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Five Year HVACR Service Technician Apprenticeship Curriculum



Year 1

Module 1-1 OSHA 10 Hour Certification

A General Safety Practices

- 1 PPE
- 2 Fire Safety
- 3 Tool Safety
- 4 Electrical Safety
- 5 Fall Protection
- 6 Stairways and Ladders
- 7 Vehicle Safety (DOT)
- 8 Red Cross Training and CPR
- 9 *Lock Out and Tag

Module 1-2 UA Heritage

A Your New Partners

- 1 Describe the Organizational Structure and Emblem of the United Association
- 2 Describe the History of United Association
- 3 Describe Role of Career Partnerships (4 Legged Stool)

B Getting Off to the Right Start

- 4 Identify Opportunities in the Pipe Trades
- 5 Describe a Winning Attitude
- 6 Define the Role of the JATC
- 7 Define Apprentices' Roles and Responsibilities during Their Apprenticeship

C Your Collective Voice

- 8 Describe the History of Labor Unions in the US
- 9 Define the Future Role of the Unions in the US
- 10 Trace the History of the UA in the Pipe Trades Industry
- 11 Define the UA as It Is Today

D Your Employer as Your Partner

- 12 Define the Important Role Contractors Play in the Craft
- 13 Describe the Bidding Process Including Contractors' Direct and Indirect Costs

- 14 Describe Your Role in Helping Contractors
- 15 Describe the Role of Contractors' Associations

E Effectiveness on the Job

- F** 16 Define Effectiveness on the Job
- G** 17 Develop Good Learning Habits
- 18 Develop Good Work Habits
- 19 Think Safety
- 20 Deal Well with People
- 21 Learn to Communicate Effectively
- 22 Representing Your Employer

H Your Most Important Partner

- 23 Define Attitudes in Action
- 24 Define Personal Commitmen
- 25 Define Guidelines for Growth
- 26 Strive for Excellence
- 27 Define the Need for Achievement

Module 1-3 *Thermal Dynamic Theory and Application*

A Theory

- 1 Temperature
- 2 Introduction to Heat
- 3 Conduction
- 4 Convection
- 5 Radiation
- 6 Sensible Heat
- 7 Latent Heat
- 8 Specific Heat
- 9 Sizing Heating Equipment
- 10 Pressure
- 11 Atmospheric Pressure
- 12 Pressure Gages
- 13 Temperature Conversion--Fahrenheit and Celsius
- 14 Pressure Measured in Metric Terms

B Matter and Energy

- 1 Matter and Energy
- 2 Mass and Weight
- 3 Density
- 4 Specific Gravity
- 5 Specific Volume
- 6 Gas Laws
- 7 Energy
- 8 Conservation of Energy
- 9 Energy Contained in Heat
- 10 Energy in Magnetism
- 11 Purchase of Energy
- 12 Energy Used as Work
- 13 Power
- 14 Electrical Power--the Watt

C Refrigeration Cycle and Refrigerants

- 1 Introduction
- 2 Refrigeration
- 3 Rating Refrigeration Equipment
- 4 The Refrigeration Process
- 5 Pressure and Temperature Relationship
- 6 Refrigeration Components
- 7 The Evaporator
- 8 The Compressor
- 9 The Condenser
- 10 The Refrigerant Metering Device
- 11 Refrigeration System and Components
- 12 Refrigerants
- 13 Refrigerants Must Be Safe
- 14 Refrigerants must be detectable
- 15 The Boiling Point of the Refrigerants
- 16 Pumping Characteristics
- 17 Popular Refrigerants and Their Important Characteristics
- 18 Refrigerant Cylinder Color Codes
- 19 Recovery, Recycle, or Reclaim of Refrigerants

Module 1-4 Tools and Equipment

A Tools and Equipment

- 1 General Hand Tools
- 2 Specialized Hand Tools
- 3 Tubing Tools
- 4 Specialized Service and Installation Equipment
- 5 Refrigerant Leak Detectors

B Fasteners

- 1 Nails
- 2 Staples and Rivets
- 3 Threaded Fasteners
- 4 Concrete Fasteners
- 5 Other Fasteners

C Tubing and Piping (Use with Module 1-6)

- 1 Purpose of Tubing and Piping

- 2 Types and Sizes of Tubing
- 3 Tubing Insulation 4 Line Sets
- 5 Cutting Tubing
- 6 Bending Tubing
- 7 Soldering and Brazing Processes
- 8 Heat Sources for Soldering and Brazing
- 9 Soldering Techniques
- 10 Brazing Techniques Practical Soldering and Brazing Tips
- 11 Making Flare Joints
- 12 Making a Double-Thickness Flare
- 13 Swaging Techniques
- 14 Steel and Wrought Iron Pipe
- 15 Joining Steel Pipe
- 16 Installing Steel Pipe
- 17 Plastic Pipe

D Calibrating

Instruments

- 1 The Need for Calibration
- 2 Calibration
- 3 Temperature-Measuring Instruments
- 4 Pressure Test Instruments
- 5 Electrical Test Instruments
- 6 Refrigerant Leak Detection Devices
- 7 Flue-Gas Analysis Instruments
- 8 General Maintenance

Module 1-5 Basic Electricity

A Basic Electricity and Magnetism

- 1 Structure of Matter
- 2 Movement of Electrons
- 3 Conductors
- 4 Insulators
- 5 Electricity Produced from Magnetism
- 6 Direct Current
- 7 Alternating Current
- 8 Electrical Units of Measurement
- 9 The Electrical Circuit
- 10 Making Electrical Measurement
- 11 Ohm's Law

