HVAC Apprenticeship Curriculum
June 2011
Idaho State Division of Professional Technical Education

HVAC Year One
Total Hours: Minimum = 144

- Basic math – Module 1
  Minimum: 12 hours
  - Whole numbers
  - Addition and subtraction
  - Fractions
  - Decimals
  - Measurement of
    - Lines
    - Area
    - Volume
    - Weights
    - Angles
    - Pressure
    - Vacuum
    - Temperature
  - Trade related math

Objectives:
Perform addition, subtraction, multiplication, and division calculations of whole numbers
Perform addition and subtraction calculations of common fractions
Perform multiplication and division calculations of common fractions
Perform addition, subtraction, multiplication, and division calculations of decimal fractions
Perform ratio and proportion calculations
Perform percent, percentage, and discount calculations
Perform angular, length, and converted temperature measure calculations
Perform area calculations
Perform volume calculations
Perform estimates and billing calculations

- Basic Safety Hand and Power Tools – Module 2
Minimum: 18 hours
  - OSHA 10 hour construction training
  - Tools
    - Basic hand and power tools
    - Soldering and brazing

Objectives:
Describe potential excavation site hazards (1hr)
Explain proper personal protective equipment use (1hr)
Describe proper material handling, storage, use, and disposal
Describe ladder, stairway and scaffold hazards and proper use
Describe jobsite electrical hazards and proper lockout/tagout use
Describe proper refrigerant and pressure vessel usage and storage
Identify MSDS properties for refrigerants (1hr)
Describe proper hand and power tool use
Describes soldering and brazing methods
Fuel gas piping and venting – Module 3
Minimum: 60 hours
- Installation of fuel piping according to code and industry standards
- Installation of venting according to code and industry standards
- Installation of combustion air according to code and industry standards
- Installation of make-up air according to code and industry standards
- IFGC requirements

Objectives:
- Identify International Code administrative and enforcement rules
- Define key terms as applied to the IFGC
- Describe the building structural safety requirements for fuel gas equipment installation
- Examine fuel gas equipment combustion, ventilation and dilution air requirements
- Identify fuel gas equipment location, access and service space requirements
- Describe proper appliance condensate disposal and clearance reduction methods
- Perform gas pipe sizing exercises
- Identify proper gas pipe installation methods
- Describe proper gas pipe inspection, testing and purging procedures
- Describe chimney and vent types and construction
- Examine chimney installation requirements
- Examine gas vent installation requirements
- Describe gas appliance category I, II, III and IV characteristics
- Identify proper gas vent connector installation requirements
- Describe category I venting principals
- Perform single appliance category I vent sizing exercises
- Perform multiple appliance category I vent sizing exercises
- Determine capacity penalties for offsets in common vent and vent connectors
- Examine specific fuel gas appliance installation requirements
- Describe mechanical equipment location, access and service space requirements

Introduction to code – Module 4
Minimum: 6 hours
How to access information related to HVAC industry
- Idaho Code and Administrative rules
- International Mechanical Code

Objectives:
- Describe Idaho HVAC code and Administrative Rules requirements
- Identify International Mechanical Code general chapter requirements
- List International Mechanical Code HVAC specific equipment sections

Energy sources – Module 5
Minimum: 9 hours
- Principles of different fuel sources
- Fuel Oil
- Electric
- Gas / LP
- Hydro / geothermal*
- Wind / solar*

Objectives:
- Explain natural, LP gas, and fuel oil combustion characteristics
- Describe the development and application of geothermal heat pump systems
- Describe the development and application of renewable energy systems
Basic systems overview – Module 6
Minimum: 12 hours
- Warm air furnaces
- Split system air conditioners
- Commercial air conditioning systems
- Forced air duct systems
Objectives:
- Describe mid-efficiency and high efficiency furnace operation
- Describe the typical configuration of residential split air conditioning systems
- List the various types of commercial air conditioning systems and their application
- Describe the configuration of four common duct systems

Intro to applied science – Module 7
Minimum: 24 hours
- History of HVAC/R
- Temperature measurement and conversion
- Thermodynamics
- Pressure / vacuum
- Refrigeration cycle and components
- Basic elements of matter
- *Applied math* – 6 hours
Objectives:
- Describe a brief modern history of HVAC
- Describe energy types and their properties
- Perform energy conversion calculations
- Perform sensible, latent and total heat calculations
- Differentiate between saturated, superheated, and subcooled refrigerant
- Explain atmospheric, absolute, and gauge pressure relationship
- Convert gauge pressure, absolute pressure and vacuum
- Diagram a basic refrigeration cycle identifying pressure, temperature and state of refrigerant
- List the type and function of the four major refrigeration components

