Troubleshoot Hydronic Heating Systems	
Objective 1 Follow systematic and comprehensive diagnostic practices consistent with manufacturer specifications.	pgs. 1032-1043
Objective 2 Record electrical measurements, pressures and temperatures and other system parameters not meeting specified operating parameters.	pgs. 1032-1043
Objective 3 Prepare repair plan that meets applicable manufacturer and job specifications.	pgs. 1041-1042

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Alternative Heating	
Objective 1 Understand and apply principles of alternative stoves, fireplace inserts and solar heating systems.	pgs. 1189-1191, 1237-1241
Objective 2 Explain proper venting for gas and wood stoves.	pgs. 1185, 1190
Objective 3 Explain the safety hazards of wood stoves.	pg. 762
Objective 4 Understand and apply the basic principles of active and passive solar heating.	pgs. 1189-1191
Packaged Electrical Air Conditioning and Gas Heating Units	
Objective 1 Explain the basic principles of operation for air conditioning systems that operate in conjunction with gas heating systems.	pgs. 786-790
Objective 2 Properly read and interpret schematic diagrams for an air conditioning system that operates in conjunction with a gas heating system.	pgs. 786-790
Install Air Treatment Devices	
Objective 1 Understand indoor air treatment devices and carbon monoxide safety standards.	pgs. 695, 1084-1086, 1103
Objective 2 Understand and apply principles of air treatment devices.	pgs. 704, 711-714
Objective 3 Install indoor air treatment devices according to manufacturer specifications, job requirements and local codes.	pgs. 711-714
Objective 4 Comply with applicable NEC and local codes.	pgs. 693, 704
Objective 5 Follow all applicable safety procedures.	pgs. 693, 703, 711
Objective 6 Understand and apply principles of fresh air ventilation and air exchange.	pgs. 81, 697-698, 702-703, 712-714
Objective 7 Understand and apply principles of dehumidification and humidification.	pgs. 906-909
Objective 8 Properly connect a dehumidistat and humidistat in a circuit.	pgs. 908-909
Troubleshoot Air Treatment Devices	
Objective 1 Follow systematic and comprehensive diagnostic practices consistent with manufacturer specifications.	pgs. 698-703, 706-707, 711
Objective 2 Record measurements not meeting specified operating parameters.	pg. 706
Objective 3 Prepare repair plan that meets applicable manufacturers, job specifications and local codes.	pg. 706

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Standard 11: Air Distribution Systems	
Principles of Air Distribution Systems	
Objective 1 Understand and apply principles of air distribution systems.	pgs. 719-721
Objective 2 Describe proper components of air distribution systems.	pgs. 719-721
Objective 3 Describe appropriate uses of propeller and centrifugal blowers.	pgs. 680, 721, 742-743, 750
Objective 4 Describe the different types of air-measuring devices and their uses in measuring air quantities and air flow.	pgs. 759-764
Objective 5 Understand and use a duct calculator.	pgs. 747-748
Install Air Distribution Systems	
Objective 1 Install air distribution systems with materials and practices that conform to all applicable standards and local codes.	pgs. 721, 725-728, 733-737, 739
Objective 2 Provide airflow to rooms that match heat loss/heat gain calculations.	pgs. 724, 727-728, 754
Objective 3 Fabricate, install and insulate metal square and rectangle, flexible, fiberboard, round metal and combination duct systems according to manufacturer specifications.	pgs. 726-742
Objective 4 Support trunk ducts and branch ducts with necessary brackets and hangers as specified in standards and local codes.	pgs. 728-731
Objective 5 Connect branch ducts to trunk ducts.	pgs. 731
Objective 6 Seal all seams to ensure no leakage.	pgs. 730
Objective 7 Test air distribution systems for balance, system airflow, pressure and leaks to meet job and manufacturer specifications.	pgs. 739-741, 747-748
Troubleshoot Air Distribution Systems	
Objective 1 Conduct systematic and comprehensive diagnostic practices consistent with job and manufacturer specifications and ACCA Manual D or equivalent.	pgs. 742, 747-748
Objective 2 Identify air distribution parameters not meeting required operating specifications.	pgs. 722-726, 747-748
Objective 3 Prepare repair plan that meets applicable performance requirements.	pgs. 722-726