- 12 Characteristics of Series Circuits
- 13 Characterizes of Parallel Circuits
- 14 Electrical Power
- 15 Magnetism
- 16 Inductance

- 17 Transformers
- 20 Electrical Measuring Instruments
- 21 Sine Waves (Single Phase AC)
- 22 Wire Sizes

- 23 Circuit Protection Devices

Module 1-6 Copper Tube Soldering and Brazing (See 1-4-C)

A Copper Tube Soldering and Brazing Certification

Safety and Safe Work Practices

Introduction

Types and Uses of Copper Tube

Solder, Brazing Filler Metals and Fluxes

Joint Preparation and Assembly

Heating Equipment

Making a Soldered Joint

Performance Test for Soldering

Making a Brazed Joint

Brazing Performance Test

Brazeable Metals

Nitrogen Use and Regulator Safety

Module 1-7 Basic Math

A Whole Numbers

- 1 Addition of Whole Numbers
- 2 Subtraction of Whole Numbers
- 3 Multiplication of Whole Numbers
- 4 Division of Whole Numbers
- 5 Combined Operations with Whole Numbers

B Common Fractions

- 1 Addition of Common Fractions
- 2 Subtraction of Common Fractions
- 3 Multiplication of Common Fractions
- 4 Division of Common Fractions
- 5 Combined Operations with Common Fractions

C Decimal Fractions

- 1 Addition of Decimal Fractions
- 2 Subtraction of Decimal Fractions
- 3 Multiplication of Decimal Fractions
- 4 Division of Decimal Fractions
- 5 Decimal and Common Fraction Equivalents
- 6 Combined Operations with Decimal Fractions

D Ratio and Proportion

- 1 Ratio
- 2 Proportion

E Percent, percentage, and Discount

- 1 Percent and Percentage
- 2 Discounts

Module 1-8 Customer Relations

A Basics of Customer Service

- 1 Defining Customer Service
- 2 First Impressions
- 3 Cleanliness and Neatness Equal Professionalism
- 4 Who Are Your Customers?
- 5 Qualities for the Service Technician
- 6 Fixing the Customer versus Fixing the Equipment
- 7 Verbal/Nonverbal Communication
- 8 Basic Writing Skills

Year 2

Module 2-1 *Refrigerant Safety*

- A Soldering and Refrigerant Handling and Safety
- B Chemical Safety
- C Hazardous Materials (MSDS)
- D Respiration (SCBA)

Module 2-2 *Refrigerant Characteristics and Handling*

A Refrigerant Oil Chemistry and Management (Recovery, Recycling, Reclaiming, And Retrofitting

- 1 Refrigerants and the Environment
- 2 Ozone Depletion
- 3 Global Warming
- 4 Refrigerants
- 5 CFC Refrigerants
- 6 HCFC Refrigerants

- 7 HFC Refrigerants
- 8 HC Refrigerants
- 9 Naming Refrigerants
- 10 Refrigerant Blends
- 11 Popular Refrigerants and Their Compatible Oils
- 12 Refrigerant Oils and Their Applications
- 13 Oil Groups
- 14 Regulations (EPA)
- 15 Recovery, Recycle, or Reclaim
- 16 Methods of Recovery
- 17 Mechanical Recovery Systems
- 18 Recovering Refrigerant from Small Appliances
- 19 Reclaiming Refrigerant
- 20 Refrigerants and Tools In the Future

B System Evacuation

- 1 Reliable and Efficient Systems
- 2 Standing Pressure Test
- 5 Leak Detection Methods
- 6 Leak Detection Tips
- 7 Repairing Leaks
- 8 Purpose of System Evacuation
- 9 Theory Involved With Evacuation
- 10 Measuring the Vacuum
- 11 Recovering Refrigerant
- 12 The Vacuum Pump
- 13 Deep Vacuum
- 12 Multiple Evacuation
- 13 Leak Detection While in a Vacuum
- 14 Removing Moisture with a Vacuum
- 15 General Evacuation Procedures
- 16 Systems with Schrader Valves
- 17 Gauge Manifold Hoses
- 18 System Valves
- 19 Using Dry Nitrogen
- 20 Cleaning a Dirty System (Filter Dryers)

C System Charging

- 1 Charging a Refrigeration System
- 2 Vapor Refrigerant Charging
- 3 Liquid Refrigerant Charging
- 4 Weighing Refrigerant
- 5 Using Charging Devices
- 6 Using Charging Charts
- 7 Sub-Cooling Method of Charging For TXV Systems
- 8 Charging Near-Azeotropic (Zeotropic) Refrigerant Blends

Module 2-3 Electric Motors

A Types of Electric Motors

- 1 Uses of Electric Motors
- 2 Parts of an Electric Motor

3	Electric Motors and Magnetism
4	Determining a Motor's Speed
5	Start Windings
6	Starting and Running Characteristics
7	Electrical Power Supplies
8	Single-Phase Open Motors
9	Split-Phase Motors
10	The Centrifugal Switch
11	The Electronic Relay
12	Capacitor-Start Motors
18	Capacitance
19	Impedance
13	Capacitor-Start, Capacitor-Run Motors
14	Permanent Split-Capacitor Motors
15	Shaded-Pole Motors
16	Three-Phase Motors
17	Single-Phase Hermetic Motors
18	The Potential Relay
19	The Current Relay
20	Positive Temperature Coefficient Start Device
21	Two-Speed Compressor Motors
22	Special Application Motors
23	Three-Phase Motor Compressors
24	Variable-Speed Motors
25	DC Converters (Rectifiers)
26	Inverters
27	Electronically Commutated Motors
28	Cooling Electric Motors