Customer Service – Module 8
Minimum: 3 hours
- Cleanliness
  - Site
  - Personal
- Professional appearance
- Timeliness
- Work ethic
- Communication skills
Objectives:
- Describe good customer communication procedures
HVAC Year Two
Total Hours: Minimum = 144

- Appliance installation – Module 1
  Minimum hours: 24
  - Oil and fuel gas appliance installation
  - Split and packaged air conditioning system installation
  - Forced-air system installation
  - NEC – electrical code as applied to HVAC installation
  - IFGC, IMC, IRC code requirements for HVAC installation

Objectives:
- Explain HVAC electrical branch circuit sizing and installation factors
- Interpret HVAC manufacturer electrical name plate data
- Explain combustion air and venting requirements for Category I, III and IV appliances
- Describe gas appliance installation, start-up and checkout procedures
- Describe oil appliance installation, start-up and checkout procedures
- Describe sheet metal, fiberglass and flex duct installation procedures
- Identify split and packaged air conditioning unit components
- Explain split and packaged air conditioning unit installation guidelines

- Introduction to blueprints and specifications – Module 2
  Minimum hours: 24
  - Site plans, floor plans and elevation drawings
  - Mechanical, plumbing and electrical drawings
  - Specifications
  - Shop drawings and submittals
  - Takeoff procedures
  - As-built drawings

Objectives:
- Read blueprints and architect plans
- Interpret mechanical, plumbing and electrical drawings
- Interpret specification documents and apply to plans
- Interpret shop drawings and apply to plans and specifications
- Describe a submittal and its derivation, routing and makeup
- Develop cut lists for duct runs from shop drawings
- Interpret as-built modifications on HVAC mechanical plans
- Perform an HVAC equipment and material takeoff

- Basic electricity – Module 3
  Minimum hours: 60
  - Basic electrical theory
  - Electrical safety
  - Series and parallel circuits
  - AC and DC theory
  - HVAC electrical control devices
  - HVAC electrical load devices
  - HVAC electrical schematic diagrams
  - Power generation and distribution
  - HVAC branch circuits
  - Applied math – 9 hours integrated
    - Ohm’s Law
    - Engineering notation
  - Single-phase, three-phase and ECM Motors
  - Single-phase motor starting components

Objectives:
Examine basic electrical theory
Explain series circuit characteristics
Explain parallel circuit characteristics
Calculate electrical circuit values
Analyze series/parallel circuits
Describe electrical meter operation
Measure electrical circuit values
Identify electrical symbols
Draw basic HVAC electrical circuit diagrams
Interpret basic HVAC schematic diagrams
Interpret advanced HVAC schematic diagrams
Explain AC circuit characteristics
Describe power distribution transformer systems
Calculate HVAC branch circuit conductor, breaker and disconnect sizes
Examine basic motor theory
Draw single phase motor diagrams
Explain single-phase motor starting relay operation
Calculate motor capacitor replacement values
Explain three-phase motor operation
Explain ECM motor operation

- Indoor air quality – Module 4
  Minimum hours: 15
  o Pollutants and pollutant pathways
  o Prevention, control and remediation strategy
  o Tools and testing
  o Energy recovery ventilation systems*
  o Filters and humidifiers*
  o IAQ checklists
  o Home energy/IAQ evaluation*

Objectives:
Describe indoor air quality factors as related to HVAC
Identify various indoor air quality pollutant and pollutant pathways
Describe indoor air quality evaluation and measurement tools
Explain appropriate prevention, control and resolution strategies for IAQ issues
Determine guidelines for involving professionals in IAQ issues

- Residential load calculation – Module 5
  Minimum hours: 21
  o Calculations to determine residential heat gain / loss*

Objectives:
Examine importance of heat load calculation in building design
Differentiate sensible, latent and total heat gain/loss
Determine U values and R values for various building construction components
Calculate Btu gain/loss values using HTM and temperature difference factors
Determine heating and cooling load temperature difference and daily range values
Explain the relationship between house orientation and solar heat gain
Perform building component area and volume calculations from blueprints
Perform winter/summer infiltration calculations using Manual J procedures
Perform heat gain calculations using Manual J procedures
Perform heat loss calculations using Manual J procedures
Determine sensible, latent and total heat house block and room values
HVAC Year Three
Total Hours: Minimum = 144

- Basic controls – Module 1
  Minimum: 30 hours
  - Basic electro-mechanical control devices
  - Gas, oil, electric and hydronic heating controls
  - Manufacturer wiring diagram analysis
  - Troubleshooting electric control devices
  - Residential air conditioning control systems
  - Commercial and industrial air conditioning control systems
  - Electronic control devices
  - Electronic control module troubleshooting procedures

