Skilled Trades Ontario | Métiers spécialisés Ontario

Apprenticeship Curriculum Standard

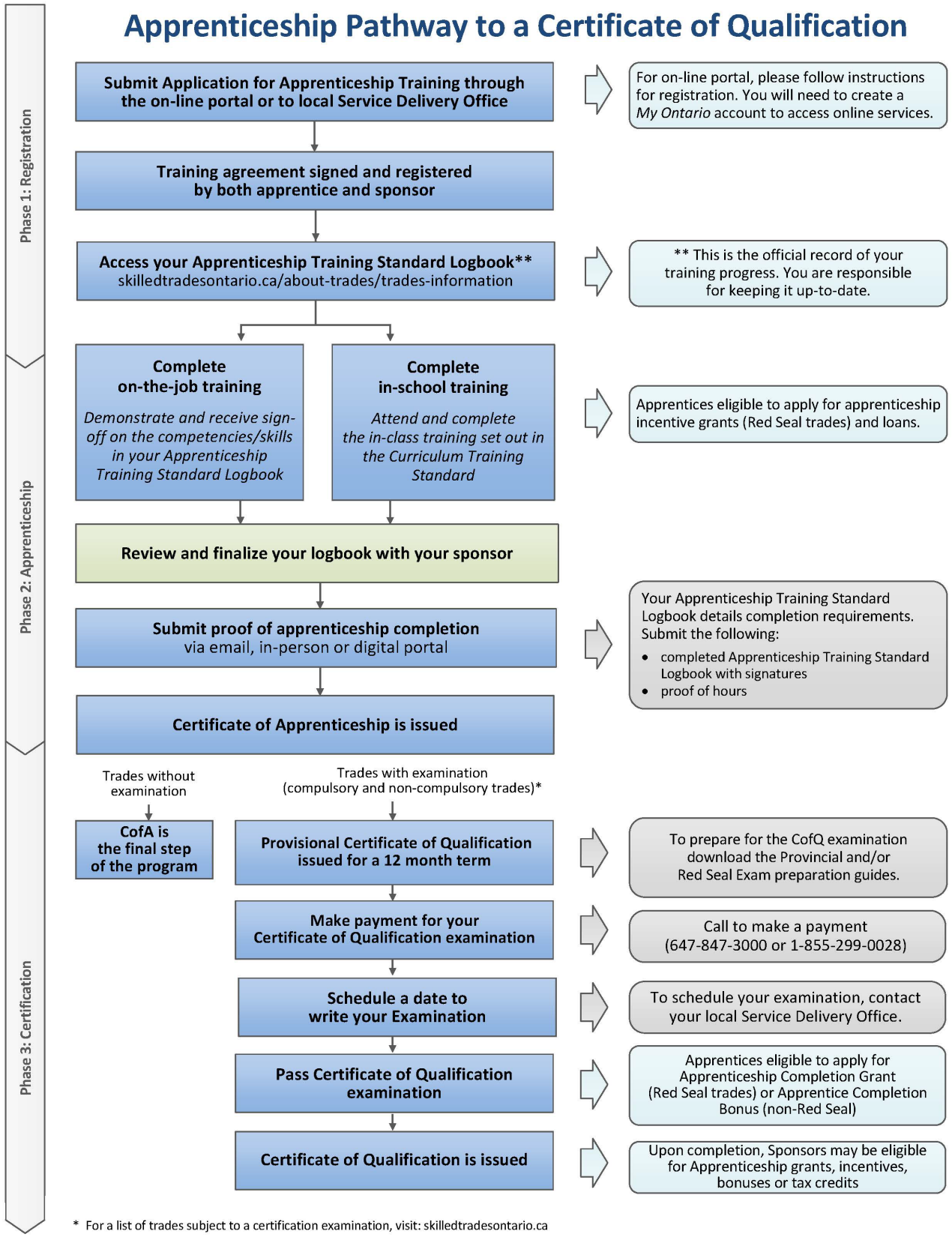
Appliance Service Technician

Levels 1, 2 & 3

445A

1999

Apprenticeship Pathway to a Certificate of Qualification



* For a list of trades subject to a certification examination, visit: skilledtradesontario.ca

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Please Note: This Standard has been revised to reflect the visual identity of Skilled Trades Ontario (STO) which replaced the Ontario College of Trades on January 1, 2022. The content of this Standard may refer to the former organization; however, all trade specific information or content remains relevant and accurate based on the original date of publishing.

Please refer to STO's website: **skilledtradesontario.ca** for the most accurate and up to date information. For information about BOSTA and its regulations, please visit ***Building Opportunities in the Skilled Trades Act, 2021* (BOSTA).**

Any updates to this publication are available on-line; to download this document in PDF format, please follow the link: Skilled Trades Ontario.ca.

Maintained with transfer to Skilled Trades Ontario 1999 (V100)

Preface

This curriculum standard for the Appliance Service Technician trade program is based upon the on-the-job performance objectives, located in the industry-approved training standard.

The curriculum is organized into 3 levels of training. The Reportable Subjects Summary chart (located on pages 3–5) summarizes the training hours for each reportable subject.

The curriculum identifies the learning that takes place in-school. The in-school program focuses primarily on the theoretical knowledge and the essential skills required to support the performance objectives of the Apprenticeship Training Standards.

Employers/Sponsors are expected to extend the apprentice's knowledge and skills through practical training on a work site. Regular evaluations of the apprentice's knowledge and skills are conducted throughout training to verify that all apprentices have achieved the learning outcomes identified in the curriculum standard.

It is not the intent of the in-school curriculum to perfect on-the-job skills. The practical portion of the in-school program is used to reinforce theoretical knowledge. Skill training is provided on the job.

Please refer to Skilled Trades Ontario website (www.skilledtradesontario.ca) for the most accurate and up-to-date information about Skilled Trades Ontario. For information on *Building Opportunities in the Skilled Trades Act, 2021 (BOSTA)*) and its regulations, please visit Building Opportunities in the Skilled Trades Act, 2021, S.O. 2021, c. 28 - Bill 288 (ontario.ca)

Pre-requisites

In order to advance to Level 2 of the apprenticeship program, an individual must have completed all of the units outlined in Level 1. Similarly, in order to advance to Level 3 of the program, an individual must have completed all of the units outlined in Level 1 and 2.

If in-school training levels are not being offered for this apprenticeship program, apprentices may apply for a prior learning assessment (PLAR) with their local Ministry of Advanced Education and Skills Development (MAESD) Apprenticeship office in order to complete the requirements of this apprenticeship program.

Prior Learning Assessment and Recognition (PLAR):

PLAR is a process of identifying, assessing and recognizing what a person knows and can do. PLAR is a method for matching learning with the learning required in specific courses or schedules of training.

Ministry staff may conduct a Prior Learning Assessment and Recognition (PLAR) review to determine whether an approved apprenticeship applicant or an apprentice may be exempted from some or all of the formal instruction requirements (curriculum standards/learning outcomes) of the apprenticeship program for the relevant trade.

Hours Disclaimer (if applicable)
It is agreed that Training Delivery Agents (TDAs) may need to make slight adjustments (with cause) according to particular apprentice needs and may deviate from the unit sequencing and the prescribed practical and theoretical hours shown within the standard. However, all TDAs will comply with the hours at the reportable subject level.

Suggested Equipment for Training Delivery Agencies
The Training Delivery Agent is in the best position to determine needs, related to tools and equipment, based on its delivery methodology.

Personal and Safety Equipment: Personal protective equipment is at the discretion of the TDA who must conform to Ontario Provincial Health and Safety Regulations.

Please note that all practices described in this standard must be performed according to the appropriate legislation, regulation and industry best practice. For example, in this curriculum, the performance of certain learning outcomes and objectives may require compliance with legislative or regulatory requirements such as the Ministry of the Environment and Climate Change's requirements related to the handling of refrigerants and the Technical Standards and Safety Associations' (TSSA) requirements related to working with fuels and gas appliances.

Program Summary of Reportable Subjects

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
Level 1				
1	Working Practices and Procedures	10	10	0
2	Fundamentals of Electricity	15	11	4
3	Electrical Measuring Devices	5	5	0
4	Basic Electrical Circuits	40	10	30
5	Electrical Switches and Controls	10	5	5
6	Current Limiting Devices & Conductor Sizing	5	5	0
7	Alternating Current Fundamentals & Single Phase Motors	20	16	4
8	Advanced Appliance Circuitry	25	5	20
9	Drawing and Interpreting Advanced Circuitry	25	5	20
10	Electrical Codes	5	5	0
11	Fundamentals of Electronics & Electronic Controls	10	8	2
12	Troubleshooting Electrical Systems	15	10	5
13	Natural & Propane Gas Properties, Safety, & Characteristics	15	15	0
14	Gas Utilization Codes, Acts and Regulations	12	10	2
15	Gas Piping & Tubing Systems	40	20	20
	Total	**252**	**140**	**112**

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
Level 2				
16	Domestic and Non-Vented Gas Appliances	30	15	15
17	Gas Meters, Pressure Regulators and Relief Valves	30	10	20
18	Domestic Gas Refrigerators & The Building as a System	15	13	2
19	Troubleshooting Domestic Gas Systems	25	10	15
20	Technical Manuals Drawings and Specifications	10	5	5
21	Customer Relations	10	5	5
22	Fundamentals of Cooking Appliances, Compactors & Garburators	5	5	0
23	Design and Operation of Microwave Ovens	5	5	0
24	Troubleshooting & Repairing Microwave Ovens	20	5	15
25	Electric Range or Wall Oven Installation, Design and Operation	20	11	9
26	Troubleshooting & Repairing Ranges and Wall Ovens	25	5	20
27	Fundamentals of Water Systems	10	10	0
28	Electric Clothes Dryer Installation, Design and Operation	13	11	2
29	Troubleshooting & Repairing Clothes Dryers	35	10	25
	Total	**253**	**120**	**133**