B Application of Motors

C	1	Motor Applications
	2	The Power Supply
	3	Electric Motor Working Conditions
	4	Insulation Type or Class
	5	Types of Bearings
	6	Motor Mounting Characteristics
	7	Motor Drives

D Motor Controls

	1	Introduction to Motor Control Devices
	2	Run-Load and Locked-Rotor Current
	3	The Relay

- 4 The Contactor
- 5 Motor Starters
- 6 Motor Protection
- 7 Inherent Motor Protection
- 8 External Motor Protection
- 9 National Electrical Code's Standards
- 10 Temperature-Sensing Devices
- 11 Magnetic Overload Devices
- 12 Restarting the Motor

E Troubleshooting Electric Motors

- 1 Electric Motor Troubleshooting
- 2 Mechanical Motor Problems
- 3 Removing Drive Assemblies
- 4 Belt Tension
- 5 Pulley Alignment
- 6 Electrical Problems
- 7 Open Windings
- 8 Shorted Motor Windings
- 9 Short Circuit to Ground (Frame)
- 10 Single-Phase Motor Starting Problems
- 11 Checking Capacitors
- 12 Identification of Capacitors
- 13 Wiring and Connectors
- 14 Troubleshooting Hermetic Motors
- 15 Service Technician Calls

Module 2-4 Controls

A Introduction to Automatic Controls

- 1 Types of Automatic Controls
- 2 Devices That Respond to Thermal Change
- 3 The Bimetal Device
- 4 Control by Fluid Expansion
- 5 The Thermocouple
- 6 Electronic Temperature-Sensing Devices

B Automatic Control Components and Application

- 1 Recognition of Control Components
- 2 Temperature Controls
- 3 Space Temperature Controls, Low Voltage
- 4 Space Temperature Controls, High (Line) Voltage
- 5 Sensing the Temperature of Solids
- 6 Measuring the Temperature of Fluids
- 7 Sensing Temperature in an Airstream
- 8 Things to Remember About Sensing Devices
- 9 Pressure-Sensing Devices
- 10 Pressure Transducers
- 11 High-Pressure Controls
- 12 Low-Pressure Controls
- 13 Oil Pressure Safety Controls
- 14 Air Pressure Controls
- 15 Gas Pressure Switches
- 16 Devices That Control Fluid Flow and Do Not Contain Switches
- 17 Water Pressure Regulators
- 18 Gas Pressure Regulators
- 19 Mechanical Controls
- 20 Electromechanical Controls
- 21 Maintenance of Mechanical Controls
- 22 Maintenance of Electromechanical Controls
- 23 Service Technician Calls

Module 2-5 *Basic Commercial Refrigeration*

A **Evaporators and the Refrigeration System**

- 1 Refrigeration
- 2 Temperature Ranges of Refrigeration
- 3 The Evaporator
- 4 Boiling and Condensing
- 5 The Evaporator and Boiling Temperature
- 6 Removing Moisture
- 7 Heat Exchange Characteristics of the Evaporator
- 8 Types of Evaporators
- 9 Evaporator Evaluation
- 10 Latent Heat in the Evaporator
- 11 The Flooded Evaporator
- 12 Dry-Type Evaporator Performance
- 13 Evaporator Superheat
- 14 Hot Pull Down (Excessively Loaded Evaporator)

- 15 Pressure Drop in Evaporators
- 16 Liquid Cooling Evaporators (Chillers)
- 17 Evaporators for Low-Temperature Application
- 18 Defrost of Accumulated Moisture

B Condensers 1 The Condenser

- 2 Water-Cooled Condensers
- 3 Tube within a Tube Condenser
- 4 Mineral Deposits
- 5 Cleanable Condensers
- 6 Shell and Coil Condensers
- 7 Shell and Tube Condensers
- 8 Wastewater Systems
- 9 Refrigerant-to-Water Temperature Relationship for Wastewater Systems
- 10 Re-circulated Water Systems
- 11 Cooling Towers
- 12 Natural-Draft Towers
- 13 Forced- or Induced-Draft Towers
- 14 Evaporative Condensers
- 15 Air-Cooled Condensers
- 16 High-Efficiency Condensers
- 17 The Condenser and Low Ambient Conditions
- 18 Head Pressure Control
- 19 Using the Condenser Superheat
- 20 Heat Reclaim
- 21 Floating Head Pressures
- 22 Condenser Evaluation

C Compressors

- 1 The Function of the Compressor
- 2 Types of Compressors
- 3 Reciprocating Compressor Components
- 4 Belt-Drive Mechanism Characteristics
- 5 Direct-Drive Compressor Characteristics
- 6 Reciprocating Compressor Efficiency
- 7 Discus Valve Design
- 8 Liquid in the Compressor Cylinder
- 9 System Maintenance and Compressor Efficiency