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Standard 12: Air Conditioning	
Principles of Air Conditioning	
Objective 1 Understand and apply the basic principles of air conditioning related to heat transfer, temperature, humidity, and air movement.	pgs. 678-987, 777-779, 899-902, 953-954
Objective 2 Describe and explain the function of air conditioning components including evaporator, condenser, compressor, metering devices, fans, air distribution systems, and air filtration systems.	pgs. 467-468, 718-722, 748-754, 801-802, 891-893
Objective 3 Describe and explain the function of condensate drains.	pgs. 766, 806-808
Objective 4 Understand and apply the basic principles and effects of dew-point temperature, wet- and dry bulb temperature, room temperature, ambient temperature and relative humidity.	pgs. 58-59, 665-666, 668, 720, 899-900
Objective 5 Explain the relationship of air properties to comfort of humans.	pgs. 676-678
Objective 6 Understand air conditioning design standards set by the Air Conditioning and Refrigeration Institute (ARI).	pgs. 851
Install Air Conditioning Systems	
Objective 1 Install air-conditioning package or split system to manufacturer specifications.	pgs. 786-790, 797-799
Objective 2 Comply with applicable NEC and local codes and regulations.	pgs. 790, 808-809, 841
Objective 3 Provide the airflow required by job specifications.	pgs. 780-781, 812-813, 815-816
Objective 4 Securely fasten the air conditioning unit as specified.	pgs. 781, 823, 841, 843
Objective 5 Locate and install the air handler on a solid base or suspend it from a strong support according to manufacturer specifications and local code.	pgs. 800, 804, 812
Objective 6 Locate and install the air handler, condenser and evaporator coil in serviceable positions.	pgs. 800, 804
Objective 7 Install the condensate drain system according to job and manufacturer specifications and local codes.	pgs. 806-808
Objective 8 Properly connect all electrical and control circuits to provide voltage and safety controls as specified.	pgs. 786, 812, 816, 845-847, 865
Objective 9 Install air filtration system according to manufacturer and job specifications.	pgs. 702-703, 770-773
Objective 10 Install evaporative cooling system according to manufacturer specifications.	pgs. 891-894
Objective 11 Test condensate drain to verify that it meets job and manufacturer specifications.	pgs. 800, 804, 806, 808

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Air Conditioning Control Systems	
Objective 1 Understand and describe basic components of air conditioning control systems.	pgs. 337-341, 781-782, 799-800
Objective 2 Understand the differences between operating controls and safety controls.	pgs. 799-800
Objective 3 Describe the functions of system components such as operating and safety controls, thermistors, internal relief valves, overload protectors and thermostats.	pgs. 799-800, 916-923
Air Conditioning Evacuation and Charging	
Objective 1 Understand the purpose of evacuating systems before charging.	pgs. 240-244, 810
Objective 2 Perform evacuation and charging according to manufacturer specifications.	pgs. 240-244, 810
Recover, Reclaim and Recycle Refrigerants	
Objective 1 Perform recovery, reclamation and recycling of refrigerants in compliance with EPA regulations based on Section 608 of the Clean Air Act.	pgs. 160-161, 214, 1526-1527
Air Conditioning Start-up and Performance Testing	
Objective 1 Check all electrical and refrigerant connections and drains at start-up as specified by local codes.	pgs. 790, 807-809
Objective 2 Understand and evaluate ambient operating conditions of air conditioning equipment according to manufacturer specifications, including system pressures and temperatures.	pgs. 549, 574, 577, 579-580
Objective 3 Compare operating performance of air conditioning systems with manufacturer specifications.	pgs. 799-800
Troubleshoot Air Conditioning Systems	
Objective 1 Perform systematic and comprehensive diagnostic practices consistent with manufacturer specifications.	pgs. 813-816, 845, 855, 858, 936-938
Objective 2 Compare suction, discharge pressures and refrigerant temperatures to manufacturer specifications at current ambient conditions.	pgs. 780, 786-787, 804, 807-808, 816
Objective 3 Check and record Delta T (temperature difference) of air across the evaporator.	pgs. 60-62, 812, 816
Objective 4 Check and record line and low-voltage power measurements not meeting specified operating parameters.	pgs. 937-938
Objective 5 Prepare repair plan that meets applicable manufacturer and job specifications.	pgs. 813-816, 845, 855, 858, 936-938