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
Level 3				
30	Automatic Clothes Washer Installation, Design and Operation	20	15	5
31	Troubleshooting and Repairing Automatic Washers	30	6	24
32	Automatic Dishwashers Design, Installation and Operation	10	9	1
33	Troubleshooting and Repairing Automatic Dishwashers	25	5	20
34	Mechanical Cooling Cycle Fundamentals	20	15	5
35	Mechanical Cooling Cycle Components	20	15	5
36	Refrigeration Tools and Test Equipment	25	5	20
37	Refrigerant Management	8	8	0
38	Design & Operation of Domestic Refrigerating/Freezing units	15	15	0
39	Diagnosing & Servicing Domestic Refrigerating/Freezing units	30	5	25
40	Design/Operating Principles & Repairs of Room Air Conditioners and Dehumidifiers	22	10	12
	Total	**225**	**108**	**117**
	Grand Total	**730**	**368**	**362**

Gas Modules Units 13, 14, 15, 16, 17, 18, 19, 20, and 21 require a pass mark of 75%, with these exceptions the passing grade is 60% for the remaining units.
Theory = 365hrs
Practical = 343 h

Level 1

Reportable Subject Summary – Level 1

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
1	Working Practices and Procedures	10	10	0
2	Fundamentals of Electricity	15	11	4
3	Electrical Measuring Devices	5	5	0
4	Basic Electrical Circuits	40	10	30
5	Electrical Switches and Controls	10	5	5
6	Current Limiting Devices & Conductor Sizing	5	5	0
7	Alternating Current Fundamentals & Single Phase Motors	20	16	4
8	Advanced Appliance Circuitry	25	5	20
9	Drawing and Interpreting Advanced Circuitry	25	5	20
10	Electrical Codes	5	5	0
11	Fundamentals of Electronics & Electronic Controls	10	8	2
12	Troubleshooting Electrical Systems	15	10	5
13	Natural & Propane Gas Properties, Safety, & Characteristics	15	15	0
14	Gas Utilization Codes, Acts and Regulations	12	10	2
15	Gas Piping & Tubing Systems	40	20	20
	Total	**252**	**140**	**112**

Number:	1		
Title:	**Working Practices and Procedures**		
Duration:	Total Hours: 10	Theory: 10	Practical: 0

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to describe safe working practices and procedures that should be followed to minimize chances of personal harm or harm to others and to prevent damage to property, equipment or the environment.

Learning Outcomes

Upon completion of this unit the apprentice will be able to:

Approx. hrs
Theory/Application

2/0 1.1 discuss the history of the trade.

1/0 1.2 explain the requirements of safety legislation.

2/0 1.3 describe general on-the-job safety principles.

2/0 1.4 identify common fasteners employed in appliances.

2/0 1.5 describe common hand tools identification, selection, use and care.

1/0 1.6 discuss power tools employed in the trade.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

1.1 discuss the history of the trade.

- identify the early beginnings of the role of a major appliance technician and traces it to present times.
- identify associations, manufacturers, and distributors related to the industry.

1.2 explain the requirements of safety legislation.

- identify the roles of (WHMIS), (O.H.S.A.), (C.S.A.), (W.C.B.), and (U.L.).
- describe what a (MSDS) Material Safety Data Sheet is.
- describe briefly some the materials used in the trade that would normally come with or require accompaniment with MSDS
- discuss hazardous materials disposal
- discuss reporting hazards and accidents to comply with regulations

1.3 describe general on-the-job safety principles.

- discuss or describe key safety factors to be considered on the job
  - personal protection equipment for eyes, ears, feet, head, lungs, muscles, bones and skin (clothing)
  - site protections such as housekeeping, warning signs, barricades, emergency exits
  - safety equipment and its location
  - good housekeeping practices such as
    - cleaning up oil or other liquid spills immediately
    - ensuring adequate lighting
    - covering or barricading open pits or holes
    - careful placement of extension cords line cords etc.
    - keeping exits clear in case of emergencies
    - storage of gas cylinders in upright position
    - storage of flammable liquids in approved containers only
    - storage of oily rags in metal container with lid
  - general rules of safe conduct while on the job such as
    - no horseplay
    - no use of reaction impairing substances
    - removing or restraining loose or dangling jewelry and clothing
    - warning others of unsafe conditions
    - no smoking near flammable or combustible materials
    - not using any unfamiliar power equipment until receiving proper training
    - employ proper lifting techniques
- identify mechanical and electrical lock out procedures
- identify fire classifications and match extinguisher to class of fire

1.4 identify common fasteners employed in appliances.

- identify fasteners in terms of size, applications, and capacities or tensile strength
  - electrical fasteners
  - electrical couplings
  - non metallic cable connectors
  - crimp-on or solder-less connectors
  - BX connectors and bushings
  - wire nuts or marrettes
  - pipe fasteners
  - pipe rings
  - u-bolts
  - grappling bar
  - clamps
  - pipe saddles
  - beam clamps
  - brackets
  - rod attachments
  - pipe hangers
  - general fasteners
  - machine, allen, metal, and wood screws
  - bolts and nuts
  - hose clamps
  - rawl plugs
  - powder activated (shot type)
  - retaining clips, pins and keys
  - speed and blind nuts
- identify criteria for selecting fasteners
  - type of materials being used
  - size
  - type of operation being performed
  - restrictions of fastener being used
  - necessary force to be applied
  - most efficient usage

1.5 describe common hand tools identification, selection use and care.

- describe hand tools in terms of size and shape, application to specific materials, strength, operating range, assembly and adjustment
  - general tools: screw or nut drivers, tin snips, allen keys, wire brushes, pliers, crimping tools, wrenches, chisels, tube benders, hammers, files, levels, chalk lines, plumb bob, sockets and ratchets, measuring tapes
  - Cutting tools: saws, pipe and tube cutters
  - Threading tools: taps, dies, reamers, clamps, vise
- describe criteria for hand tool selection based on following factors
  - type of materials being used
  - size
  - type of operation being performed
  - restrictions of fastener being used
  - necessary force to be applied
  - most efficient usage
- describe proper methods of storing and handling tools based on the following
  - type of tool, size, type of construction, safety, cleanliness, and lubrication

1.6 discuss power tools employed in the trade.

- discuss general selection, use, and care of the following power tools
  - electric or pneumatic impact wrenches
  - reciprocating saws
  - cordless drills
  - electric hand drills
  - bench grinders
- describe precautions that must be employed when performing
  - drilling operations in customer’s home
  - grinding operations

Number:	2		
Title:	**Fundamentals Of Electricity**		
Duration:	Total Hours: 15	Theory: 11	Practical: 4
Prerequisite:	Unit 1		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to explain basic electrical theories and laws.

Learning Outcomes

Approx. hrs
Theory/Application

1/0	2.1	relate the electron theory to electricity.
1/0	2.2	distinguish between conducting and insulating materials.
3/0	2.3	describe current flow, resistance, and voltage.
4/0	2.4	describe sources and kinds of electrical energy.
1/0	2.5	describe the elements and operation of a basic circuits.
1/4	2.6	use ohms law to solve electrical problems.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

2.1 relate the electron theory to electricity.

- describe the structure of the atom
- describe the electrical charges of the parts of the atom
- state the law of electrical charges
- define current flow
- describe the direction of current flow

2.2 distinguish between conducting and insulating materials.

- review element chart
- describe relevance of the electron theory to materials used as:
  - conductors (copper, aluminium, silver)
  - semi conductors (nichrome, silicon, carbon)
  - insulators (glass, vinyl, mica)

2.3 define or describe current flow, resistance, and voltage.

- describe electromotive force and its effect on current flow
- describe resistance and its effect on current flow
- describe the basic units of measurement, meters, and symbols associated with
  - voltage
  - resistance
  - current
- describe factors that influence the amount of resistance in conductors
- describe control resistors and heating resistors

2.4 describe sources and kinds of electrical energy.

- describe the six sources of electrical energy
  - friction
  - light
  - pressure
  - chemical
  - heat
  - magnetism
- describe difference between alternating and direct current

2.5 describe the elements and operation of basic electrical circuits.

- list fundamental parts of a basic electrical circuit and describe purpose of each
  - load
  - conductors
  - energy source
- describe different types of load connections
  - series
  - parallel
  - series parallel
- describe current flow, voltage, and resistance when loads are connected in
  - series
  - parallel
  - series parallel

2.6 use ohms law to solve electrical problems.

- review ohms law and it’s limitations
- review symbols for current, voltage and resistance (E, I, R)
- express the relationship between E, I, and R both practically and mathematically
- describe formulas for calculating total resistance in series and parallel
- use ohms law and resistance formulas to compute totals of resistance, voltage and voltage drops, and current flow in series and parallel circuits.

Number:	3		
Title:	**Electrical Measuring Devices**		
Duration:	Total Hours: 5	Theory: 5	Practical: 0
Prerequisite:	Unit 2		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to select and explain the use and care of different electrical measuring and test instruments to troubleshoot electrical circuits.

Learning Outcomes

Approx. hrs
Theory/Application

1/0 3.1 describe the general purpose of electrical meters.

1/0 3.2 describe the basic operation and care of meters.