D Expansion devices

- 1 Expansion Devices
- 2 Thermostatic Expansion Valve
- 3 TXV Components
- 4 The Valve Body
- 5 The Diaphragm
- 6 Needle and Seat
- 7 The Spring
- 8 The Sensing Bulb and Transmission Tube
- 9 Types of Bulb Charge
- 10 The Liquid Charge Bulb
- 11 The Cross Liquid Charge Bulb 12 The Vapor Charge Bulb
- 13 The Cross Vapor Charge Bulb
- 14 Functioning Example of a TXV with Internal Equalizer
- 15 TXV with External Equalizers
- 16 TXV Response to Load Changes
- 17 TXV Valve Selection
- 18 Balanced-Port TXV
- 19 Dual-Port TXV
- 20 Pressure-Limiting TXV
- 21 Servicing the TXV
- 22 Sensing Element Installation
- 23 The Solid-State Controlled Expansion Valve
- 24 Step-Motor Expansion Valves
- 25 Algorithms and PID Controllers
- 26 The Automatic Expansion Valve
- 27 Automatic Expansion Valve Response to Load Changes
- 28 Special Considerations for the TXV and AXV
- 29 The Capillary Tube Metering Device
- 30 Operating Charge for the Capillary Tube System

Module 2-6 Customer Relations

A Communicating with Customers

- 1 Review of Year One
- 2 Strategies When Communicating
- 3 Speak the Customer's Language
- 4 Listening
- 5 Asking Appropriate Questions

- 6 Clarifying and Restating
- 7 The Cycle of Service

Module 2-7 CFC Certifications

- A EPA Universal Certification CFC (Required)
- B R410A Certification (Required)

Module 2-8 Routine Maintenance

- A Coil Cleaning

Year 3

Module 3-2 Air Conditioning (Heating and Humidification)

A Electric Heat

- 1 Introduction
- 2 Portable Electric Heating Devices
- 3 Radiant Heating Panels
- 4 Electric Baseboard Heating
- 5 Unit Heaters
- 6 Electric Hydronic Boilers
- 7 Central Forced-Air Electric Furnaces
- 8 Automatic Controls for Forced-Air Electric Furnaces
- 9 The Low-Voltage Thermostat
- 10 Controlling Multiple Stages
- 11 Wiring Diagrams
- 12 Control Circuits for Forced Air Electric Furnaces.
- 13 Fan Motor Circuits
- 14 Contactors to Control Electric Furnaces
- 15 Airflow in Electric Furnaces
- 16 Service Technician Calls

B Gas Heat

- 1 Introduction to Gas Fired Forced Hot - Air Furnaces
- 2 Types of Furnaces
- 3 Gas Fuels

4	Gas Combustion
5	Gas Regulators
6	Gas Valve
7	Solenoid Valve
8	Diaphragm Valve
9	Heat Motor-Controlled Valve
10	Automatic Combination Gas Valve
11	Manifold
12	Orifice
13	Burners
14	Heat Exchangers
15	Fan Switch
16	Limit Switch
17	Pilots
18	Safety Devices at the Standing Pilot
19	Ignition Systems
20	Flame Rectification
21	High-Efficiency Gas Furnaces
22	Electronic Ignition Modules and Integrated Furnace Controllers
23	Two-Stage Gas Furnaces
24	Modulating Gas Furnaces
25	Venting
26	Gas Piping
27	Gas Furnace Wiring Diagrams and Troubleshooting Flowcharts
28	Troubleshooting the Safety Pilot-Proving Device-The Thermocouple
29	Troubleshooting Spark-Ignition or Intermittent Pilot Systems
30	Combustion Efficiency
31	Service Technician Calls

C Oil Heat

1	Introduction to Oil-Fired Forced-Warm Air Furnaces
2	Physical Characteristics
3	Fuel Oils
4	Preparation of Fuel Oil for Combustion
5	By-Products of Combustion
6	Gun-Type Oil Burners
7	Oil Furnace Wiring Diagrams
8	Stack Switch Safety Control
9	Cad Cell Safety Control
10	Fuel Oil Supply Systems

- 11 Combustion Chamber
- 12 Heat Exchanger
- 13 Condensing Oil Furnace
- 14 Service Procedures
- 15 Combustion Efficiency
- 16 Service Technician Calls

D Hydronic Heat

- 1 Introduction to Hydronic Heating
- 2 Boiler
- 3 Limit Control
- 4 Water-Regulating Valve
- 5 Pressure Relief Valve
- 6 Air Cushion Tank or Expansion Tank
- 7 Zone Control Valves
- 8 Centrifugal Pumps
- 9 Finned-Tube Baseboard Units
- 10 Balancing Valves
- 11 Flow Control Valves
- 12 Horizontal and Vertical (Downflow) Forced-Air Discharge Unit Heaters
- 13 Hydronic Heating Piping Systems
- 14 Tankless Domestic Hot Water Heaters
- 15 Service Technician Calls

E Indoor Air Quality

- 1 Introduction
- 2 Sources of Indoor Air Pollution
- 3 Controlling Indoor Air Contamination
- 4 Common Pollutants
- 5 Contamination Source Detection and Elimination
- 6 Ventilation
- 7 Air Cleaning
- 8 Duct Cleaning
- 9 Air Humidification
- 10 Sizing Humidifiers
- 11 Installation
- 12 Service, Troubleshooting, and Preventive Maintenance

Module 3-3 Air Conditioning (Cooling)

A Comfort and Psychrometrics

- 1 Comfort
- 2 Food Energy and the Body
- 3 Body Temperature
- 4 The Comfort Chart
- 5 Psychrometrics
- 6 Moisture in Air
- 7 Superheated Gases in Air
- 8 Humidity
- 9 Dry-Bulb and Wet-Bulb Temperatures
- 10 Dew Point Temperature
- 11 The Psychrometric Chart
- 12 Plotting on the Psychrometric Chart
- 13 Total Heat

