

HVAC/R Technology

Heating, Ventilation, Air Conditioning & Refrigeration

Perry Technical Institute's two-year HVAC/R Technology Program is divided into four sections: 1) HVAC/R Fundamentals, 2) Residential/Light Commercial HVAC/R, 3) Commercial Refrigeration and 4) Industrial HVAC/R. Classroom and shop training prepares students to enter the HVAC/R industry as qualified entry-level technicians who enjoy outstanding employment opportunities. The students learn the curriculum, through classroom and extensive hands-on-training. Approximately 60% of the time will encompass lab or lab related instruction.

Perry Technical Institute's HVAC/R Program is approved by Washington State Department of Labor & Industries as a 06A HVAC/R Specialty Electrical Training program. Graduates will be credited with (1 year or 2000 hours) towards the (2 years or 4000 hours) required by the State of Washington to be eligible to take the certification exam for the 06A HVAC/R Specialty Electrical License.

Students have the opportunity to gain industry certifications in six different areas, giving them competitive advantages in the employment market. Externships are encouraged with employers during the last three months of training.

The HVAC/R Technology is 24 months in length. The student will earn 235.5 credit hours (class option) or 215.3 credit hours (externship option) which is 3,024 clock hours. Tuition is payable on a quarterly basis. There are four (4) quarters in an academic year.

During the 8th quarter training, a student has the option of working in an externship with an employer or choosing the ammonia-based training provided at the school.

HVAC/R Technology Program Outline

		Clock Hours	Credit Hours
Quarter 1			
RE 101	Electrical & Tool Safety	10	1.0
RE 102	First Aid	7	0.7
RE 103	Applied Mathematics for Electricity & Electronics	40	4.0
RE 104	Electrical/HVAC/R Tools & Equipment	8	0.8
RE 105	Refrigerant E.P.A. Regulations	7	0.7
RE 106	The Refrigeration System, Electrical & Mechanical	60	6.0
RE 107	Equipment Retrofit of Oils and Refrigerants	2	0.2
RE 108	Electrical/HVAC/R Computer Software	14	1.4
RE 109	Electrical Fundamentals	32	3.2
RE 110	Interpreting Schematic & Ladder Diagrams	20	2.0
RE 111L	Silver Brazing Lab	8	0.8
RE 112L	Laboratory Projects/Shop Work	<u>170</u>	<u>8.5</u>
		378	29.3
Quarter 2			
RE 200	The Refrigeration System, Electrical/Mechanical	40	4.0
RE 201	Interpreting Schematic and Ladder wiring diagrams	40	4.0
RE 202	Fundamentals of Electricity	40	4.0
RE 203	Electric Heat Operating & Safety Controls	66	6.6
RE 204L	Laboratory Projects/Shop Work	<u>192</u>	<u>9.6</u>
		378	28.2
Quarter 3			
RE 301	Industrial & Electrical Safety	20	2.0
RE 302	Proper Use of Tools and Equipment	30	3.0
RE 303	Proper Use and Handling of Refrigerants	20	2.0
RE 304	Indoor Air Quality	20	2.0
RE 305	Electrical Motors & Diagrams	35	3.5
RE 306	Controls and Theory	20	2.0
RE 307	Heating and Cooling Equipment	30	3.0
RE 308L	Laboratory Projects/Shop Work	89	4.4
RE 309L	Sheet Metal Lab	14	0.7
RE 310L	Application of Heating and A/C Lab	75	3.8
RE 311L	Application of Controls Lab	<u>25</u>	<u>1.3</u>
		378	27.8

