

Appendix A.2

WORK PROCESS SCHEDULE HVAC Technician

O*NET-SOC CODE: 49-9021.01 RAPIDS CODE: 0637

This schedule is attached to and a part of these Standards for the above identified occupation.

1. APPRENTICESHIP APPROACH

Time-based Competency-based Hybrid

2. TERM OF APPRENTICESHIP

The term of the apprenticeship is approximately 4 years with an OJL attainment of 8000 hours, supplemented by the minimum required 576 hours of related instruction. (Note: The competency-based training approach does not require hours.)

3. RATIO OF APPRENTICE TO JOURNEYWORKER (Trainer/Mentor/Professional)

The apprentice to journey worker (trainer/mentor/professional) ratio is: 2 Apprentice(s) to 1 Journeyworker(s) when the apprentice license is with the State of Idaho and 1 apprentice to 1 Journey worker when the apprentice license is with the State of Washington as per 29 CFR § 29.5 (b)(7).

4. APPRENTICE WAGE SCHEDULE

Apprentices shall be paid a progressively increasing schedule of wages based on either a percentage or a dollar amount of the current hourly trainer (journeyworker / mentor / professional) wage rate, which is \$25.00.

Progressive Wage Schedule is as follows:

Term	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8
Hours	1000 Hours	1000 Hours	1000 Hours	1000 Hours	1000 Hours	1000 Hours	1000 Hours	1000 Hours
Percent/Dollar Amount	50%	55%	60%	65%	70%	75%	80%	85%

5. PROBATIONARY PERIOD

Every applicant selected for apprenticeship will serve a probationary period of 1000 hours.



6. SELECTION PROCEDURES

The process for finding and selecting the best talent possible for an apprenticeship opening position includes the following:

The sponsor may post open positions on career sites or the company's internal career board to solicit applications.

Applications will be pre-screened to eliminate candidates who do not meet the basic qualifications requirements of the position.

Those applicants that meet basic qualifications will be processed through an assessment to screen out those who lack the desire and interest for the apprenticeship. Screening applicants will be performed through interviews and job simulations to select candidates with the highest potential for apprenticeship success.

The Apprentice(s) will be selected based on the most qualified candidate.

Applicants that have accepted the position will be registered within 45 days.

The apprenticeship selection process and procedures will be uniformly and consistently applied to all applicants.

Any applicant who feels that they were wrongfully denied entry into the apprenticeship program may appeal the decision using the applicant appeals procedure described in Section J of the Standards.

Maintenance of Applications and Selection Records

The sponsor and participating employer will keep adequate records according to their own internal systems, policies, and procedures. There will be no undue burden placed on the company in regarding to hiring the applicant as their apprentice. The items and records maintained, including qualifications of each applicant; the basis for evaluation for selection or rejection of each applicant; the records pertaining to interviews of applicants; the original application for each applicant; information relative to the operation of the apprenticeship program, including, but not limited to, job assignment, promotion, demotion, layoff, or termination; rates of pay or other forms of compensation or conditions of work; hours including hours of work and, separately, hours of training provided; and any other records pertinent to a determination of compliance with 29 CFR § 30, as may be required by the U.S. Department of Labor.

The records pertaining to individual applicants selected will be maintained in such manner as to permit the identification of race, gender, or ethnicity.

Records will be maintained for 5 years from the date of last action and made available upon request to the U.S. Department of Labor or other authorized representative.



WORK PROCESS SCHEDULE HVAC Technician

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Work Process Schedule:

Total Minimum Hours Required: 8000

Tasks/Competencies	Hours/Testing
<p>This trade schedule supplement, work process, is attached to and a part of the Apprenticeship Standards for the above identified occupation. During the term of apprenticeship, the Apprentice shall receive such instruction and experience, in all branches of the occupation, as is necessary to develop a practical and versatile worker. Major processes in which Apprentices will be trained (although not necessarily in the order listed) and approximate hours (not necessarily continuous) to be spent in each are as follows:</p>	
A. DUCT SYSTEMS	1000
<i>Erection and installation of duct distribution system in residential, light commercial environ-mental control systems, including dampers, registers, grilles, diffusers, hanging sealing, and insulating.</i>	
B. HEATING EQUIPMENT ERECTION AND INSTALLATION	1000
<i>Erection and installation of gas, electric and oil furnaces, unit and duct heaters, boilers and hot water coils, rooftop or makeup air furnaces</i>	
C. COOLING EQUIPMENT ERECTION AND INSTALLATION	1000
<i>Erection and installation of condensing units, evaporator coils, fan coil units, packaged units, rooftop units, chillers and chilled water coils, and heat pumps.</i>	
D. MISCELLANEOUS EQUIPMENT INSTALLATION	750
<i>Installation of exhaust or supply air fans, humidifiers, electronic air cleaners, zone dampers, special filtering devices, and odor control systems.</i>	
E. SHEET METAL SHOP LAYOUT AND FABRICATION	1000
<i>Layout and fabrication of residential and light commercial ductwork and associated fittings, including rectangular duct, ells, offsets, transitions, plenums, roof caps, flashings.</i>	



F. CONTROLS, TESTING, BALANCING**750**

Installation of power wiring and wiring of all low voltage controls and control components of residential and light commercial heating and air conditioning systems and accessories. Testing and adjusting of heating and air conditioning control systems and equipment. Balancing of heating and air conditioning air distribution systems.

G. PIPING SYSTEMS**750**

Fabrication and installation of refrigerant, gas, drain, hot and chilled water piping systems. Training shall include cutting, threading, brazing, soldering, welding, testing, insulating and hanging.

H. EQUIPMENT REPLACEMENT**1000**

Removal and replacement of existing heating and air conditioning systems of equipment, including reconnection of ductwork, piping, wiring, and testing and adjustment.

I. MATERIALS TAKEOFF AND ESTIMATING**750**

Complete estimate and takeoff of materials and equipment requirements, and labor or man-hour requirements for residential and light commercial heating and air conditioning systems.

RELATED INSTRUCTION OUTLINE



HVAC Technician

O*NET-SOC CODE: 49-9021.01 RAPIDS CODE: 0637

INSTRUCTION PROVIDED BY:



North Idaho College

North Idaho College
Workforce Training Center
Industry & Trades Department
525 Clearwater Loop, Post Falls, ID 83854

Related Instruction Descriptions:

Total Minimum Hours Required: 576

Each of the following subjects may take more or less time than is shown, but a minimum of 144 hours per year is recommended.

Period	Tasks/Competencies	Hours/Testing
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Basic Safety/Hand and Power Tools

- 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

Basic Math (used throughout year)

- 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

Introduction to Applied Science

- *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

Energy Sources

- *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

- *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

Customer Service

- *Cleanliness*
- *Professional appearance*
- *Timeliness*
- *Work ethic*
- *Communication skills*

Objectives:

Describe good customer communication procedures

Fuel Piping and Venting

- *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

International Mechanical Code

- *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

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Basic Electricity

- *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

Appliance Installation

- *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

- *Basic Controls*
- *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

Introduction to Service

- *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



Basic AC and Refrigeration

- *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

- *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

EPA Certification

Indoor Air Control

- *Pollutants and pollutant pathways*
- *Prevention, control and remediation strategy*
- *Tools and testing*
- *Energy recovery ventilation systems**
- *Filters and humidifiers**
- *IAQ checklists*
- *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 Calculations

- *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*

System Air Flow and Duct Sizing

- *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*

Introduction to Blueprints and Specifications

- *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

Introduction to Duct Construction Standards (SMACNA)

Basic Sheet Metal

- *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

Integration of Field Trips and Planning

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Introduction to Testing and Air Balancing

- *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

- *HVAC Systems & Control Basics*
- *Electric Control Systems*
- *Pneumatic & DOC Control Systems*



Objectives:

Describe basic HVAC control principals
Interpret basic HVAC pneumatic control diagrams
Explain DDC control system basic operation

Advanced Air Condition and Heat Pumps

- *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 and Troubleshooting

- *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 airflow 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

- *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

- *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

- *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.*

TOTAL MINIMUM HOURS 576