B Refrigeration Applied to Air Conditioning

- 1 Refrigeration
- 2 Structural Heat Gain
- 3 Evaporative Cooling
- 4 Refrigerated Cooling or Air Conditioning
- 5 The Evaporator
- 6 The Function of the Evaporator
- 7 Design Conditions
- 8 Evaporator Application
- 9 The Compressor
- 10 The Reciprocating Compressor
- 11 Compressor Speeds (rpm)
- 12 Cooling the Compressor and Motor
- 13 Compressor Mountings
- 14 Rebuilding the Hermetic
Compressor
- 15 The Rotary Compressor
- 16 The Scroll Compressor
- 17 The Condenser
- 18 Side-Air-Discharge Condensing Units
- 19 Top-Air-Discharge Condensers
- 20 Condenser Coil Design
- 21 High-Efficiency; Condensers
- 22 Cabinet Design

- 23 Expansion Devices
- 24 Air-Side Components
- 25 Installation Procedures

C Air Distribution and Balance

- 1 Conditioning Equipment
- 2 Correct Air Quantity
- 3 The Forced Air System
- 4 The Blower
- 5 System Pressures
- 6 Air-Measuring Instruments for Duct Systems
- 7 Types of Fans
- 8 Types of Fan Drives
- 9 The Supply Duct System
- 10 The Plenum System
- 11 The Extended Plenum System
- 12 The Reducing Plenum System
- 13 The Perimeter Loop System
- 14 Duct System Standards
- 15 Duct Materials
- 16 Galvanized Steel Duct
- 17 Fiberglass Duct
- 18 Spiral Metal Duct
- 19 Flexible Duct
- 20 Combination Duct Systems
- 21 Duct Air Movement
- 22 Balancing Dampers
- 23 Duct Insulation
- 24 Blending the Conditioned Air with Room Air
- 25 The Return Air Duct System
- 26 Sizing Duct for Moving Air
- 27 Measuring Air Movement for Balancing
- 28 The Air Friction Chart
- 29 Practical Troubleshooting Techniques
- 30 Residential Duct System Problems
- 31 Commercial Duct Systems

D Installation

- 1 Introduction to Equipment Installation
- 2 Square and Rectangular Duct
- 3 Round Metal Duct Systems
- 4 Insulation for Metal Duct
- 5 Ductboard Systems
- 6 Flexible Duct
- 7 Electrical Installation
- 8 Installing the Refrigeration System
- 9 Installing Split-System Air Conditioners
- 10 The Split-System Condensing Unit
- 11 Installing Refrigerant Piping
- 12 Equipment Start-Up

E Controls

- 1 Controls for Air Conditioning
- 2 Prime Movers-Compressors and Fans
- 3 Low-Voltage Controls
- 4 Some History of Residential Central Air Conditioning
- 5 Economics of Equipment Design
- 6 Operating Controls for Older Air-Cooled Systems
- 7 Safety Controls for Older Air-Cooled Systems
- 8 Operating Controls for Modern Equipment
- 9 Safety Controls for Modern Equipment
- 10 The Working Control Package
- 11 Electronic Controls and Air-Conditioning Equipment

F Typical Operating Conditions

- G** 1 Mechanical Operating Conditions
- H** 2 Relative Humidity and the Load
- 3 System Component Relationships under Load Changes
- 4 Evaporator Operating Conditions
- 5 High Evaporator Load and a Cool Condenser
- 6 Grades of Equipment
- 7 Documentation with the Unit
- 8 Establishing a Reference Point on Unknown Equipment
- 9 Metering Devices for High-Efficiency Equipment
- 10 Equipment Efficiency Rating
- 11 Typical Electrical Operating Conditions
- 12 Matching the Unit to the Correct Power Supply

- 13 Starting the Equipment with the Correct Data
- 14 Finding a Point of Reference for an Unknown Motor Rating
- 15 Determining the Compressor Running Amperage
- 16 Compressors Operating at Full-Load Current
- 17 High Voltage, the Compressor, and Current Draw
- 18 Current Draw and the Two-Speed Compressor

I Troubleshooting

- 1 Introduction
- 2 Mechanical Troubleshooting
- 3 Gage Manifold Usage
- 4 When to Connect the Gages
- 5 Low-Side Gage Readings
- 6 High-Side Gage Readings
- 7 Temperature Readings
- 8 Charging Procedures in the Field
- 9 Electrical Troubleshooting
- 10 Compressor Overload Problems
- 11 Compressor Electrical Checkup
- 12 Troubleshooting the Circuit Electrical Protectors-Fuses and Breakers
- 13 Service Technician Calls

Module 3-4 Mechanical

- A Troubleshoot/Repair/Replace Bearings and Bushings
- B Troubleshoot/Repair/Replace Shafts
- C Troubleshoot/Repair/Replace Seals and O-Rings
- D Troubleshoot/Replace Belts, Sheaves/Pulley
- E Perform Alignment and Balancing
- F Maintain Couplings

Module 3-5 Blueprint Reading

- A Basic Mechanical Symbols
- B Basic Blueprint Symbols
- C Interpret Schematics