		Clock Hours	Credit Hours
Quarter 4			
RE 400	Electrical Diagrams	20	2.0
RE 401	Heating and Cooling Equipment	20	2.0
RE 402	Theory of Combustion	20	2.0
RE 403	Psychrometrics	20	2.0
RE 404L	Application of Heating and A/C Lab	65	3.3
RE 405	Residential Duct Design	28	2.8
RE 406L	Application of Controls Lab	25	1.3
RE 407	Residential Load Calculations	30	3.0
RE 408	Air Distribution and Balance	20	2.0
RE 409	Oil Heat	10	1.0
RE 410L	Oil Heat Lab	10	0.5
RE 411L	Laboratory Projects/Shop Work.....	<u>110</u>	<u>7.6</u>
		378	29.5
Quarter 5			
RE 501	WAC & NEC for HVAC/R	25	2.5
RE 502	Commercial Systems & Components	50	5.0
RE 503	Troubleshooting Commercial Systems	25	2.5
RE 504	Electrical Theory, Circuits, Controls & Wiring Schematics	50	5.0
RE 505	Commercial Compressors	15	1.5
RE 506	Refrigerant Retrofits	20	2.0
RE 507	Evaporators, Condensers and Cooling Towers	10	1.0
RE 508L	Laboratory Projects/Shop Work	<u>183</u>	<u>9.1</u>
		378	28.7
Quarter 6			
RE 601	WAC & NEC for HVAC/R	25	2.5
RE 602	Commercial Systems & Components	20	2.0
RE 603	Electrical Theory-Circuits, Controls & Wiring Schematics	45	4.5
RE 604	Heat Load & Piping Calculations for Commercial Equipment	40	4.0
RE 605	Commercial Ice & Ice Cream Machines	35	3.5
RE 606	Ultra Low Temperature Systems	20	2.0
RE 607	Troubleshooting Commercial Systems	20	2.0
RE 608L	Laboratory Projects/Shop Work	<u>173</u>	<u>8.6</u>
		378	29.2
Quarter 7			
RE 701	Direct Digital Controls	55	5.5
RE 702	Central Fan Systems	20	2.0
RE 703	Pneumatic Systems	20	2.0
RE 704	Industrial Chiller & Boiler Systems	65	6.5
RE 705	Water Treatment for HVAC Systems	15	1.5
RE 706	Hydronic Heating Systems	30	3.0
RE 707	Residential/Commercial HVAC/R Systems Review	45	4.5
RE 708L	Laboratory Projects	<u>128</u>	<u>6.4</u>
		378	31.4
Quarter 8			
RE 800	Externship	378	11.2
or			
RE 800	Ammonia Refrigeration Training		
RE 801	Industrial & Ammonia Plant Safety	40	4.0
RE 802	Ammonia Refrigeration & Electrical Systems	70	7.0
RE 803	Industrial Compressors	50	5.0
RE 804	Industrial Maintenance	40	4.0
RE 805	Industrial Electrical Systems	50	5.0
RE 806L	Laboratory Projects	<u>128</u>	<u>6.4</u>
		378	31.4
Program Totals		3024	215.3 / 235.5

HVAC/R Technology Course Descriptions

RE 101 Electrical & Tool Safety

Safety topics for both the classroom & shop environment. Specific tools, procedures & equipment.

RE 102 First Aid

First aid and C.P.R. training. First aid card given upon successful completion of class.

RE 103 Applied Mathematics for Electricity & Electronics

Mathematics used for electrical theory, series/parallel/combo electrical circuits, algebraic formulas, exponents, electronic units of measure, Ohms Law, Watts Law/Power, areas and volume.

RE 104 Electrical / HVAC/R Tools & Equipment

Safety practices and working concepts of electrical measuring instruments, hand tools, including tools & equipment such as Voltmeter, Ammeter, Ohmmeter, refrigerant recovery equipment, vacuum pumps, oxy-acetylene torches, thermistor vacuum gages and gage manifolds.

RE 105 Refrigerant E.P.A. Regulations

The rules and regulations concerning the handling of refrigerants. Upon successful completion, student will become universally certified under the 608 provisions of the Environmental Protection Agency.

RE 106 The Refrigeration System, Electrical & Mechanical

Four main components of a mechanical compression refrigeration system, each of their functions within the system including the pressures and temperatures associated with each component, along with fluid flow, state change, heat transfer both sensible and latent. Motor operation, function, troubleshooting, replacement and maintenance.

RE 107 Equipment Retrofit of Oils and Refrigerants

Retrofitting existing systems with an alternative refrigerant due to costs and/or environmental concerns. Alternative refrigerants characteristics including changes in pressures, temperatures, charging techniques, and compatible oils.

RE 108 Electrical HVAC/R Computer Software

Training on computers using software specifically tailored to the needs of the refrigeration technician. Software concentrates on the fundamentals required to be successful in the trade including electrical fundamentals, series, parallel and combination electrical circuits, operation of electrical components, electrical troubleshooting by application and use of electrical diagrams and electrical meters, area and volume calculations, types of heat and heat transfer, gas laws, temperature scales (Fahrenheit, Celsius, Rankin & Kelvin), absolute and gage pressures, pressure enthalpy diagrams, function and operation of compressor, evaporator, condenser and metering device.