1/0 3.3 describe scales and interpreting meter readings.

2/0 3.4 describe selection and use of meters.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

3.1 describe the general purpose of electrical meters.

- describe
  - the invisibility of electricity
  - the effects of electric shock to humans
  - inaccuracies and dangers of using test lights
  - different circumstances which would require the use of the following meters
    - voltmeter or millivoltmeter
    - ammeter
    - ohmmeter
    - wattmeter

3.2 describe the basic operation and care of meters.

- describe basic differences between analog and digital meters
- describe basic care procedures for test leads, protection from over current, replacement batteries or fuses, and protection from physical damage usually caused by dropping or exposure to moisture.
- describe the basic operating principles of analog meters

3.3 describe scales and interpreting meter readings.

- describe interpretation of readings on multiple scales and reading multipliers
- discuss parallax view
- describe significance of using correct test lead ports in multimeters

3.4 describe selection and use of meters.

- describe different scenarios which would affect the choice of meter
- describe isolation of system or components being tested when using ohmmeter
- describe test points for application that will produce optimum accuracy

Number:	4		
Title:	**Basic Electrical Circuits and Safety**		
Duration:	Total Hours: 40	Theory: 10	Practical: 30
Prerequisite:	Unit 2		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to construct basic electrical circuits by following pictorial diagrams and exercising electrical safety precautions.

Learning Outcomes

Approx. hrs Theory/Application		
6/23	4.1	construct basic electrical circuits.
2/4	4.2	prove ohms and power laws experimentally.
1/2	4.3	use meters to test for shorts, verify correct polarity and voltage supply
1/1	4.4	make electrical connections to electrical code standards.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

Special Instructions: The following circuits should be designed to reinforce and verify student's knowledge of electrical circuits and test meter usage. It is suggested that ordinary household lamp holders, bulbs of various wattage, single pole light switches, 14/2 wire, wire nuts, 120v line cord, switch boxes, octagon boxes, and cable connectors be used as they are easy to obtain and relatively inexpensive. Projects can be assembled on a breadboard and the same wires can be used and saved over and over, as well, they can be used later in Unit 8. A practical evaluation checklist including oral questions can be made so that the apprentice is clear on the evaluation process. Note: SAFETY must be stressed as they are working with potentially lethal voltage.

Neat and accurate pictorial diagrams should be supplied to apprentice along with test procedures to be carried out before commencing. It is strongly suggested that each project be tested with an ohmmeter and checked by the instructor before applying voltage. Apprentice should be expected to convert the pictorial diagram into a schematic or ladder form before commencing the building of each project after the first one.

4.1 construct basic electrical circuits.

- use supplied pictorial diagrams to construct the following circuits
  - simple circuit with one switch and one light.
  - 2 switches in series controlling one light
  - 2 switches in parallel controlling one light
  - 1 switch controlling 2 lights in series (bulbs of different wattage's should be used)
  - 1 switch controlling 2 lights in parallel
  - 2 switches each controlling a different light

4.2 prove ohms and power laws experimentally.

- describe or review the power law and ohms law as they relate to A.C. resistive circuits
- perform calculations based on each project using ohms and power laws
- verify calculations with meters

4.3 use meters to test for shorts, verify correct polarity and voltage supply .

- describe the meaning of, open and closed circuits
- describe appropriate scales to be used (where applicable)
- use ohmmeter to
  - test for shorts or confirm proper grounding
  - test operation of switches
  - test circuit for continuity or resistance
- use voltmeter to
  - verify power source
  - test polarity and grounding of power source
  - test voltage across loads and switches with switches open and or closed
- use ammeter to
  - check current flow in circuits
  - describe the use of current multiplier loops when testing for low current

4.4 make electrical connections to electrical code standards.

- identify electrical code requirements with respect to
  - grounding
  - selection and use of wire nuts
  - selection and use of cable or box connectors
  - polarity of connections to loads
  - connecting wires to switches
- makes electrical connections to conform with electrical code

Number:	5		
Title:	**Electrical Switches and Controls**		
Duration:	Total Hours: 10	Theory: 5	Practical: 5
Prerequisite:	Unit 2		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to describe the operation and general uses of electrical switches and controls that are commonly employed in appliances.

Learning Outcomes

Approx. hrs Theory/Application		
1/0	5.1	describe the various types of switches and their use in appliances.
1/0	5.2	identify names of internal parts of various switches and controls.
1.5/1	5.3	describe symbols used in schematics and basic troubleshooting or adjustments.
.5/0	5.4	describe current limitations of switches and controls.
1/4	5.5	create selector switch charts.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

5.1 describe the various types of switches and their use in appliances.

- describe use of switches in categories of
  - thermal (bimetal and hydraulic)
  - mechanical (door, interlock, micro, rotary or selector, pressure)
  - electromechanical (relays and timers)

5.2 identify names of internal parts of various switches and controls.

- identify switch terminology such as; contacts, spring loaded, snap action, bellows, bourdon tube, capillary tube, sensing element, cams, cam followers, escapements, bimetal heaters, relay coils, etc.

5.3 describe symbols used in schematics and basic troubleshooting or adjustments.

- describe action of switches and schematic representation of (spst, spdt, dpdt, normally closed or open, three way, rotary or selector, timer, bimetal, hydraulic, thermal, pressure
- describe charts used to interpret selector or rotary and timer switch operation
- verify operation of switches and controls by using ohmmeter and charts or voltmeter if switch must be must be energized
- identify or discuss diagnosing and use of schematic to isolate problems to switch faults
- identify basic adjustment procedures for controls (where applicable)

5.4 describe current limitations of switches and controls.

- describe limitations of voltage and current of switches with respect to contact or coil ratings

5.5 create selector switch charts.

- test various rotary selector switches with ohmmeter and indicate operation of switch by drawing up selector switch chart

Number:	6		
Title:	**Current Limiting Devices and Conductor Sizing**		
Duration:	Total Hours: 5	Theory: 5	Practical: 0
Prerequisite:	Unit 2		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to describe circuit protection as it relates to the ampacity of conductors.

Learning Outcomes

Approx. hrs
Theory/Application

.5/0 6.1 describe purposes of circuit protection.

2/0 6.2 describe types, actions and applications.

2.5/0 6.3 describe conductor sizing and insulation.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

6.1 describe purposes of circuit protection.

- describe circuit protection from the perspective of
  - user safety
  - protecting equipment or related components

6.2 describe types, actions and applications.

- describe the fundamentals of residential main panel fusing, breakers, ground fault receptacles, split receptacles
- describe the basic actions and applications of fuses, and breakers employed in appliances

6.3 describe conductor sizing and insulation.

- define ampacity
- describe the meaning of A.W.G. (American wire gauge)
- describe relationship between wire gauge and fuse or breaker values
- identify typical electrical requirements for circuits that lead to the following appliances
  - refrigerator
  - microwave
  - full size electric clothes dryer
  - full size electric range
  - chest freezer
  - room air conditioner
- describe characteristics of wire insulating materials used in appliances with respect to temperature and voltage (include high voltage circuit in microwave ovens)

Number:	7		
Title:	**Alternating Current Fundamentals and Single Phase Motors**		
Duration:	Total Hours: 20	Theory: 16	Practical: 4
Prerequisite:	Unit 2		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to describe the fundamentals of alternating current and its relation to the construction and operation of split phase motors used in appliances.

Learning Outcomes

Approx. hrs Theory/Application		
3/0	7.1	describe the components and operation of basic generators.
2/0	7.2	describe alternating current fundamentals.
1/.5	7.3	describe the design and operation of basic transformers.
5/0	7.4	describe the design, operation, and applications of split phase motors.
1/.5	7.5	describe basic motor starting devices and overload protection.
4/3	7.6	perform procedures for troubleshooting motors.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

7.1 describe the components and operation of basic generators.

- describe electromagnetism and some of it's uses
- describe components
  - armature
  - commutator
  - brushes
  - magnetic poles
- describe principles of operation of an elementary generator

7.2 describe alternating current fundamentals.

- define
  - vector
  - phase
  - lead
  - lag
  - frequency
  - cycle
  - angles in electrical degrees
  - describe capacitance and the factors which affect it
- describe the construction and characteristics of capacitors
- describe test procedures for open, shorts and grounded
- describe capacitor types and applications
- state the unit of measurement for the charge of a capacitor and give its symbol
- define inductance and state its symbol
- list the factors that affect inductance
- describe some of the common inductors used in appliances
- state the phase relationship between current and voltage in a circuit containing pure
  - resistance
  - inductance
  - capacitance
- define impedance

7.3 describe the design and operation of basic transformers.

- describe the structure of a transformer and its purposes
- define the primary and secondary windings of a transformer
- define or explain the term counter e.m.f.
- differentiate between a step-up and a step-down transformer
- describe and solve problems, involving transformer voltage, turns and current ratios
- describe a typical single phase transformer supplying voltage to a residential fuse panel
- describe basic difference between three phase and single phase voltages
- describe troubleshooting procedures.
- perform tests of various smaller transformers using voltmeter and or ohmmeter to prove their operation or failures

7.4 describe the design, operation, and applications of split phase motors.

- describe the components of a
  - split phase motor
  - universal motor
- explain the meanings of split phase and universal
- demonstrate the different characteristics and applications of single phase motors including:
  - series (universal)
  - shaded pole and synchronous
  - split phase (open or sealed)
  - capacitor start
  - capacitor run
  - capacitor start capacitor run
  - so called reversing motor (using run capacitor and equal value windings)
  - P.S.C. (permanent split capacitor)
- explain motor terminology including: actual speed, synchronous speed, rotor slip, torque, horsepower, LRV (locked rotor voltage), LRA (locked rotor amperage), FLA(full load amperage), poles, and rotating magnetic field
- describe lubrication or maintenance of motors where applicable

7.5 describe basic motor starting devices and overload protection.