Module 3-6 Controls

A Troubleshooting Basic Controls

- 1 Introduction to Troubleshooting
- 2 Troubleshooting a Simple Circuit
- 3 Troubleshooting a Complex Circuit
- 4 Troubleshooting the Thermostat
- 5 Troubleshooting Amperage in the Low-Voltage Circuit
- 6 Troubleshooting Voltage in the Low-Voltage Circuit
- 7 Electrically Troubleshooting Switches and Loads
- 8 Pictorial and Line Diagrams
- 9 Service Technician Calls

Module 3-7 Math for Troubleshooting

A Direct Measure

- 1 Equivalent Units of Temperature Measure
- 2 Angular Measure
- 3 Units of Length Measure
- 4 Equivalent Units of Length Measure
- 5 Length Measure

B Computed Measure

- 1 Area Measure
- 2 Equivalent Units of Area Measure
- 3 Rectangular Volumes
- 4 Cylindrical Volumes

C Formulas

- 1 Ohm's Law and Electrical Relationships
- 2 Gas Laws
- 3 Heat Load Calculations

D Stretchouts and Lengths of Arcs

- 1 Stretchouts of Square and Rectangular Ducts
- 2 Stretchouts of Circular Ducts
- 3 Lengths of Arcs of Circles

E Trigonometry

1 Trigonometric Functions

F Graphs

1 Graphs and Graphing

G Billing

1 Estimates and Bills

Module 3-8 Customer Relations

A Dealing with the customer

- 1 Review of Year Two
- 2 The Relationship between Service and Customer Loyalty
- 3 Behavior Breeds Behavior
- 4 Empathy
- 5 Saying "No" Effectively
- 6 Develop Successful Recovery Skills
- 7 Dealing with Irate, Demanding, and Indifferent Customers

Module 3-9 Residential Light Commercial Air Conditioning

A Residential Light Commercial Air Conditioning

- 1 Domestic Refrigerators
- 2 Domestic Freezers
- 3 Room Air Conditioners

B Insert "UA STAR Residential-Light Commercial Study Guide"

C UA STAR Residential-Light Commercial Certification Exam

Requirement- Three years work experience or be in 3rd year of Apprenticeship.

D UA STAR Commercial Refrigeration Certification Exam

Requirement- Three years work experience or be in 3rd year of Apprenticeship.

Year 4

Module 4-1 *Intermediate Commercial Refrigeration*

A Special Refrigeration System Components

- 1 The Four Basic Components
- 2 Mechanical Controls
- 3 Two-Temperature Controls
- 4 Evaporator Pressure Control
- 5 Multiple Evaporators
- 6 Electric Evaporator Pressure Regulator Valve
- 7 Crankcase Pressure Regulator
- 8 Adjusting the CPR Valve
- 9 Relief Valves
- 10 Low Ambient Controls
- 11 Fan-Cycling Head Pressure Controls
- 12 Fan Speed Control for Controlling Head Pressure
- 13 Air Volume Control for Controlling Head Pressure
- 14 Condenser Flooding
for Controlling Head
Pressure
- 15 The Solenoid Valve

- 16 Pressure Switches
- 17 Low-Pressure Switch
- 18 Low-Pressure Control Applied as a Thermostat
- 19 Automatic Pump-Down Systems
- 20 High-Pressure Control
- 21 Low Ambient Fan Control
- 22 Oil Pressure Safety Control

- 23 Defrost Cycle
- 24 Medium-Temperature
Refrigeration
- 25 Random or Off-Cycle Defrost

- 26 Planned Defrost

- 27 Low-Temperature Evaporator Design
- 28 Defrost Using Internal Heat (Hot Gas Defrost)

- 29 External Heat Type of Defrost
- 30 Defrost Termination and Fan
Delay Control
- 31 Refrigeration Accessories

- 32 Receivers
- 33 The King Valve on the Receiver
- 34 Filter Driers
- 35 Refrigerant Check Valves
- 36 Refrigerant Sight Glasses
- 37 Liquid Refrigerant Distributors
- 38 Heat Exchangers
- 39 Suction-Line Accumulators
- 40 Suction-Line Filter Driers
- 41 Suction Service Valves
- 42 Discharge Service -Valves
- 43 Refrigeration Line Service Valves
- 44 Diaphragm Valves
- 45 Ball Valves
- 46 Oil Separators
- 47 Vibration Eliminators
- 48 Pressure Access Ports
- 49 Crankcase Heat
- 50 Plotting the Refrigerant Cycle
- 51 Plotting the Refrigerant Cycle for Blends with Noticeable
Temperature Glide (Zeotropic Blends)

B Application of Refrigeration Systems

- 1 Application Decisions
- 2 Reach-In Refrigeration Merchandising
- 3 Self-Contained Reach-In Fixtures
- 4 Individual Condensing Units
- 5 Multiple Evaporators and Single- Compressor Applications
- 6 Parallel Compressor Systems
- 7 Secondary Fluid Refrigeration Systems
- 8 Pressurized Liquid Systems
- 9 Unitary Stand-Alone Refrigeration Systems
- 10 Evaporator Temperature Control

- 11 Interconnecting Piping in Multiple- Evaporator Installations
- 12 Temperature Control of the Fixture
- 13 The Evaporator and Merchandising
- 14 Chest-Type Display Fixtures
- 15 Refrigerated Shelves
- 16 Closed-Type Chest Fixtures
- 17 Controlling Sweating on the Cabinet of Fixtures
- 18 Maintaining Store Ambient Conditions
- 19 Walk-In Refrigeration
- 20 Knock-Down Walk-In Coolers
- 21 Walk-In Cooler Doors
- 22 Evaporator Location in a Walk-In Cooler
- 23 Condensate Removal
- 24 Refrigeration Piping
- 25 Package Refrigeration for Walk-In Coolers
- 26 Vending Machine Refrigeration
- 27 Water Coolers
- 28 Refrigerated Air Driers **C Commercial Ice Machines**