RE 109 Electrical Fundamentals

Electrical safety, Atomic structure, electron flow theory, voltage current resistance relationships (Ohms law), Electrical: heating, operating and safety controls heat and magnetism produced by current flow, electrical circuits, series and parallel circuits, resistive and inductive loads, conductors (hot, neutral and safety ground) and measuring instruments. 120 volt circuits.

RE 110 Interpreting Schematic & Ladder Diagrams

Tracing of electric circuits and the study of controls, their use and installation. Conversion of schematic to ladder diagrams. The development of electrical diagrams so as to meet required system operation. Sequence of operation of equipment by "reading" electrical diagrams. Troubleshooting by use of electrical diagrams.

RE 111L Silver Brazing Lab

Introduction to proper joining of copper to copper and copper to steel tubing by use of oxy-acetylene torches.

RE 112L Laboratory Projects/Shop Work

Practical application of classroom instruction on actual equipment. Application and use of electrical and HVAC/R tools and equipment. Introduction to servicing residential refrigerators and freezers. Lab time includes the following: Electrical checks, wiring and operations of relays, capacitors, cold controls, defrost controls, heaters, thermostats, compressor and fan motors. Mechanical checks of the refrigeration system. Repair of customer equipment on campus.

RE 200 The Refrigeration System, Electrical & Mechanical

Expansion of material on the four main components of a mechanical compression refrigeration system includes motor operation, function, troubleshooting and wiring.

RE 201 Interpreting Schematic & Ladder Wiring Diagrams

Tracing of electric circuits and the study of controls, their use and installation. Conversion of schematic to ladder diagrams. The development of electrical diagrams so as to meet required system operation. Sequence of operation of equipment by "reading" electrical diagrams. Troubleshooting by use of electrical diagrams.

RE 202 Fundamentals of Electricity

Expansion of material on electrical fundamentals including electrical safety, voltage current resistance relationships, Ohms law, heat and magnetism produced by current flow, electrical circuits, series and parallel circuits, 120, 240 and 24 volt circuits.

RE 203 Electrical/Heating Equipment, Operating & Safety Controls

Electrical/Electrical Mechanical/Solid state and Mechanical operating and safety controls. Introduction to operating and safety controls as related to domestic refrigeration systems and electric forced air furnaces. Theory, application and operation of these controls so as to allow students to apply this knowledge on various equipment types. 120, 240 & 24 volt controls. Introduction to residential forced air electric furnaces and controls. Topics include maintenance, airflow calculations, temperature rise, reading and developing wiring diagrams. Operation & troubleshooting of electric heat sequencers, transformers, thermostats, motors, capacitors, heating elements, safety devices, relays and contactors.

RE 204L Laboratory Projects/Shop Work

This section of the course is used for practical application of principles introduced in the classroom. Lab time includes the following: Emphasis on electrical measurements for troubleshooting and hands on wiring of equipment. Electrical checks, wiring and operations of relays, capacitors, single and multi-speed single phase fractional horsepower motors (shaded pole, PSC, CSR) heaters, low voltage heat/cool thermostats, compressor and fan motors. Shop time is used for wiring, troubleshooting and maintaining controls as well as actual operation and troubleshooting of electric furnaces and their controls.

RE 301 Industrial/Electrical Safety

Review and reinforcement of shop safety procedures and techniques. Introduction to fall protection and ladder safety with emphasis on application of all safety related concepts in the workplace or shop environments. Proper lockout/tag-out of electrical equipment, as well as equipment safety grounding procedures are introduced. NEC compliance Articles 100 and 250.

RE 302 Proper Use of Tools and Equipment

Proper use and application of tools utilized in the HVAC trade. Examples of tools would include refrigerant recovery equipment, vacuum pumps, electronic scales, and micron gauges. Proper use of digital multi-meters, ammeters and temperature analyzers is emphasized.

RE 303 Proper Use & Handling of Refrigerants

Safe handling of refrigerants. Proper HVAC system charging, refrigerant recovery and applications of R-22 and R-410A.

RE 304 Indoor Air Quality

The fundamentals of air filtration, including all types of air filters associated with residential and light commercial HVAC systems, from disposable air filters to state-of-the-art electronic air cleaners. Humidification and types of Humidifiers are covered as well.