- describe basic functions of starting device and overload
- describe or demonstrate installation and operation of (solid state (PTC), current, hot wire, and potential relays)
- test relays and overloads with ohmmeters and show test results in a pictorial diagram

7.6 perform procedures for troubleshooting motors.

- describe common symptoms and causes of motor failure to start or run such as: bearing failure, open circuits, shorted windings, lack of air circulation, low or high voltage, mechanical obstructions to rotor.
- demonstrate motor troubleshooting techniques
- perform troubleshooting techniques using voltmeter, ammeter, wattmeter, and ohmmeter
- prepare a short written report based on troubleshooting procedures performed and results of testing

Number:	8		
Title:	**Advanced Appliance Circuitry**		
Duration:	Total Hours: 25	Theory: 5	Practical: 20
Prerequisite:	Units 3, 4, 5, 6, and 7		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to construct more complex circuits containing rotary or selector switches, relays, transformers, thermostats and motors.

Learning Outcomes

Approx. hrs
Theory/Application

2/5 8.1 design complex appliance circuits.

2/12 8.2 construct complex circuits.

1/3 8.3 use electric meters to assist in analysis and troubleshooting.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

8.1 design complex appliance circuits.

- describe some of the more complex circuits used in appliance servicing such as
  - push to start circuits involving holding relay
  - rotary switch controlling multiple loads
  - single pole double throw action (light and fan)
  - low voltage control circuitry involving step down transformer, low voltage relay and high voltage load
- design schematics for all of the above operations (or equivalent) and show in neat schematic representation.

8.2 construct complex circuits.

- construct the following projects
  - push to start circuits involving holding relay
  - rotary switch controlling multiple loads
  - single pole double throw action (light and fan)
  - low voltage control circuitry involving step down transformer, low voltage relay and high voltage load

8.3 use electric meters to assist in analysis and troubleshooting.

- use appropriate meters to analyze or explain operation of circuits
- discuss troubleshooting techniques

Number:	9		
Title:	**Drawing and Interpreting Advanced Circuitry**		
Duration:	Total Hours: 25	Theory: 5	Practical: 20
Prerequisite:	Units 3, 4, 5, 6, and 7		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to interpret appliance schematics that contain temperature or pressure control circuitry and low or line voltage control circuitry.

Learning Outcomes

Approx. hrs
Theory/Application

2/2 9.1 describe most of the component symbols used in appliances.

1/8 9.2 trace path(s) of current flow on appliance schematics.

2/10 9.3 interpret schematic for troubleshooting purposes.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

9.1 describe most of the component symbols used in appliances.

- describe electrical component symbols used in appliances
  - make comparisons of symbols used in European schematics to North American

9.2 trace path(s) of current flow on appliance schematics.

- trace through active circuits in various cycles or modes of operation

9.3 interpret schematic for troubleshooting purposes.

- describe process of isolating electrical faults to specific areas or components in appliances by using schematic and electrical reasoning
- interpret schematic to isolate and identify fault
- describe process of confirming fault using electric meter(s)

Number:	10		
Title:	**Electrical Codes**		
Duration:	Total Hours: 5	Theory: 5	Practical: 0
Prerequisite:	Units 3, 4, 5, 6, and 7		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to describe electrical codes and responsibilities that the appliance technician must be aware of in order to perform their duties in a safe and legal manner.

Learning Outcomes

Approx. hrs
Theory/Application

3/0 10.1 describe electrical codes that are relevant to the appliance technician.

2/0 10.2 describe electrical limitations or restrictions of the technician.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

10.1 describe electrical codes that are relevant to the appliance technician.

- describe electrical codes related to placement, orientation and ampacity of receptacles supplying voltages to the full range of appliances in residential applications
- describe grounding requirements of appliances
- describe the use of anti-shorts or wire bushings used in BX cable
- describe the use of strain relief connectors in appliances
- identify unsafe electrical installations and procedures to be taken if any are found

10.2 describe electrical limitations or restrictions of the technician.

- describe the scope of electrical work that can be performed by an appliance technician
- describe instances that require the services of a qualified electrician (generally related to installation of supply to appliance or fuse panel problems)

Number:	11		
Title:	**Fundamentals of Electronics and Electronic Controls**		
Duration:	Total Hours: 10	Theory: 8	Practical: 2
Prerequisite:	Units 8, 9 and 10		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to describe methods of testing and handling electronic controls and components.

Learning Outcomes

Approx. hrs
Theory/Application

1/0 11.1 describe briefly the history of electronics use in appliances.

1/0 11.2 identify schematic symbols of electronic components.

4/0 11.3 describe the purpose, application and test procedures for electronic components.

1/2 11.4 test electronic boards and devices as per manufacturer’s instructions.

1/0 11.5 describe precautions to be employed when handling boards.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

11.1 describe briefly the history of electronics use in appliances.

- explain the chief reasons for the influx of electronics into appliances from a standpoint of reliability, manufacturing cost, marketing, accuracy

11.2 identify schematic symbols of electronic components.

- define the meaning of rectification
- identify the follow electronic component symbols
  - diode
  - zenier diode
  - transistor (PNP and NPN)
  - SCR
  - triac
  - varistors
  - thermistors

11.3 describe the purpose, application and test procedures for electronic components.

- describe the purpose, application and test procedures of:
  - diode
  - zenier diode
  - transistor (PNP and NPN)
  - SCR
  - triac
  - varistors
  - thermistors

11.4 test electronic boards and devices as per manufacturer's instructions.

- perform testing of electronic boards and various components using test procedures outlined in manufacturer's service literature and record results
- describe or perform soldering of components to boards

11.5 describe precautions to be employed when handling boards.

- describe the
  - effects of component exposure to static electricity and methods of prevention
  - critical requirements of tight and clean connections
  - need for proper and secure grounding of components or boards

Number:	12		
Title:	**Troubleshooting Electrical Systems**		
Duration:	Total Hours: 15	Theory: 10	Practical: 5
Prerequisite:	Unit 11		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to perform basic troubleshooting procedures to determine faults in electrical systems of appliances.

Learning Outcomes

Approx. hrs
Theory/Application

10/0 12.1 describe the essential steps leading to proper diagnosis.

0/5 12.2 perform troubleshooting procedures on appliance circuits.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

12.1 describe the essential steps leading to proper diagnosis.

- describe
  - the need for listening carefully to customers complete operational complaint
  - procedures for questioning customer about history of appliance
  - the need for looking for obvious problems first
  - procedures for ruling out mechanical, fuel or water supply and customer misuse problems that may adversely affect the operation of electrical or electronic systems
  - alternative test procedures for verifying defects in components (double check)
  - alternative test procedures when schematic is unavailable or not legible
  - importance of testing electrical measuring instruments to avoid false diagnosis

12.2 perform troubleshooting procedures on appliance circuits.

- perform tests and troubleshooting procedures on some of the base-model appliances using appropriate meters and schematic diagrams.

Number:	13		
Title:	**Natural and Propane Gas Properties,Safety and Characteristics**		
Duration:	Total Hours: 15	Theory: 15	Practical: 0
Prerequisite:	Unit 2		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to identify or explain the properties, characteristics and safe handling of Propane and Natural gas.

Learning Outcomes

Approx. hrs
Theory/Application

3/0 13.1 identify the properties of propane and natural gases.

3/0 13.2 identify the characteristics of propane and natural gases.

3/0 13.3 identify the requirements of complete combustion of propane and natural gases.

2/0 13.4 describe primary secondary and excess air.

1/0 13.5 determine how and when to evacuate a propane or natural gas environment.

3/0 13.6 recognize potential sources of ignition and other safety issues.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

13.1 identify the properties of propane and natural gases.

- identify and explain the properties of each of the two gases (propane and natural) such as:
  - explosive limits
  - density
  - specific gravity
  - flame speed
  - heat content
  - physical states (at well head, transmission, storage, and end user)
  - flame temperature
  - ignition temperature
  - vaporization (propane only)
    - vapour to liquid ratio
    - temperature to pressure relationship for liquid
    - boiling point
    - physical properties of propane liquid vapour phases

13.2 identify the characteristics of propane and natural gases.

- identify and explain the characteristics of each of the two gases (propane and natural)
  - colour (in natural form and delivery state)
  - odour (natural, additives or odourants used , health factors)
  - toxicity (levels and exposure risks)
- differentiate between the properties and characteristics of propane and natural gas to ensure public and personal safety

13.3 identify the requirements of complete combustion of propane and natural gases.

- define combustion
- identify the:
  - required elements of combustion
  - combustion triangle
  - products of combustion
  - heat of combustion
- differentiate between the characteristics of complete and incomplete combustion of each of the gases using the chemical properties of each for comparison
- describe causes of incomplete combustion

13.4 describe primary secondary and excess air.

- describe the
  - composition of air (effect of altitude changes)
  - types of flames (Bunsen and luminous)
  - types of air and where types of air are entrained
  - effect of changes in primary air, secondary air, and excess

13.5 determine how and when to evacuate a propane or natural gas environment.

- determine
  - upper and lower explosive limits
  - when to evacuate
  - how to evacuate
  - procedures to ventilate

13.6 recognize potential sources of ignition and other safety issues.