Objectives:
- Explain contactor, relay and overload operation
- Explain thermostat, pressure switch and transformer operation
- Describe standing pilot gas burner control systems
- Describe intermittent and direct ignition gas burner control systems
- Examine gas furnace manufacturer wiring diagrams
- Explain oil furnace primary control operation
- Describe electric furnace operating sequence
- Describe hydronic heating system controls
- Perform gas, oil and electric heating control system troubleshooting procedures
- Describe motor circuit troubleshooting procedures
- Examine packaged and split air conditioning systems wiring diagrams
- Identify commercial and industrial air conditioning system control methods
- Describe basic electronic control system troubleshooting procedures

- System air flow and duct sizing – Module 2
  Minimum: 30 hours
  - Basic principles of air flow
  - Air distribution system components
  - Air distribution system application and configuration
  - Air flow calculation
  - Primary equipment selection using Manual J and Manual S*
  - Secondary equipment selection using manufacturer tables
  - Basic duct system layout from floor plans
  - Duct system sizing using Manual D*

Objectives:
- Describe basic air flow characteristics
- Explain duct system pressures
- Calculate duct system air flow
- Determine proper air flow requirements
- Describe air distribution system configurations
- Select primary heating/cooling equipment using Manual J and Manual S data
- Determine air-side component pressure drops from manufacturer tables
- Sketch a residential duct system layout using a home floor plan and Manual D tables
- Complete Manual D effective length, friction rate and duct sizing worksheets
- Perform Manual D duct sizing exercises

- Basic air conditioning and refrigeration – Module 3
  Minimum: 30 hours
  - Thermodynamics and heat transfer principals
Refrigeration cycle operating principals
Pressure / temperature relationship
Refrigeration system components and operation
Refrigerant properties and characteristics
Refrigerant oils – types and application
Refrigeration system access tools and procedures
Refrigerant management- EPA Section 608*
Refrigeration system recovery, evacuation and charging procedures

Objectives:
Explain latent, sensible and total heat differences
Diagram refrigeration cycle conditions and components
Explain pressure-enthalpy diagrams
Examine compressor design and efficiency
Explain water/air-cooled condenser operation and performance
Examine metering device design and operation
Describe evaporator types
Identify proper refrigerant line sizing and installation practices
Explain various refrigerant physical and chemical properties
Explain refrigerant oil properties and application
Describe proper refrigeration system access procedures
Differentiate between recovered, recycled and reclaimed refrigerant
Explain proper refrigerant recovery, evacuation and charging procedures

Introduction to Hydronics – Module 4
Minimum: 6 hours
Operating principles
Piping systems
Preventative maintenance
Components
System overview

Objectives:
Identify hydronic piping system types
Describe hydronic heating system components
Explain hydronic heating systems drain and fill procedures
Diagram basic hydronic heating system control circuits

Basic sheet metal – Module 5
Minimum: 39 hours (If performing actual sheet metal layout & fabrication in a shop setting, it will take 39 hours to complete these objectives. If using construction paper to layout and fabricate in a classroom setting, less time is required to complete the objectives.)
Sheet metal layout and processes
Parallel line development and fabrication
Radial line development and fabrication
Triangulation development and fabrication
Layout and fabricate various duct fittings

Objectives:
Define basic sheet metal layout terms
Explain three methods of sheet metal layout development
Explain parallel line development procedures
Layout and fabricate the following sheet metal fittings: Pittsburgh seam and square elbow
Layout and fabricate the following sheet metal fitting: 90 degree elbow and transition
Explain radial line development procedures
Layout and fabricate the following sheet metal fitting: symmetrical tapered duct
Layout and fabricate the following sheet metal fitting: square to square tapered duct
Explain triangulation development procedures
Layout and fabricate the following sheet metal fitting: two-way offset transition
Layout and fabricate the following sheet metal fitting: tapered duct section

- Introduction to service – Module 6
  Minimum: 9 hours
  - Air conditioning mechanical, electrical and refrigeration system analysis
  - Gas heating system mechanical, electrical and combustion analysis
  - Oil heating system mechanical, electrical and combustion analysis
  - Electric heating system mechanical and electrical analysis
  - Heating and cooling equipment maintenance procedures*

Objectives:
- Describe air conditioning system problems and prescribe corrections
- Describe gas heating system problems and prescribe corrections
- Describe oil heating system problems and prescribe corrections
- Describe electric heating system problems and prescribe corrections
- List gas, oil and electric heating and air conditioning maintenance procedures
HVAC Year Four
Total Hours: Minimum = 144

- **Introduction to Testing and Balancing – Module 1**
  - Minimum: 12 hours
    - Psychrometrics – Fundamentals of the Properties of Air
    - Psychrometrics – Calculating the Performance of HVAC Equipment
    - Testing and Balancing Tools
    - Basic Air & Water Testing and Balancing Procedures
  
  **Objectives:**
  - Explain psychrometric properties
  - Diagram psychrometric conditions
  - Describe air flow and water flow measuring devices
  - Explain basic air flow and water flow balancing procedures