- 1 Ice-Making
Equipment,
Packaged Type
- 2 Making Flake Ice
- 3 Making Cube Ice
- 4 Microprocessors
- 5 Making Cylindrical Ice
- 6 Water and Ice Quality
- 7 Package Ice Machine Location,
- 8 Troubleshooting Ice Makers
- 9 Service Technician Calls

D Special Refrigeration Applications

- 1 Special Application Refrigeration
- 2 Transport Refrigeration
- 3 Truck Refrigeration Systems
- 4 Railway Refrigeration
- 5 Extra -Low-Temperature Refrigeration
- 6 Cascade Systems
- 7 Quick Freezing Methods

- 8 Marine Refrigeration
- 9 Air Cargo Hauling

E Troubleshooting and Typical Operating Conditions for Commercial Refrigeration 1

Organized Troubleshooting

- 3 Troubleshooting High-Temperature Applications
- 4 Troubleshooting Medium-Temperature Applications
- Troubleshooting Low-Temperature Applications
- 5 Typical Air-Cooled Condenser Operating Conditions
- 6 Calculating the Correct Head Pressure for Air-Cooled Equipment

- 7 Typical Operating Conditions for Water-Cooled Equipment
- 8 Typical Operating Conditions for Wastewater Condenser Systems
- 9 Typical Operating Conditions for Recirculated Water Systems
- 10 Six Typical Problems
- 11 Low Refrigerant Charge
- 12 Refrigerant Overcharge
- 13 Inefficient Evaporator
- 14 Inefficient Condenser
- 15 Refrigerant Flow Restrictions
- 16 Inefficient Compressor
- 17 Compressor Vacuum Test
- 18 Closed-Loop Compressor Running Bench Test

- 19 Closed-Loop Compressor Running Field Test
- 20 Compressor Running Test in the System
- 21 Service Technician Calls

Module 4-2 All-Weather Systems

A Electric, Gas, and Oil Heat with Electric Air Conditioning

- 1 Comfort All Year
- 2 Five Processes for Conditioning Air

- 3 Add-On Air Conditioning
- 4 Insulation for Existing Ductwork
- 5 Evaluation of an Existing Duct System

- 6 Cooling Versus Heating Air Quantity

- 7 Control Wiring for Cooling and Heating
- 8 Two Low-Voltage Power Supplies
- 9 Phasing Two Low-Voltage Transformers
- 10 Adding a Fan Relay
- 11 New All-Weather Systems
- 12 All-Weather Split Systems
- 13 Package or Self-Contained All-Weather Systems
- 14 Wiring the All-Weather System
- 15 Servicing the All-Weather System

B Air Source Heat Pumps

- 1 Reverse-Cycle Refrigeration
- 2 Heat Sources for the Winter
- 3 The Four-Way Valve
- 4 Types of Heat Pumps
- 5 Solar-Assisted Heat Pumps

- 6 The Air-to-Air Heat Pump
- 7 Refrigerant Line Identification
- 8 Metering Devices
- 9 Thermostatic Expansion Valves
- 10 The Capillary Tube
- 11 Combinations of Metering
Devices
- 12 Electronic Expansion Valves

- 13 Orifice Metering Devices
- 14 Liquid-Line Accessories
- 15 Application of the Air-to-Air Heat Pump
- 16 Auxiliary Heat
- 17 Balance Point
- 18 Coefficient of Performance
- 19 Split-System Air-to-Air Heat Pump

- 20 The Indoor Unit
- 21 Air Temperature of the Conditioned Air
- 22 The Outdoor Unit Installation
- 23 Package Air-to-Air Heat Pumps
- 24 Controls for the Air-to-Air Heat Pump
- 25 The Defrost Cycle
- 26 Indoor Fan Motor Control

- 27 Auxiliary Heat
- 28 Servicing the Air-to-Air Heat Pump
- 29 Troubleshooting the Electrical System
- 30 Troubleshooting Mechanical Problems
- 31 Troubleshooting the Four-Way Valve
- 32 Troubleshooting the Compressor
- 33 Checking the Charge
- 34 Special Applications for Heat Pumps
- 35 Heat Pumps Using Scroll Compressors
- 36 Heat Pump Systems with Variable Speed Motors
- 37 Service Technician Calls

C Geothermal Heat Pumps

- 38 Reverse-Cycle Refrigeration
- 39 Geothermal Heat Pump
Classifications
- 40 Open-Loop Systems
- 41 Water Quality
- 42 Closed-Loop Systems
- 43 Ground-Loop Configurations and Flows
- 44 System Materials and Heat Exchange Fluids
- 45 Geothermal Wells and Water Sources
- 46 Troubleshooting
- 47 Waterless, Earth-Coupled, Closed-Loop Geothermal Heat
Pump Systems
- 48 Service Technician Calls

Module 4-3 Commercial Refrigeration

A Supermarket Refrigeration

1. Insert "UA STAR Commercial Refrigeration Study Guide"

Module 4-4 Lifting and Rigging

A Insert UA Material

Module 4-5 *Customer Relations*

A **Maintaining the Customer Relationship**

- 1 Review of Year Three
- 2 The Customer Is Always Right
- 3 Customer Perceptions versus Reality
- 4 Writing the Work Order
- 5 Creating Options and Alternatives
- 6 Keeping Customers Informed
- 7 Adapting to Customer Requests