- recognize potential sources of ignition such as
  - light switches
  - electrical switches
  - spark ignition
  - open flames
  - door bells
  - telephones
  - construction equipment
  - static electricity
- define carbon monoxide
- explain procedures to perform CO tests
- outline procedures for using combustible gas indicators to determine gas leaks from various sources
- demonstrate how to shut down valves
- determine sources of odours such as gasoline, sewer gas, paint, carbon monoxide, methane

Number:	14		
Title:	**Gas Utilization Codes, Acts and Regulations**		
Duration:	Total Hours: 12	Theory: 10	Practical: 2
Prerequisite:	Unit 13		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to identify codes and acts that affect the installation of propane and natural gas equipment.

Learning Outcomes

Approx. hrs
Theory/Application

1/0 14.1 identify the governing bodies and agencies that regulate the installation of propane and natural gas and their respective roles.

2/0 14.2 describe the scope of the installation codes and acts.

1/0 14.3 locate sections of the codes as they apply to work performed.

2/0 14.4 discuss the general requirements for natural gas and propane installations.

2/0 14.5 refer to sections of codes and acts that have an impact on natural gas and propane installation.

2/0 14.6 distinguish between propane tanks and cylinders.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

14.1 identify the governing bodies and agencies that regulate the installation of propane and natural gas and their respective roles.

- identify or review the roles of
  - MCCR- Ministry of Consumers and Commercial Relations
  - CGA- Canadian Gas Association
  - CSA-Canadian Standard Association
  - IAS-International Approval Services
  - ETL- Equipment Testing Laboratories
  - WHPS- Warnock Hersey Professional Services Ltd.
  - ULC- Underwriter's Laboratories of Canada
  - UL- Underwriter's Laboratories
  - TC- Transport Canada
  - DOT- Department of Transport (US)
  - PGAC- Propane Gas Association of Canada

14.2 describe the scope of the installation codes and acts.

- describe the scope of the installation codes and acts for Natural Gas with respect to:
  - applications
  - exclusions
- describe the scope of the installation codes and acts for Propane with respect to:
  - applications
  - exclusions
- provide a brief description of the pertinent regulations of the Energy Act such as
  - Fuel oil code Regulation 329
  - Gas Pipeline Systems Regulation 330
  - Gas Installation Code Regulation 331
  - Oil pipeline transportation systems Regulation 332
  - Propane storage, handling and utilization code Regulation 250/94

14.3 locate sections of the codes as they apply to work performed.

- locate sections from the Ontario Gas Utilization Code such as:
  - scope
  - definitions, abbreviations, and reference publications
  - general requirements re: approval and installation of appliances and equipment, clearance from combustibles
  - pressure inside buildings and devices used to control system pressures
  - installation of piping and tubing systems, including fittings and accessories
  - Information related to the installation of specific appliances
  - Venting systems and air supply requirements
  - Requirements for installation of natural gas compressors and cylinder filling, storage and utilization
  - Vehicles refueling appliances without storage
- locate sections from the Propane Installation Code such as:
  - scope
  - definitions, abbreviations, and reference publications
  - general requirements re: approval and installation of appliances and equipment, clearance from combustibles
  - pressure inside buildings and devices used to control system pressures
  - installation of piping and tubing systems, including fittings and accessories
  - information related to the installation of specific appliances
  - venting systems and air supply requirements
  - general requirements specific to propane and to propane equipment
  - cylinder systems
  - tank systems, filling plants and refill centres
  - tank trucks, tank trailers and cargo liners
  - the requirements for the installation of vaporizers
    - propane as an engine fuel
    - installation of appliances, equipment and containers on highway vehicles, recreational vehicles, mobile housing, outdoor food service units and wash-mobiles

14.4 discuss the general requirements for natural gas and propane installations.

14.5 refer to sections of codes and acts that have an impact on natural gas and propane installations.

14.6 distinguish between propane tanks and cylinders.

Number:	15		
Title:	**Gas Piping and Tubing Systems**		
Duration:	Total Hours: 40	Theory: 20	Practical: 20
Prerequisite:	Unit 14		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to install gas piping or tubing in accordance with applicable acts or codes.

Learning Outcomes

Approx. hrs
Theory/Application

5/5 15.1 select gas piping/tubing.

5/5 15.2 identify and select pipe fittings and valves.

5/5 15.3 identify pipes and uses of pipes and hangers and supports.

1/1 15.4 refer to code for purging.

2/4 15.5 identify all types of water service piping and tubing material.

2/0 15.6 describe the reasons for corrosion protection for gas lines.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

15.1 select gas piping/tubing.
8.01

15.2 identify and select pipe fittings and valves.
8.02

15.3 identify pipes and uses of pipes and hangers and supports.
8.03

15.4 refer to code for purging.
8.04

15.5 identify all types of water service piping and tubing material.
8.05

15.6 describe the reasons for corrosion protection for gas lines.
8.06

Level 2

Reportable Subject Summary – Level 2

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
16	Domestic and Non-Vented Gas Appliances	30	15	15
17	Gas Meters, Pressure Regulators and Relief Valves	30	10	20
18	Domestic Gas Refrigerators & The Building as a System	15	13	2
19	Troubleshooting Domestic Gas Systems	25	10	15
20	Technical Manuals Drawings and Specifications	10	5	5
21	Customer Relations	10	5	5
22	Fundamentals of Cooking Appliances, Compactors & Garburators	5	5	0
23	Design and Operation of Microwave Ovens	5	5	0
24	Troubleshooting & Repairing Microwave Ovens	20	5	15
25	Electric Range or Wall Oven Installation, Design and Operation	20	11	9
26	Troubleshooting & Repairing Ranges and Wall Ovens	25	5	20
27	Fundamentals of Water Systems	10	10	0
28	Electric Clothes Dryer Installation, Design and Operation	13	11	2
29	Troubleshooting & Repairing Clothes Dryers	35	10	25
	Total	**253**	**120**	**133**

Number:	16		
Title:	**Domestic and Non-Vented Gas Appliances**		
Duration:	Total Hours: 30	Theory: 15	Practical: 15
Prerequisite:	Unit 15		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to describe basic gas appliances and their operating characteristics.

Learning Outcomes

Approx. hrs
Theory/Application

2/2 16.1 describe venting types, purposes, and troubleshooting.

3/3 16.2 describe the operating characteristics and features of gas appliances.

2/2 16.3 describe burner design.

2/2 16.4 describe basic ignition control systems.

1/0 16.5 describe the theory of operation for temperature sensing devices.

2/1 16.6 describe the requirements to convert an appliance from propane to natural gas or visa versa.

3/5 16.7 perform re-activation of appliances.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

16.1 describe venting types, purposes, and troubleshooting.
9.01

16.2 describe the operating characteristics and features of gas appliances.
9.02

16.3 describe burner design.
9.03

16.4 describe basic ignition control systems.
9.04

16.5 describe the theory of operation for temperature sensing devices.
9.05

16.6 describe the requirements to convert an appliance from propane to natural gas or visa versa.
9.06

16.7 perform re-activation of appliances.
9.07

Number:	17		
Title:	**Gas Meters, Pressure Regulators, and Relief Valves**		
Duration:	Total Hours: 30	Theory: 10	Practical: 20
Prerequisite:	Unit 16		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to describe the purpose, design features, operation and (where applicable) test and adjustment procedures of gas meters, pressure regulators, and relief valves.

Learning Outcomes

Approx. hrs Theory/Application		
3/5	17.1	explain procedures for installation of gas pressure regulators.
2/3	17.2	explain procedures for installing appliance regulators.
2/5	17.3	explain procedures for installing relief valves.
2/5	17.4	explain procedures for installing meters.
1/2	17.5	explain procedures for servicing cylinders.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

17.1 explain procedures for installation of gas pressure regulators.
15.01

17.2 explain procedures for installing appliance regulators.
15.02

17.3 explain procedures for installing relief valves.
15.03

17.4 explain procedures for installing meters.
15.04

17.5 explain procedures for servicing cylinders.
15.05

Number:	18		
Title:	**Domestic Gas Fired Refrigerators & Building as a System**		
Duration:	Total Hours: 15	Theory: 13	Practical: 2
Prerequisite:	Unit 17		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to describe or explain the operating characteristics and test procedures of a domestic gas fired refrigerator and the building as an operating system.

Learning Outcomes

Approx. hrs Theory/Application		
2/0	18.1	describe the construction and operating fundamentals of gas fired refrigerators.
1/2	18.2	describe service and maintenance of propane/natural gas refrigerators.
2/0	18.3	explain the key components of the building as a system.
2/0	18.4	describe building science principles as they relate to heat, moisture, and air flows in a building.
2/0	18.5	explain ways of incorporating energy conservation measures into building construction and renovation.
2/0	18.6	explain how mechanical systems affect the heat, moisture, and air flows of a building.
1/0	18.7	explain the requirement for ventilation and filtration in a building and the issues and control of indoor air quality.
1/0	18.8	determine the minimum sizes for combustion air and ventilation air openings.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

18.1 describe the construction and operating fundamentals of gas fired refrigerators.
16.01

18.2 describe service and maintenance of propane/natural gas refrigerators.
16.02

18.3 explain the key components of the building as a system.

18.4 describe building science principles as they relate to heat, moisture, and air flows in a building.

18.5 explain ways of incorporating energy conservation measures into building construction and renovation.

18.6 explain how mechanical systems affect the heat, moisture, and air flows of a building.

18.7 explain the requirement for ventilation and filtration in a building and the issues and control of indoor air quality.

18.8 determine the minimum sizes for combustion air and ventilation air openings.