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Standard 13: Air-to-Air Heat Pumps (Air Source Heat Pumps)	
Principles of Air-to-Air Heat Pumps	
Objective 1 Understand and apply the basic principles of air-to-air heat pumps including heat sources, types of heat pumps, balance points and heat transfer.	pgs. 1051-1055
Objective 2 Understand the coefficient of performance (COP) and heating seasonal performance factor (HSPF).	pgs. 1055-1056
Objective 3 Describe the functions of various air-to-air heat pump components including reversing valve, metering devices, thermostatic expansion valves, condensate drains and controls.	pgs. 1056-1067
Objective 4 Use the manufacturer performance data with calculations of heat loss and equipment capacity to determine the balance point.	pgs. 1071
Install Heat Pump	
Objective 1 Install air source heat pump (package or split systems) according to manufacturer specifications.	pgs. 1051-1052, 1073-1074
Objective 2 Comply with applicable NEC and local codes.	pgs. 1055, 1067
Objective 3 Securely fasten the heat pump unit.	pgs. 1073-1074
Objective 4 Properly install all electrical and control circuits to provide voltage and safety controls as specified.	pgs. 1073-1074
Objective 5 Test the condensate drain to verify that it meets manufacturer specifications and local codes.	pgs. 1071, 1074
Supplementary, Auxiliary or Emergency Heat	
Objective 1 Understand and apply the principles of supplemental, auxiliary or emergency heat including electric, oil and gas sources.	pgs. 1067-1072
Charging and Evacuating Heat Pumps	
Objective 1 Charge and evacuate heat pumps according to manufacturer specifications.	pgs. 1056, 1074
Performance and Start-up Testing	
Objective 1 Check all electrical and refrigerant connections and drains at start-up as specified by local codes.	pgs. 1061-1062, 1067, 1074
Objective 2 Verify that all safety devices function properly.	pgs. 1062
Objective 3 Understand and evaluate ambient operating conditions of heat pump equipment according to manufacturer specifications, including system pressures and temperatures.	pgs. 1057-1058
Objective 4 Test that the system has proper airflow per specifications.	pgs. 1064, 1070, 1074
Objective 5 Compare operating performance of heat pump systems with manufacturer specifications.	pgs. 1055-1056

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Troubleshoot Heat Pumps	
Objective 1 Perform systematic and comprehensive diagnostic practices consistent with manufacturer specifications.	pgs. 1075-1076
Objective 2 Compare suction, discharge pressures and refrigerant temperatures to manufacturer specifications at current ambient conditions.	pgs. 1061-1063
Objective 3 Check and record delta T (temperature difference) of air across the indoor coil.	pgs. 1055
Objective 4 Check operation of reversing valve and defrost system.	pgs. 1050, 1056, 1061-1063, 1069-1071
Objective 5 Check and record line and low-voltage power measurements not meeting specified operating parameters.	pgs. 1058, 1073-1075
Objective 6 Prepare repair plan that meets applicable manufacturer and job specifications and local codes.	pgs. 1073-1076
Standard 14: Geothermal or Water-Source Heat Pumps	
Principles of Geothermal Heat Pumps	
Objective 1 Understand and apply the principles of open loop and closed-loop heat pumps.	pgs. 1052-1055
Objective 2 Describe different ground-loop configurations for closed-loop geothermal systems.	pgs. 1055
Objective 3 Explain the advantages and disadvantages of series- and parallel-flow configurations in geothermal pump systems.	pgs. 1067-1068
Objective 4 Describe the different types and water sources for geothermal or water-source heat pumps.	pgs. 1054, 1065-1066
Install Geothermal or Water-Source Heat Pumps	
Objective 1 Install geothermal or water-source heat pump according to manufacturer specifications.	pgs. 1073-1074
Objective 2 Comply with applicable NEC and local codes.	pgs. 1055, 1067
Objective 3 Securely fasten the heat pump unit.	pgs. 1073-1074
Objective 4 Properly install all electrical and control circuits to provide voltage and safety control as specified.	pgs. 1073-1074
Objective 5 Properly size and assemble heat pump transfer piping system without leaks to meet manufacturer and job specifications.	pgs. 1065, 1074
Objective 6 Test system for air and water leaks.	pgs. 1074-1076
Supplementary, Auxiliary or Emergency Heat	
Objective 1 Understand and apply the principles of supplemental, auxiliary or emergency heat including electric, oil and gas sources.	pgs. 1067-1072