Year 5

Module 5-1 *Chilled Water Air Conditioning Systems*

A High Pressure, Low Pressure, and Absorption Chilled Water Systems

- 1 Chillers
- 2 Compression Cycle Chillers
- 3 Reciprocating Compressor Chillers
- 4 Cylinder Unloading and Variable Frequency Drives
- 5 Scroll Compressor Chillers
- 6 Rotary Screw Compressor Chillers
- 7 Centrifugal Compressor Chillers (High-Pressure)
- 8 Evaporators for High-Pressure Chillers
- 9 Direct Expansion Evaporators
- 10 Flooded Evaporator Chillers
- 11 Condensers for High-Pressure Chillers
- 12 Water-Cooled Condensers
- 13 Condenser Sub-cooling
- 14 Air-Cooled Condensers
- 15 Sub-cooling Circuit
- 16 Metering Devices for High-Pressure Chillers
- 17 Thermostatic Expansion Valve 18 Orifice
- 19 Float-Type Metering Devices
- 20 Electronic Expansion Valve
- 21 Low-Pressure Chillers
- 22 Compressors
- 23 Condensers for Low-Pressure Chillers
- 24 Metering Devices for Low-Pressure Chillers
- 25 Purge Units
- 26 Absorption Air-Conditioning Chillers
- 27 Solution Strength
- 28 Solutions Inside the Absorption System
- 29 Circulating Pumps for Absorption Systems
- 30 Capacity Control
- 31 Crystallization
- 32 Purge System
- 33 Absorption System Heat Exchangers
- 34 Direct-Fired Systems
- 35 Motors and Drives for Compression Cycle Chillers
- 36 Part-Winding Start

- 37 Autotransformer Start
- 38 Wye-Delta
- 39 Electronic Starters
- 40 Motor Protection
- 41 Load-Limiting Devices
- 42 Mechanical-Electrical Motor Overload Protection
- 43 Electronic Solid-State Overload Device Protection
- 44 Anti-Recycle Control
- 45 Phase Failure Protection
- 46 Voltage Unbalance
- 47 Phase Reversal

B Cooling Towers and Pumps

- 1 Cooling Tower Function
- 2 Types of Cooling Towers
- 3 Fire Protection
- 4 Fill Material
- 5 Flow Patterns
- 6 Tower Material

- 7 Fan Section
- 8 Tower Access
- 9 Tower Sump
- 10 Makeup Water
- 11 Blowdown
- 12 Balancing the Water Flow for a Tower
- 13 Water Pumps

C Operation, Maintenance, and Troubleshooting Of Chilled Water Air-Conditioning Systems

- 1 Chiller Start-Up
- 2 Scroll Chiller Start-Up
- 3 Reciprocating Chiller Start-Up
- 4 Rotary Screw Chiller Start-Up
- 5 Centrifugal Chiller Start-Up
- 6 Scroll and Reciprocating Chiller Operation
- 7 Large Positive Displacement Chiller Operation
- 8 Centrifugal Chiller Operation
- 9 Air-Cooled Chiller Maintenance
- 10 Water-Cooled Chiller Maintenance

- 11 Absorption Chilled Water System Start-Up
- 12 Absorption Chiller Operation and Maintenance
- 13 General Maintenance for All Chillers
- 14 Low-Pressure Chillers
- 15 Recovering Refrigerant from a Low-Pressure Chiller
- 16 High-Pressure Chillers
- 17 Service Technician Calls

Module 5-2 *Pneumatic Fundamentals*

- A Air Station
- B Function of Air Station
- C Air Filtration
- D Pressure
Regulators
- E Thermostat
- F Controllers
Sensors
- H Transmitter
- I Receiver Controllers
Switches & Relays
- K Controlled Devices

Module 5-3 *Building Automation Fundamentals*

- A Terminology
- B Hardware/Software
- C Input/Output Types
- D Data Types
- E User Interfaces
- F Network Types and Devices
- G Network Cabling
- H Programming Introduction

Module 5-4 *Steam Systems*

- A Maintain Steam Traps
- B Maintain Steam Regulators
- C Maintain Steam Coils

- D Maintain Vacuum Breakers
- E Maintain Steam Flash (Vent) Tanks
- F Maintain Insulation Systems

Module 5-5 *Controls*

A *Advanced Automatic Controls (Including DDC, Pneumatics)*

- 1 Control Applications
- 2 Types of Control Systems
- 3 Pneumatic Controls Cleaning and
- 4 Drying Control Air
- 5 Control Components
- 6 Direct Digital Controls (DDC)
- 7 Residential Electronic Controls

Module 5-6 *Customer Relations*

A *Evaluating Your Service*

- 1 Review of Year One Through Four
- 2 Exceeding Customers' Expectations
- 3 Dimensions of Quality Service
- 4 Personal Quality Audit
- 5 Resolving Service Conflicts
- 6 Evaluating the Service You Provide

Module 5-7 *Codes and Standards*

- A ASHRAE
- B BOCA
- C IRC
- D ARI Standards
- E UBC Code
- F Local Codes
- G NFPA
- H Permits and Inspections

Module 5-8 *Final Exam*

A UA STAR HVACR Certification

B Review and Prep