Number:	19		
Title:	**Troubleshooting Domestic Gas Systems**		
Duration:	Total Hours: 25	Theory: 10	Practical: 15
Prerequisite:	Unit 18		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to describe or perform test procedures on domestic gas appliances to ascertain problems and recommend corrective actions.

Learning Outcomes

Approx. hrs
Theory/Application

1/2 19.1 describe the operation and installation procedures for gas ranges.

2/2 19.2 describe procedures for servicing gas ranges.

1/2 19.3 describe the operation and installation for a gas clothes dryer.

1/2 19.4 describe procedures for servicing gas dryers.

1/2 19.5 describe the operation and installation of gas barbecues.

2/2 19.6 describe procedures for servicing gas barbecues.

1/2 19.7 identify gas lamp installation and service requirements

1/1 19.8 describe procedures for servicing gas lamps

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

19.1 describe the operation and installation procedures for gas ranges.
14.01

19.2 describe procedures for servicing gas ranges.
14.02

19.3 describe the operation and installation for a gas clothes dryer.
14.03

19.4 describe procedures for servicing gas dryers.
14.04

19.5 describe the operation and installation of gas barbecues.
14.05

19.6 describe procedures for servicing gas barbecues.
14.06

19.7 identify gas lamp installation and service requirements
14.07

19.8 describe procedures for servicing gas lamps
14.08

Number:	20		
Title:	**Technical Manuals Drawings and Specifications**		
Duration:	Total Hours: 10	Theory: 5	Practical: 5
Prerequisite:	Unit 12		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to interpret charts, graphs, and general technical data found in manufacturers' installation, service, and parts literature and in code books.

Learning Outcomes

Approx. hrs
Theory/Application

1/0 20.1 utilize reference material.

2/5 20.2 interpret technical manuals and manufacturer's specifications.

1/0 20.3 interpret mechanical drawings and specifications.

1/0 20.4 interpret graphs, charts and tables.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

20.1 utilize reference material.
6.01

20.2 interpret technical manuals and manufacturer’s specifications.
6.02

20.3 interpret mechanical drawings and specifications.
6.03

20.4 interpret graphs, charts and tables.
6.04

Number:	21		
Title:	**Customer Relations**		
Duration:	Total Hours: 10	Theory: 5	Practical: 5
Prerequisite:	Unit 12		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to identify or describe methods of dealing with most of the customer service issues related to the industry.

Learning Outcomes

Approx. hrs
Theory/Application

1/1 21.1 respond to customer inquiries.

1/1 21.2 describe procedures for preventing property damage.

1/1 21.3 respond to irate customers.

.5/.5 21.4 demonstrate sensitivity to cultural differences.

1/1 21.5 complete jobs according to policies and regulations.

.5/.5 21.6 identify situations where it is not advisable to enter the customer's home.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

21.1 respond to customer inquiries.
7.01

21.2 describe procedures for preventing property damage.
7.02

21.3 respond to irate customers.
7.03

21.4 demonstrate sensitivity to cultural differences.
7.04

21.5 complete jobs according to policies and regulations.
7.05

21.6 identify situations where it is not advisable to enter the customer's home.
7.06

Number:	22		
Title:	**Fundamentals of Cooking Appliances, Compactors and Garburators**		
Duration:	Total Hours: 5	Theory: 5	Practical: 0
Prerequisite:	Unit 12		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to describe the basic functions of cooking appliances, and waste disposal or compactor systems.

Learning Outcomes

Approx. hrs
Theory/Application

2/0 22.1 explain terms associated with cooking and cooking appliances.

1/0 22.2 describe different types of cooking appliances.

1/0 22.3 describe the fundamentals of garburators and compactors.

1/0 22.4 describe how foods are cooked in a microwave oven.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

22.1 explain terms associated with cooking and cooking appliances.

- explain terms such as
  - baking
  - roasting
  - cook and hold
  - timed baking
  - broiling, broil stop position, broil pan
  - variable broil
  - convection cooking
  - self clean, pyrolitic
  - continuous clean, catalytic
  - manual clean

22.2 describe different types of cooking appliances.

- describe the features of the following types of cooking systems
  - built-in or wall ovens
  - free standing (30 or 24 inch)
  - drop in units
  - countertop (glass top)
  - down-draft unit
  - over the range microwave oven

22.3 describe the fundamentals of garburators and compactors.

- describe the location, purpose, and principles of operation of
  - garburators
  - trash compactors

22.4 describe how foods are cooked in a microwave oven.

- explain the term molecular friction
- discuss the facts and myths of microwave cooking

Number:	23		
Title:	**Design and Operation of Microwave Ovens**		
Duration:	Total Hours: 5	Theory: 5	Practical: 0
Prerequisite:	Unit 22		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to explain the theory of microwave oven operation.

Learning Outcomes

Approx. hrs Theory/Application		
1/0	23.1	describe the operating principles of a microwave oven.
.5/0	23.2	describe door and cabinet construction.
2/0	23.3	describe each of the electrical components and their functions.
.5/0	23.4	describe the meaning of the voltage doubler circuit.
.5/0	23.5	describe wave distribution systems.
.5/0	23.6	describe safety precautions that must be observed when servicing microwave ovens.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

23.1 describe the operating principles of a microwave oven.

- describe characteristics of the wave
- discuss the basics of wave generation
- describe the electromagnetic spectrum and where the microwave fits in
- describe the travel of the wave after it leaves the magnetron
- differentiate between materials that will allow passage and ones that will reflect microwave energy
- describe the normal operating sounds
- describe cooking wattages

23.2 describe door and cabinet construction.

- describe the construction of the door with respect to safety to the user
- describe the construction and different finishes of the oven cavity
- explain the term wave guide
- describe how the interior of the cabinet is illuminated
- discuss the significance of proper door alignment
- describe recommended procedures for use and care

23.3 describe each of the electrical components and their functions.

- describe the following components and their functions as a unit
  - internal fuse, circuit board or timer, door switches including monitor switch, relay or triac, high voltage transformer, high voltage capacitor, magnetron, diode, magnetron thermal protector, cooling fan, stirrer motor, carosel

23.4 describe the meaning of the voltage doubler circuit.

- define the term voltage doubler circuit
- describe the operation of the voltage doubler circuit

23.5 describe wave distribution systems.

- describe various distribution systems

23.6 describe safety precautions that must be observed when servicing.

- describe methods of, and reasons for, discharging high voltage capacitor
- describe other safety issues such as
  - not operating with cabinet off
  - keeping curious onlookers away or at a safe distance

Number:	24		
Title:	**Troubleshooting and Repairing Microwave Ovens**		
Duration:	Total Hours: 20	Theory: 5	Practical: 15
Prerequisite:	Unit 23		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to diagnose faults that can occur in microwave ovens to recommend corrective action to be taken.

Learning Outcomes

Approx. hrs Theory/Application		
.5/2	24.1	perform power output tests to establish cooking wattage of oven.
.5/1	24.2	test microwave ovens for microwave leakage.
1/1	24.3	identify common causes of microwave failure.
1/4	24.4	interpret schematic of oven to isolate faults to a specific area.
2/7	24.5	perform fault finding tests and recommend corrective actions.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

24.1 perform power output tests to establish cooking wattage of oven.

- describe the meaning of power output or performance test
- describe procedures and reasons for power performance testing
- perform tests on various microwaves and record results

24.2 test microwave ovens for microwave leakage.

- identify areas in oven most prone to leakage
- describe test procedures such as
  - maximum allowable leakage
  - amount of water to be used for test
  - equipment needed
  - temperature of water to start
  - multiplier to be used for Celsius or Fahrenheit
- demonstrate test and the recording of results

24.3 identify common causes of microwave failure.

- review service and parts manual for oven
- describe common complaints and relate them to probable causes, such as:
  - poor cooking results-(probable causes inoperative stirrer, low voltage)
  - microwave dead- (oven fuse gone, shorted door switch,)

24.4 interpret schematic of oven to isolate faults to a specific area.

- describe use of schematic to narrow search grid
- describe optimum test points based on interpretation of schematic and symptoms

24.5 perform faultfinding tests and recommend corrective actions.

- demonstrate static testing (using ohmmeter) of high voltage circuitry
- demonstrate discharging capacitor.
- describe process to be used in troubleshooting
- describe meters to be used and safety
- perform troubleshooting tests on ovens with predetermined defects
- describe methods of removing and replacing each of the components in the oven
- explain what a matrix chart is and how it can be used to test touch pad interface cables

Number:	25		
Title:	**Electric Range, or Wall Oven Installation, Design, and Operation**		
Duration:	Total Hours: 20	Theory: 11	Practical: 9
Prerequisite:	Unit 22		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to describe the installation procedures and the operating features/sequences of standard, self-cleaning or downdraft electric ranges.

Learning Outcomes

Approx. hrs
Theory/Application

1/1 25.1 describe procedures for installation of an electric range.

4/2 25.2 describe the different types of surface elements, and switches that control their operation on an electric range.

6/6 25.3 describe the various types of switch sequencing and control circuitry used to control oven operations in electric ranges.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

25.1 describe procedures for installation of an electric range.