- **Introduction to HVAC Control Strategies – Module 2**
  - Minimum: 6 hours
    - HVAC Systems & Control Basics
    - Electric Control Systems
    - Pneumatic & DDC Control Systems
  
  **Objectives:**
  - Describe basic HVAC control principals
  - Interpret basic HVAC pneumatic control diagrams
  - Explain DDC control system basic operation

- **Advanced Air Conditioning and Heat Pump Systems – Module 3**
  - Minimum: 39 hours
    - Commercial Air Conditioning Systems
    - Packaged Unit Air Handling Systems
    - Water Chillers
    - Cooling Towers
    - Basic Heat Pump Theory
    - Heat Pump Components
    - Heat Pump Charging Procedures
    - Heat Pump Electrical Systems
    - Heat Pump Defrost Systems
    - Heat Pump Service Procedures
    - Heat Pump Troubleshooting Procedures
    - Water Source Heat Pump Design
    - Water Source Heat Pump Components
    - Water Source Heat Pump Troubleshooting Procedures
  
  **Objectives:**
  - Explain commercial fan coil unit operation
  - Examine package unit building system configurations
  - Describe building chilled water system operation
  - Describe induced and forced draft cooling tower operation
  - Explain heat pump heating and cooling cycles
  - Describe the purpose and operation of various heat pump components
  - Prescribe heat pump charging procedures
  - Examine heat pump manufacturer electrical wiring diagrams
  - Differentiate heat pump time/temperature and demand defrost control systems
Explain heat pump service checklist readings
Interpret air source heat pump diagnostics
Explain geothermal heat pump system applications
Describe water-to-air and water-to-water heat pump operation
Interpret water source heat pump diagnostics

- Advanced Service – Module 4
  Minimum: 24 hours
  - Air Conditioning Air Side Troubleshooting Procedures
  - Air Conditioning Refrigeration Side Troubleshooting Procedures
  - Air Conditioning Service Diagnostics
  - Air Conditioning Electrical Schematics & Troubleshooting Procedures
  - Gas Furnace Electrical Schematics & Troubleshooting Procedures
  - Gas Furnace Service Diagnostics
  - Electric Furnace Service Diagnostics
  - Oil Furnace Service Diagnostics

Objectives:
- Prescribe air flow troubleshooting procedures
- Explain standard and high efficiency air conditioner operation
- Explain service checklist readings
- Determine variable load air conditioning operating conditions
- Prescribe refrigeration side troubleshooting procedures
- Troubleshoot residential and commercial control systems
- Interpret air conditioning manufacturer electrical wiring diagrams
- Perform interactive air conditioning technician service calls
- Prescribe gas furnace troubleshooting procedures
- Perform interactive gas furnace technician service calls
- Prescribe electric furnace troubleshooting procedures
- Prescribe oil furnace troubleshooting procedures

- System Integration and Design (Project format) – Module 5
  Minimum: 12 hours
  - Residential Comfort and Design Standards*
  - Primary Equipment Selection and Sizing*
  - Primary Equipment Installation and Operation*
  - System Replacement and Retrofit*

Objectives:
- Describe residential comfort and design standards
- Examine residential equipment selection and sizing requirements
- List residential equipment installation and startup procedures
- Prescribe residential equipment retrofit procedures

Code review – Module 6
Minimum: 42 hours
- Review of International Fuel Gas Code (27 hrs)
- Review of International Mechanical Code* (9 hrs)
- Review of National Electrical Code (6 hrs)

Objectives:
- Identify International Code administrative and enforcement rules
- Describe the building structural safety requirements for fuel gas equipment installation
- Examine fuel gas equipment combustion, ventilation and dilution air requirements
- Identify fuel gas equipment location, access and service space requirements
- Perform gas pipe sizing exercises
Identify proper gas pipe installation methods
Examine chimney and gas vent installation requirements
Perform single and multiple category I vent sizing exercises
Examine specific fuel gas appliance installation requirements
Describe mechanical equipment location, access and service space requirements
Identify proper supply, return and exhaust air system installation methods
Examine specific mechanical equipment installation requirements
Identify proper HVAC equipment branch circuit installation methods
Perform HVAC equipment branch circuit sizing exercises

- Project Management – Module 7
  Minimum: 9 hours
  - Personnel Management
  - Communication Skills
  - Project Control
  - Inter-Trade Relations
  - Work Ethics

  Objectives:
  - Perform problem solving and decision making exercises
  - Perform active communication exercises
  - Describe proper project control methods

* Denotes curriculum areas that cover energy efficiency, environmental impact and green construction.

Ideally, conducting 3 hour blocks of classroom instruction for each Performance Objective listed is suggested but will equal more than the minimum of 144 hours per year.