RE 305 Electric Motors and Wiring Diagrams

Interpretation of both ladder and pictorial type wiring diagrams. ARI standard graphic electrical symbols are introduced and applied to electrical diagrams. All types of single-phase motors are discussed. NEC compliance using Article 430.

RE 306 Controls and Theory

Introduced to specific controls and control strategies that relate to residential and light commercial HVAC/R systems. Types of controls included range from residential and commercial programmable setback thermostats to HVAC system protection controls and safeties. NEC compliance, Article 725 and Table 11A.

RE 307 Heating and Cooling Equipment

Residential and light commercial HVAC equipment, both packaged and split systems. Heating systems covered include fossil fuel units, such as natural and LP gas units. Oil heating systems, electric heating and heat pump systems. .

RE 308L Laboratory Projects/Shop Work

Typical lab projects will include tasks such as soldering, steel pipe threading, wiring, and proper refrigerant charging of A/C units.

RE 309L Sheet Metal Lab

Basic sheet metal fabrication concepts. Fabrication of several sheet metal projects using not only purchased sheet metal hand tools, but the heavier shop fabrication equipment associated with HVAC duct systems. Examples include hand-operated brakes, manual and electro-mechanical shears.

RE 310L Application of Heating and A/C Lab

Application of concepts learned in the classroom to operational HVAC equipment. Hands on orientation and application of mechanical and electrical concepts as they relate to residential and light commercial HVAC/R equipment.

RE 311L Application of Controls Lab

Application of control strategies to wire and operate several types of HVAC equipment. Types of systems include heat pumps, oil, gas and electric forced air HVAC systems. Both packaged and split systems are addressed.

RE 400 Electrical Diagrams

Interpretation of both ladder and pictorial type wiring diagrams relating to residential and light commercial HVAC systems. Additional ARI standard graphic electrical symbols are introduced and applied to electrical diagrams. NEC compliance using Article 300

RE 401 Heating and Cooling Equipment

Residential and light commercial HVAC equipment, both packaged and split systems. Heating systems covered include fossil fuel units (such as natural) LP gas units, oil heating systems, electric heating and heat pump systems.

RE 402 Theory of Combustion

Combustion process relating to fossil fuel heating systems. Fuel types included are natural, LP gas and oil. Venting of combustion by-products, by induced draft and gravity draft. Proper combustion vent sizing utilizing equipment manufacturer approved AGA /GAMA sizing tables.

RE 403 Psychrometrics

Introduction to psychrometrics: defined as the study of air and its properties. The psychrometric chart is utilized for better understanding the process of conditioning air.

RE 404L Application of Heating and A/C Lab

Application of concepts learned in the classroom to operational HVAC equipment. Hands-on orientation involving application of mechanical and electrical concepts as they relate to residential and light commercial HVAC equipment. NEC compliance.

RE 405 Residential Duct Design

Introduction to duct design process. Residential duct design utilizing the Manual D duct design method published by Air Conditioning Contractors of America (ACCA).

RE 406L Application of Controls Lab

Application of control strategies learned in the classroom to wire and operate several types of HVAC equipment. Types of systems include heat pumps, oil, gas and electric forced air HVAC systems. Both packaged and split systems are addressed.

RE 407 Residential Load Calculation

Residential load calculation utilizing the Manual J load calculation method published by Air Conditioning Contractors of America (ACCA). Correct sizing of the heating and cooling equipment is covered.

RE 408 Air Distribution and Balance

Basics of air distribution and balancing residential and light commercial HVAC air delivery systems. Introduction to several types of air system side components such as grills, registers and diffusers. Proper application of each type of air delivery component. Introduction to equipment typically used for air balancing.

RE 409 Oil Heat

Application of knowledge learned in the classroom to the lab/shop environment. All laboratory/shop tasks are performed on functional oil furnaces. The scope of tasks involves electrical wiring, mechanical operation and combustion analysis of oil heating systems.

RE 410L Oil Heat Lab

Oil heating systems focusing on high pressure, gun-type oil burners that utilize number two fuel oil. Ignition primary control systems include both stack and cadmium cell types. Other subjects covered include fuel pump pressure regulation, fuel nozzle sizing, venting and combustion analysis.