- review installation guide for an electric range
- describe site preparation procedures such as
  - removal of old range
  - verification of correct power supply (panel fuses or breakers, hard wired or plug-in receptacle)
  - clearances from walls, cabinets or other appliances
  - order of work to be performed (are there other items to be installed such as an over the range microwave oven or range hood prior to installing new range
  - condition of floor where range is to be installed
  - measurements of door openings to ensure new appliance can be brought in
  - installation of vent tube for down draft appliances, or remote fuse panels for countertop or built in ovens
- review the operation of devices designed for lifting or moving appliances in a manner that property damage can be avoided, such as appliance trucks or scissor-lift for built in ovens or over the range microwave ovens
- review personal protection devices that must be worn by installer such as back support and footwear.
- list key elements of installation after site preparation such as:
  - uncrating of range
  - connecting to power supply
  - installing anti-tip brackets (where applicable)
  - leveling procedures
  - verification of correct operation with customer’s involvement
  - discussing product warranties and care with customer
- outline procedures for completing financial transaction

25.2 describe the different types of surface elements, and switches that control their operation on an electric range

- describe briefly the history or evolution of surface elements and control switches beginning with the three heat switch and dual coil element to the present elements and control switches
- describe the basic construction, operation and characteristics of the following types of elements and switches:
  - 3,5,and 7 heat switches
- infinite heat switches (voltage and current sensitive)
- hydraulic control of surface elements

- electronic (using internal rectifiers or relay boards)
- open coil elements (old style and newer in glass top units)
- single, dual, and tri-coil rod type surface elements
- halogen elements
- induction elements
- solid elements
- interpret schematics of different ranges to identify:
  - surface element fusing (where applicable)
  - pilot light connections (shared or individual)
  - top element circuitry as a whole unit

25.3 describe the various types of switch sequencing and control circuitry used to control oven operations in electric ranges

- describe oven construction and principles of operation for the four basic types of ranges manual clean, continuous clean, self-clean, convection ovens with respect to:
  - oven liner construction including chimney
  - accessories such as rotisserie motors and meat probe system
  - typical wattage ratings of oven elements (smoke eliminator, bake, broil)
  - door, window and hinge/spring assembly
  - element control circuitry
    - analog timers
    - hydraulic oven thermostat
    - rotary selector switches
    - appliance receptacles
    - solid state or electronic control systems (with thermistor or hydraulic)
    - oven light/switch
    - the latching system (self-clean models)
    - convection system
    - safety thermostat
    - broiling system
    - thermal relays
  - interpret schematic diagram to identify current flow during the different modes of operation in a self cleaning oven (bake, timed bake, broil, and clean cycles)

Number:	26		
Title:	**Troubleshooting and Repairing Ranges and Wall Ovens**		
Duration:	Total Hours: 25	Theory: 5	Practical: 20
Prerequisite:	Unit 25		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to diagnose common faults that can occur in electric ranges to recommend or apply corrective action.

Learning Outcomes

Approx. hrs Theory/Application		
.5/0	26.1	identify common operational problems that can occur in electric ranges.
.5/0	26.2	analyze operational complaints to aid in diagnosis of problem in range or oven.
2/2	26.3	interpret schematic of an electric range to isolate and locate electrical faults.
1/3	26.4	perform fault finding tests and recommend corrective action.
1/15	26.5	perform repair, replacement, or adjustment procedures as needed to restore operating or cosmetic integrity of range.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

26.1 identify common operational problems that can occur in electric ranges.

- review parts and service manuals for range
- describe common problems with surface elements and related hardware such as:
  - element warpage
  - poor or burnt connections at terminal block or element terminals
  - blown fuse
  - open or grounded elements
  - open bimetal heater in voltage sensitive switch
  - open limit switch (glass top or solid elements)
- describe common problems that affect proper oven operation
  - open or grounded elements
  - misuse by customer such as timer not set correctly (where applicable)
  - open fuses, conductors burnt off terminals
  - open or erratic operation of temperature control
  - open safety thermostat
  - various defects in solid state circuitry such as; thermistor, controller, relay board, or touch pad)

26.2 analyze operational complaints to aid in diagnosis of problem in range or oven.

- review service manual for typical complaints and possible causes or solutions such as:
  - two surface elements not working one side of the stove (probable cause fuse blown)
  - cooking complaints such as cakes to dark (using incorrect pans)
  - lights work in range but elements fail to heat or extremely low heat (main fuse in panel gone or wire burnt off main terminal block in range)
  - self-clean cycle won’t work (door not latching correctly, thermostat or timer not set correctly or inoperative)

26.3 interpret schematic of electric range to isolate and locate electrical faults.

- review schematic of range outlining current flow during various cycles of operation
- describe hypothetical open circuits and operation symptoms experienced by user
- explain use of schematic to narrow search grid
- describe optimum test points based on interpretation of schematic and symptoms

26.4 perform faultfinding tests and recommend corrective action.

- review service and or parts manual of range
- perform tests to determine (pre arranged) electrical and or mechanical problems

26.5 perform repair, replacement, or adjustment procedures as needed to restore operating or cosmetic integrity of range.

- consult service manual as necessary and:
  - remove and replace cabinet parts or hardware (making adjustments upon reassembly where necessary) such as:
    - top, console, end caps, glass crystal, side and rear panels, oven drawer and glide or roller system, hinges, springs, door and window assemblies, latching mechanisms, shelves and door seals
  - remove and replace electrical components such as:
    - thermostat, safety thermostat, elements, selector switch, rotisserie, fuse holder or assembly, electronic control components, relays, door switch, fused appliance receptacle, fluorescent light, starter
- explain reasons for, and methods of testing or confirming oven temperature
  - describe use of thermometer or thermocouple
  - describe the meaning of “dip switches” as used in some oven controllers
  - explain methods for adjusting dip switches to adjust oven temperature
  - explain thermostat terminology such as, differential, range, hunting, bellows, bourdon tube, swing
  - describe practical limits of adjustment
  - describe methods of adjusting hydraulic thermostats.
- perform adjustment of oven temperature on an oven equipped with hydraulic oven control with adjustment capabilities.

Number:	27		
Title:	**Fundamentals of Water Systems**		
Duration:	Total Hours: 10	Theory: 10	Practical: 0
Prerequisite:	Unit 12		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to describe residential water systems as they pertain to the appliance technician.

Learning Outcomes

Approx. hrs
Theory/Application

2/0 27.1 describe the basics of residential plumbing.

5/0 27.2 describe water qualities and how they can affect the operation of appliances that use water.

1/0 27.3 explain the use of detergents in laundry and dishwashing systems.

1/0 27.4 describe connections of appliances to building plumbing systems.

1/0 27.5 identify the limitations of appliance technicians as they relate to installing appliances that use water.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

27.1 describe the basics of residential plumbing.

- use a pictorial diagram of a typical house plumbing system to illustrate and help explain:
  - water flow and typical pressures encountered in system (pressure side)
  - normal cold water temperature ranges (seasonal effect)
  - water hammer and means of prevention
  - hot water tanks (types, sizes, best location for appliance applications, temperature settings of tank control)
  - tubing or piping used (diameter and materials)
  - drain requirements and flow
  - venting requirements and reasons for vents
  - drain traps (P and S type and reasons for)
  - waste systems (sewer or septic tank)

27.2 describe water qualities and how they can affect the operation of appliances that use water.

- define or explain the term “water qualities” (hardness, iron, mineral or impurities content)
- describe the differences between treated water such as that in a town or city versus the water from a private well in a rural setting
- explain briefly water softeners in residential applications with respect to:
  - location in household water system
  - basic construction and operating principles
  - taps that should be isolated from softener
  - need (often unnecessary or problematic on town or city water)
- describe indicators in the home that may indicate water is too hard, soft or contains too much iron or other minerals and the adverse effects that these qualities will have on.
  - automatic washers
  - dishwashers
  - ice makers
  - refrigerator internal water coolers

27.3 explain the use of detergents in laundry and dishwashing systems.

- explain what detergents are, (their basic differences) and how they work in
  - dishwashers
  - automatic washers
- explain their effectiveness in various water temperatures
- explain the effects of using too much or too little detergent in both dishwashers and automatic washers
- explain the different types of fabric softeners and how they work

27.4 describe connections of appliances to building plumbing systems.

- describe the need for, and optimum locations of shutoff valves between house plumbing and appliance requiring water
- describe use of devices that can automatically shut off water in the event of leak in an appliance being fed from them
- describe various types of fill hoses and tubing that can be used to connect supply water to an appliance with respect to:
  - durability
  - maximum internal pressure
  - construction materials
  - lengths and diameters
  - quality
  - requirements (by local codes and hot or cold or both)
- explain the responsibility of the customer to close valves on water supply to washer when not in use and the responsibility of the technician to remind customer when it is obviously not being done
- describe drain requirements of dishwasher and automatic washer and connections to house plumbing
- explain the term siphoning and its importance to the technician

27.5 identify the limitations of appliance technicians as they relate to installing appliances that use water.

- identify current plumbing regulations or codes that may restrict or limit the technician with respect to connecting to water supply or drain in a residence.
- discuss legal ramifications that could take place if water damage to residence was a result of an unqualified tradesperson’s installation

Number:	28		
Title:	**Electric Clothes Dryer Installation, Design and Operation**		
Duration:	Total Hours: 13	Theory: 11	Practical: 2
Prerequisite:	Unit 27		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to describe the installation procedures and the operating features/sequences of electric clothes dryers.

Learning Outcomes

Approx. hrs Theory/Application		
2/1	28.1	describe procedures for installation of an automatic clothes dryer.
8/1	28.2	explain the design and operation of an automatic clothes dryer.
1/0	28.3	explain the relationship between drying time/temperature and various types of fabrics.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

28.1 describe procedures for installation of an automatic clothes dryer.