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Charging and Evacuating Heat Pumps	
Objective 1 Charge and evacuate heat pumps according to manufacturer specifications.	pgs. 1056, 1074
Performance and Start-up Testing	
Objective 1 Check all electrical and refrigerant connections and drains at start-up as specified by local codes.	pgs. 1061-1062, 1067, 1074
Objective 2 Verify that all safety devices function properly.	pgs. 1062
Objective 3 Understand and evaluate ambient operating conditions of heat pump equipment according to manufacturer specifications, including system pressures and temperatures.	pgs. 1057-1058
Objective 4 Test that the system has proper airflow per specifications.	pgs. 1064, 1070, 1074
Objective 5 Test that the system has proper waterflow pressure and temperature per specifications.	pgs. 1068
Objective 6 Compare operating performance of heat pump systems with manufacturer specifications.	pgs. 1055-1056
Troubleshoot Geothermal or Water-Source Heat Pumps	
Objective 1 Perform systematic and comprehensive diagnostic practices consistent with manufacturer specifications.	pgs. 1075-1076
Objective 2 Compare suction, discharge pressures and refrigerant temperatures to manufacturer specifications at current ambient conditions.	pgs. 1061-1063
Objective 3 Check and record delta T (temperature difference) of air across the indoor coil.	pgs. 1055
Objective 4 Check operation of reversing valve.	pgs. 1050, 1056, 1061-1063, 1069-1071
Objective 5 Check waterflow, GPM, and inlet and outlet temperatures.	pgs. 1058, 1073-1075
Objective 6 Check and record line and low-voltage power measurements not meeting specified operating parameters.	pgs. 1058, 1073-1075
Objective 7 Prepare repair plan that meets applicable manufacturer and job specifications and local codes.	pgs. 1073-1076

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Standard 15: Evaporative Coolers	
Principles of Evaporative Coolers	
Objective 1 Understand and apply principle of evaporative coolers.	pgs. 891
Install Evaporative Coolers	
Objective 1 Install evaporator coolers according to manufacturer specifications.	pgs. 891-894, 1240
Objective 2 Comply with applicable NEC and local codes.	pgs. 891-894
Objective 3 Provide airflow as required by specifications.	pgs. 891
Objective 4 Securely fasten the cooling unit and all electrical and control circuits to provide voltage and safety controls as specified.	pgs. 891-894
Objective 5 Test system for air and water leaks.	—
Objective 6 Install piping system and drains with no leakage.	pgs. 891-894
Performance and Start-up Testing	
Objective 1 Check all electrical and water connections and drains at start-up as specified by local codes.	pgs. 891-894
Objective 2 Verify that all safety devices function properly.	pgs. 891-894
Objective 3 Understand and evaluate ambient operating conditions of equipment according to manufacturer specifications, including system pressures and temperatures.	pgs. 891-894
Objective 4 Test system for proper airflow per specifications.	pgs. 891-894
Objective 5 Test that the system has proper water flow over evaporator pads per specifications.	pgs. 891-894
Objective 6 Compare operating performance of system with manufacturer specifications.	pgs. 891-894
Troubleshoot Evaporative Coolers	
Objective 1 Conduct systematic and comprehensive diagnostic practices consistent with manufacturer specifications.	pgs. 891-894
Objective 2 Record electrical voltage, airflow, temperature and relative humidity measurements.	pgs. 891-894
Objective 3 Prepare repair plan that meets applicable manufacturer and job specifications.	pgs. 891-894