RE 411L Laboratory Projects/Shop Work

Completion of several lab projects including wiring, airflow calculation, and combustion analysis tasks performed on functional HVAC equipment.

RE 501 WAC & NEC for HVAC/R

RCW 19.28, WAC 296-46A, WAC 296-401B, and articles from the NEC will be covered.

RE 502 Commercial Systems and Components

Use of pressure controls relating to commercial equipment including low-pressure controls, high-pressure controls and fan cycling controls. Operating pressures and temperatures required for the different applications of commercial equipment. Different refrigerant controls used in commercial refrigeration including thermal expansion valves, automatic expansion valves, capillary tubes, crankcase pressure regulators, evaporator pressure regulators, solenoid valves, head pressure control valves and pressure differential valves. Installation, setting and proper wiring methods as specified by NEC will be covered for a wide variety of control applications.

RE 503 Troubleshooting Commercial Systems

Mechanical and electrical problems that occur within commercial equipment. Recognizing symptoms, identifying the problem and formulating a solution. Proper usage of meters and instruments as well as safety procedures will be covered.

RE 504 Electrical Theory, Circuits, Controls & Wiring Schematics

Operations of electrical controls as applied to commercial refrigeration including relays, contactors, motor starters, fan delays, temperature-actuated controls, and a variety of switching devices. Single Phase 120/240 volt, Three Phase 240/480 volts as well as Delta High Leg will be covered. Wiring and operating characteristics of a wide variety of motors will be covered. Manufacturers electrical schematics and control strategies as applied to commercial systems. Wiring and control strategies. Installation, setting and proper wiring methods as specified by NEC will be covered for a wide variety of control/motor applications.

RE 505 Commercial Compressors

Replacement of compressors and related electrical starting components. Testing of motor windings and related electrical starting components. Interpretation of manufacture electrical performance charts under all conditions. Operations and evaluation of commercial compressors for all applications. Efficiency tests of compressors in and out of systems. Installation and proper wiring methods as specified by NEC will be covered for a wide variety of compressor applications.

RE 506 Refrigerant Retrofits

Replacement refrigerants used in place of the CFC refrigerant now banned by EPA. Proper techniques for oil changes and charging procedures for the alternative refrigerants. The effect of retrofits affecting motor amp draw as well as possible fan installation and electrical control adjustments to prevent motor overheating and motor overload.

RE 507 Evaporators, Condensers & Cooling Towers

Components that transfer heat within the refrigeration system including evaluating, servicing, maintaining, repairing and replacement of the various components. Installation, setting and proper wiring methods as specified by NEC will be covered for a wide variety of motor applications.

RE 508L Laboratory Projects/Shop Work

Hands-on evaluation and repair of a wide variety of live refrigeration equipment. Drawing of electrical diagrams and the wiring of systems to match their electrical diagram. Recognizing a symptom, identifying the problem and formulating a solution. Ability to set, adjust and evaluate a wide variety of refrigerant and electrical controls under different conditions. Installation, setting and proper wiring methods as specified by NEC will be covered for a wide variety of control applications.

RE 601 WAC & NEC for HVAC/R

RCW 19.28, WAC 296-46A, WAC 296-401B, and articles from the NEC will be covered.

RE 602 Commercial Systems and Components

Use of pressure controls relating to commercial equipment including low-pressure controls, high-pressure controls, oil pressure safety controls, and fan cycling controls. Operating pressures and temperatures required for the different applications of commercial equipment. Different refrigerant controls used in commercial refrigeration including thermal expansion valves, automatic expansion valves, capillary tubes, crankcase pressure regulators, evaporator pressure regulators, solenoid valves, oil pumps, head pressure control valves and pressure differential valves. Installation, setting and proper wiring methods as specified by NEC will be covered for a wide variety of control applications.

RE 603 Electrical Theory, Circuits, Controls & Wiring Schematics

Operations of electrical controls as applied to commercial refrigeration including relays, contactors, motor starters, fan delays, temperature-actuated controls, and a variety of switching devices. Single Phase 120/240 volt, Three Phase 240/480 volts as well as Delta High Leg will be covered. Wiring and operating characteristics of a wide variety of motors will be covered. Manufacturers electrical schematics and control strategies as applied to commercial systems. Wiring and control strategies. Installation, setting and proper wiring methods as specified by NEC will be covered for a wide variety of control/motor applications.

RE 604 Heat Load and Piping Calculations for Commercial Equipment

Calculation of the heat gain due to infiltration and product load for medium and low temperature applications. Proper piping and installation of commercial equipment using sizing charts and piping schematics to learn the various piping techniques involved with commercial systems for medium and low temperature applications. Proper sizing of equipment based on BTUH requirements as well as voltages, amp draw and phase of electricity available. Installation, setting and proper wiring methods as specified by NEC will be covered for a wide variety of installation applications.

RE 605 Commercial Ice and Ice Cream Machines

Examination of wide variety of ice and ice cream machines. Water-related problems as well as operational, mechanical, and electrical problems involving ice and ice cream machines. Installation of well as service will be covered. Emphasis is put on the reading and interpretation of the manufactures wiring schematics. Installation, setting and proper wiring methods as specified by NEC will be covered for a wide variety of ice and ice cream machine applications.

RE 606 Ultra Low Temperature Systems

Ultra low temperature systems including training on cascade and compound systems. Pressures and temperatures as well as wiring methods and wiring schematics for ultra low temperature equipment will be covered. Installation, setting and proper wiring methods as specified by NEC will be covered for a variety of low temperature applications.

RE 607 Troubleshooting Commercial Systems

Mechanical and electrical problems that occur with commercial equipment. Recognizing symptoms, identifying the problem and formulating a solution. Proper usage of meters and instruments as well as safety procedures will be covered.

RE 608L Laboratory Projects/Shop Work

Hands on evaluation and repair of a wide variety of live refrigeration equipment, including ice machines, ice cream machines and ultra low temperature units. Basic arc and acetylene welding will be covered. Drawing of electrical diagrams and the wiring of systems to match their electrical diagram. Recognizing a symptom, identifying the problem and formulating a solution. Ability to set, adjust and evaluate a wide variety of refrigerant and electrical controls under different conditions. Installation, setting and proper wiring methods as specified by NEC will be covered for a wide variety of control applications.

RE 701 Direct Digital Control Systems

Control terminology and fundamentals of computer control as applied to HVAC/R Energy Management Systems. Types of control systems; network wiring, types of inputs and outputs and system configurations. NEC compliance using Chapters 2, 3 and 9. Lab work will include: Wiring direct digital control simulators, (including communication cables) component wiring of input boards, output boards, modems, sensors and controlled devices.

RE 702 Central Fan Systems

Types of fan systems used in large industrial facilities: including proportional motor control operation of dampers, heating valves, chilled water valves and humidification requirements. Electrical control of these systems will be covered in detail. This includes the NEC compliance, using Chapters 2, 3 and 9.

RE 703 Pneumatic Systems

Fundamentals of Pneumatic Systems: including air supply, sensors, actuators, transmitters and receiver controllers. Operation and maintenance of these components will be discussed for use in HVAC systems. Electrical wiring of end control devices, air compressors and refrigerated air dryers will be taught. This includes the NEC compliance, using Chapter 2, 3 and 9.

RE 704 Industrial Chiller & Boiler Systems

Industrial air conditioning systems using chilled water. Compressor types, evaporator chiller barrels, water-cooled condensers, air-purgers, absorption systems and low-pressure refrigerant. Electrical safety, diagnostics and troubleshooting; oil temperature and pressure safety controls, capacity control wiring, high-pressure refrigerant and water flow controls. Operation and maintenance of large industrial boilers including high and low pressure design, water tube and fire tube models, vertical and horizontal types. The types of fuel systems used. Boiler safety controls including low water cutoff, high water cutoff, water-makeup and ignition systems. This includes the NEC compliance, using Chapters 2, 3 and 9.

RE 705 Water Treatment for HVAC Systems

Fluid coolers, cooling towers and boilers require technicians to maintain the water quality for proper heat exchange. Metal corrosion and higher energy costs are the results of neglect of these components. Students will learn why chemical treatment is necessary, the types of chemicals used, conductivity testing, PH balance and chemical feed systems.

RE 706 Hydronic Heating Systems

Systems that heat with hot water or steam including boiler types, system piping, water pumps, expansion tanks and ignition control systems. Boiler control wiring including: high limit safety controls, aquastats and pressure relief valves will be covered. Geothermal Heatpumps, open and closed loop piping systems, electrical controls, troubleshooting and related campus equipment will be covered. This includes the NEC compliance, using Chapters 2, 3 and 9.

RE 707 Residential/Commercial HVAC/R Systems Review

Review of Residential/Commercial HVAC/R Systems will be conducted throughout the 7th quarter. Students will be preparing for employment in companies repairing various types of HVAC/R equipment. This overview of material will reinforce information taught in previous sections of the program. The troubleshooting, wiring and repair of these systems will be discussed. This includes the NEC compliance, using Chapters 2, 3 and 9.

RE 708L Laboratory Projects

Lab time will give the students the opportunity to apply the skills they have learned. Training equipment, lab projects, computer simulators and on-site service work will allow the student hands-on training to help reinforce the classroom teaching.

RE 800 Externship

The last quarter (8) of the program will consist of ammonia refrigeration training or external internships with their potential employers.

RE801 Industrial & Ammonia Plant Safety

Safety precautions when using anhydrous ammonia for refrigeration. Safe handling and response to ammonia spills including industrial plant safety. Working with heavy equipment and high voltage equipment in an industrial facility. Safety working around three phases 480-volt equipment. Process Safety Management (PSM), Industrial plant safety plans and evacuation plans for facilities that contain 10,000 # or more of ammonia including code compliance, operator training, emergency response procedures and risk reduction. This includes the NEC compliance using Chapters 2, 3 and 9.

RE802 Ammonia Refrigeration & Electrical Systems

Components used in ammonia systems including direct expansion systems, brine systems, flooded systems, accumulators, evaporative condensers, hot gas defrost, water defrost, and associated controls. Evaporators and components used with flooded systems including gravity flooded, liquid re-circulation systems, surge tanks, low pressure receivers, float switches, metering devices and oil draining procedures. Cold storage and controlled atmosphere storage facilities including the refrigeration systems, room temperatures, long term storage requirements, oxygen and carbon dioxide control, humidity control and nitrogen purging. This includes the NEC compliance using Chapters 2, 3 and 9.

RE803 Industrial Compressors

Types of compressors found in Industrial HVAC/R systems: including operation and maintenance of reciprocating, centrifugal and screw compressors. Three phase 240/480-volt systems including; Wye/Delta, part winding start and autotransformers will be covered. Disassembly and repair of industrial compressors including taking measurements using inside and outside micrometers, and calipers to determine the condition of internal parts. Cylinders, crankshafts, pistons and rods along with inspection of suction and discharge valves. This includes the NEC compliance using Chapters 2, 3 and 9.

RE804 Industrial Maintenance

Maintenance requirements for Industrial facilities including preventive maintenance for compressors, drive motors, water treatment and refrigeration equipment. Maintenance of Evaporative Condensers, defrost systems and OSHA compliance. Recognition of Electrical Safety hazards in and around the Mechanical Equipment Room. This includes the NEC compliance using Chapters 2, 3 and 9.

RE805 Industrial Electrical Systems

The examination and interpretation of complex electrical circuits will be taught. Conversion of schematic to ladder diagrams and the sequence of operation of the assigned equipment. Three phase 240/480-volt systems wiring used in the operation and safety controls associated with industrial HVAC/R systems including part winding start, Y-Delta start, across the line start and compressor-starting systems. Oil temperature and pressure safety controls. Capacity control wiring, refrigerant pressure and water flow controls. This includes the NEC compliance using Chapters 2, 3 and 9.

RE806L Laboratory Projects

Lab time will give the students the opportunity to apply the skills they have learned. Training equipment, lab projects, computer simulators and on site service work will allow the student hands-on training to help reinforce the classroom teaching.

HVAC/R TECHNOLOGY

Book and Tool List

The book and tool list for students in the HVAC/R Program is intended to be a minimum requirement to complete the program. **The prices stated do not include any mark-up for program students or any sales taxes.**

Tool and book costs are approximately \$2,450.00.

Book List

Book costs for the HVAC/R Technology Program are approximately \$565.00. Books are to be purchased the first day of class. Changes may be made as more appropriate material is developed or new editions are published. **Book prices may vary. The prices stated do not include any mark-up for program students or any sales taxes.**

Refrigeration and Air Conditioning Technology, 5th edition, Whitman and Johnson
Fundamentals of Residential Controls (a programmed course), Honeywell
Copeland Service Manuals 1 through 5 and Electrical Handbook
Basic Math for Electricity, Singer
Tecumseh Manuals (Hermetic Compressor Data) and (Electrical Service Parts Guide Book)
Calculator with Trigonometry Function
Wiring Simplified, H.P. Richter and W.C. Schwan
NEC Electrical Code Book (Spiral bound version)
Key Word Index for the NEC Code Book (Tom Henry)
NEC Tabs for Spiral Bound Version (Tom Henry)
1 Test fee & study guide for E.P.A. 608 certification
2 Year Electrical Trainee Card (Purchase at Dept. of Labor and Industries)
The Job Hunting Handbook
1 Catrax Refrigeration student workshop CD software
1 Catrax Electrical student workshop CD software

Tool List

The tools in List #1 can be purchased anywhere you choose, and you may begin purchasing those tools before you start school. Please do not purchase the tools in list #2 until after you begin training. **Both tool lists will be required within the first month.** Tool prices may vary. The prices stated do not include any mark-up for program students or any sales taxes.

List #1

- 1) Stubby Driver Combo Phillips & Standard
 - 1) Phillips Driver #0 & Small Standard
 - 1) Phillips Driver #1
 - 1) Phillips Driver #2
 - 1) Screwdriver 3/16 x 4
 - 1) Screwdriver 1/4 x 4
 - 1) Screwdriver 5/16 x 6
 - 1) Screwdriver 3/8 x 8
 - 1) Off-set screw driver kit (Phillips & Standard)
 - 1) Nut Driver 1/4"
 - 1) Nut Driver 5/16"
 - 1) Combination End Wrench Set 1/4" through 3/4"
 - 1) 10" Adjustable End Wrench
 - 1) Hex Key (Allen) 15 piece set 1/16" through 3/8"
 - 1) 10" Slip Joint Pliers
 - 1) 8" Diagonal Cutters
 - 1) 8" Long Nose Pliers
 - 1) Flat File 10" (mill)
 - 1) Hacksaw frame
 - Hacksaw Blades 12" x 32 teeth *Order 3 each
 - Hacksaw Blades 12" x 18 teeth *Order 2 each
 - 1) Scratch Awl
 - 1) Steel Tape Measure (10' x 1/2")
 - 1) Safety Glasses w/side shields
 - 1) Flashlight with batteries (Flashlight with magnet recommended)
 - 1) Pocket Inspection Mirror 14" extension
 - 1) Drop Light w/receptacle 16/3 wire x 25'
 - 1) 8 oz Ball-Peen Hammer
 - 1) Wire Brush
 - 1) Wire Stripper/Crimper
 - 1) Roll Electrical Tape Scotch-33
 - 1) One pair thin leather work gloves
 - 1) 2 Red & 2 Black Alligator Clips W/insulated boots (Jumper wires)
 - 1) Tool Bag
 - 1) Clip Board
 - 1) Tube Reamer
- In addition to the tool bag a tool box is optional but size is limited

List # 2

- 1) Vise Grip Pinch-Off tool
- 1) Valve Stem Wrench (Service valve wrench)
- 1) Little "Imp" Tube Cutter
- 1) Big "Imp" Tube Cutter
- 1) Caliper Rule 4" or longer
- 1) Manifold
- 1) Glycerin Filled Gauge Low-Side
- 2) Permeation Resistant Charging Hoses standard fittings
- 1) Standard hose for manifold
- 1) Fluke 52 Temperature Analyzer
- 2) Extra temperature probes for Fluke 52 (4 total)
- 1) Leak Detecting Solution (Bubbles)
- 1) UEI DL 49 Clamp on Ammeter
- 1) Fluke 116 HVAC Multimeter
- 1) Set of Alligator Clip Accessories for Fluke Model 116
- 1) Robinair Brass Core Removal Tool
- 2) J.B. Piercing Valves
- 1 Pound Silver Braze Rod
- 1) 1/4" flare x 1/8" pipe half union
- 1) Adapter 90 degree (Seal Right, low loss fitting)
- 1 Troy oz. 56% Silver Solder
- 1) Silver Solder Flux Paste
- 1) Small Stainless Steel Brush
- 1) Roll Sanding Cloth
- 1) Tube Bender for 1/4", 5/16", 3/8" ACR copper tubing
- 1) Swaging - Flaring Kit (3/16" through 3/4")
- 1) 1/4" flare union