- review installation manual of clothes dryer to describe the following key points:
  - vent requirements
    - maximum length
    - type of vent material recommended
    - number of elbows
    - diameter of vent
    - how to connect vent pieces and routing
  - power supply requirements
    - maximum fuse size
    - conductor size
    - receptacle design and ampacity
- procedures for leveling
- clearance requirements

28.2 explain the design and operation of an automatic clothes dryer.

- use parts manual of dryer or cross section view to illustrate and explain the:
  - location of electrical components
  - forced air handling system or air flow (extraction and blower systems)
    - explain what lint is
    - describe lint filters and how often they should be cleaned
  - temperature control systems (hydraulic, bimetal and electronic control)
  - mechanical systems
    - drum construction and ideal speed of rotation in RPMs
    - drum drive systems (belt or roller systems)
    - belt and pulley designs (multi-groove, v-groove)
    - drive motor (double and single shaft)
    - door design and functions
    - drum bearings, bushings and glides or rollers
- designs and differences of various heating element systems
  - approximate temperatures of air in drum (high, medium and low heat settings)
- explain the design purpose and operation of safety devices such as:
  - safety heat switch in motor
  - belt break switch
  - push to start circuit
  - door switches
  - hi limit thermostat or thermal fuse

28.3 explain the relationship between drying time/temperature and various types of fabrics.

- explain the reasons for various cycles of a dryer timer or control system such as:
  - permanent press
  - regular or timed dry
  - automatic dry (both electronic and through conventional timer)
  - air fluff
- explain why different drying temperatures should be used for various fabrics
- describe the reason for static electricity building up in clothes during drying process
- explain how over use of softener sheets can cause build up of lint in dryer

Number:	29		
Title:	**Troubleshooting and Repairing Clothes Dryers**		
Duration:	Total Hours: 35	Theory: 10	Practical: 25
Prerequisite:	Unit 28		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to diagnose common faults that can occur in electric clothes dryers to recommend or apply repair procedures.

Learning Outcomes

Approx. hrs Theory/Application		
2/0	29.1	identify common operational problems that can occur in clothes dryers.
2/1	29.2	analyze operational complaints to aid in diagnosis of problem with dryer.
4/4	29.3	interpret schematic of electric dryer to isolate and locate electrical faults.
2/20	29.4	perform repair, replacement, or adjustment procedures as needed to restore operating or cosmetic integrity of dryer.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

29.1 identify common operational problems that can occur in clothes dryers.

- identify some of the most common mechanical and electrical faults that may occur in dryers to necessitate a service call such as:
  - door latch mechanism broken
  - worn bearings, glides or rollers
  - broken belt
  - motor seized
  - vent obstruction
  - build up of lint on motor
  - broken fans or blowers
  - open, shorted or grounded electrical circuitry or components
  - power supply problems

29.2 analyze operational complaints to aid in diagnosis of problem with dryer.

- review service manual for typical complaints to analyze possible causes given, such as:
  - dryer running but no heat (possible causes: blown panel fuse, open heating element, thermostat, timer switch, safety heat switch, wire or thermal fuse)
  - nothing working (blown panel fuse(s) or breaker)
  - high pitched noise emanating from dryer when in use (idler wheel or bearing) etc

29.3 interpret schematic of electric dryer to isolate and locate electrical faults.

- review schematic of dryer outlining current flow during various cycles of operation
- describe hypothetical open circuits and operation symptoms experienced by user
- explain use of schematic to narrow search grid
- describe optimum test points based on interpretation of schematic and symptoms

29.4 perform repair, replacement, or adjustment procedures as needed to restore operating or cosmetic integrity of dryer.

- consult manufacturer's service literature as necessary to perform the following procedures:
  - removal, replacement, and or adjustment of body components such as:
    - console, top, front and door assemblies
  - removal, replacement and or adjustment of heating elements, electrical switches or controls, drums, belts, motor, bearings, rollers, glides, fans or blowers.
- explain the use of high temperature
  - lubricants as they apply to dryers (where and when to use)
  - insulation on conductors used in dryers (where and when to use)
- demonstrate the use of circlip pliers to remove and replace retaining clips
- explain or demonstrate methods of testing temperatures in various types of dryers to confirm proper operation of thermostats or controls.

Level 3

Reportable Subject Summary – Level 3

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
30	Automatic Clothes Washer Installation, Design and Operation	20	15	5
31	Troubleshooting and Repairing Automatic Washers	30	6	24
32	Automatic Dishwashers Design, Installation and Operation	10	9	1
33	Troubleshooting and Repairing Automatic Dishwashers	25	5	20
34	Mechanical Cooling Cycle Fundamentals	20	15	5
35	Mechanical Cooling Cycle Components	20	15	5
36	Refrigeration Tools and Test Equipment	25	5	20
37	Refrigerant Management	8	8	0
38	Design & Operation of Domestic Refrigerating/Freezing units	15	15	0
39	Diagnosing & Servicing Domestic Refrigerating/Freezing units	30	5	25
40	Design/Operating Principles & Repairs of Room Air Conditioners and Dehumidifiers	22	10	12
	Total	**225**	**108**	**117**

Number:	30		
Title:	**Automatic Clothes Washer Installation, Design and Operation**		
Duration:	Total Hours: 20	Theory: 15	Practical: 5
Prerequisite:	Unit 27		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to describe the installation procedures and the operating features/sequences of automatic clothes washers.

Learning Outcomes

Approx. hrs
Theory/Application

2/1 30.1 describe procedures for installation of an automatic washer.

6/0 30.2 describe the operating principles of various types of automatic washers.

6/3 30.3 explain the various cycles of operation.

1/1 30.4 identify factors which affect washablilty.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

30.1 describe procedures for installation of an automatic washer.

- review the installation manual of an automatic washer to describe the key points such as:
  - best location
  - floor support under washer
  - water supply (how close to machine, hot and cold with shut off valves)
  - drain hose(s) (height requirements, length, venting, suds return)
  - electrical requirements
  - removal of shipping braces or bolts
  - attaching fill hoses (care to ensure cross threading doesn't occur and hose screens installation)
  - leveling procedures (explain how self leveling systems work)

30.2 describe the operating principles of various types of automatic washers.

- use pictorial views of different washers to describe the basic differences between washers that load from the front and top loading units
- describe the basic operating principles of different drive systems in top loading machines
  - explain or describe the design, purpose and where appropriate normal noise levels of:
    - transmissions (belt driven or driven directly from motor)
    - clutches (on motor, on transmission, slipping belt)
    - drain pumps (location and actuation)
    - motors (single, two and three speed, reversing)
    - suspension system (springs, snubbers, counter or balancing weights or rings)
    - water levels and amount used for each cycle
- describe the basic operating principles of various machines that load in the front
  - explain or describe the design, purpose and where appropriate normal noise levels of:
    - motors (speed control, d.c., reversing frequency)
    - belts and pulleys
    - suspension system (springs, dampers, balancing weights or rings)
    - drain pumps (location and actuation)
    - water levels and amount used for each cycle
    - door and seal or boot

30.3 explain the various cycles of operation.

- explain the reasons for and differences between, the various cycles of operation such as:
  - permanent press
  - normal wash
  - delicate
- use cycle chart of washer to explain the fill, wash, and drain operations, and switch sequencing during the various cycles such as
  - permanent press
  - normal wash
  - delicate

30.4 identify factors that affect washablilty.

- identify factors which will affect washing results favorably or adversely with respect to:
  - water quality, quantity, and temperature
  - detergent type, quality, and quantity
  - loading of machine
  - use of bleach and liquid fabric softeners

Number:	31		
Title:	**Troubleshooting and Repairing Automatic Washers**		
Duration:	Total Hours: 30	Theory: 6	Practical: 24
Prerequisite:	Unit 30		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to diagnose common faults that can occur in automatic washers to recommend or apply repair procedures.

Learning Outcomes

Approx. hrs
Theory/Application

1/0	31.1	identify common operational problems that can occur in automatic clothes washers.
1/1	31.2	analyze operational complaints to aid in diagnosis of problem in washer.
2/2	31.3	interpret schematic of washer to isolate and locate electrical faults.
2/20	31.4	perform repair, replacement, or adjustment procedures as needed to restore operating or cosmetic integrity of washer.
0/1	31.5	identify post repair tests used to verify repairs were successful.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

31.1 identify common operational problems that can occur in automatic clothes washers.

- identify some of the most common mechanical and electrical faults that may occur in automatic washers to necessitate a service call such as:
  - door or lid latch/switch mechanism broken
  - worn bearings
  - belt broken, worn, or in need of adjustment
  - motor seized
  - clothing or foreign objects lodged between tubs
  - drain obstruction or kinks
  - various transmission failures
  - water or oil leaks
  - clutches broken, worn or out of adjustment
  - pumps seized, broken, or obstructed
  - open, shorted or grounded electrical circuitry or components
  - power supply problems

31.2 analyze operational complaints to aid in diagnosis of problem in washer.

- review service manual for typical complaints to analyze possible causes given, such as:
  - clothes wet at end of cycle (possible causes: spin speed too slow, too much detergent, overloading machine)
  - machine continually filling and draining (water siphoning, drain hose too low)
  - machine won't spin (timer, clutch, belt, drain obstruction) etc.
- explain in detail methods of assessing location of water leaks (using probabilities and questions to be asked of customer)
- explain or demonstrate abnormal and normal sounds that customer may complain of during various cycles

31.3 interpret schematic of washer to isolate and locate electrical faults.

- review schematic of washer outlining current flow during various cycles of operation
- describe hypothetical open circuits and operation symptoms experienced by user
- explain use of schematic to narrow search grid
- describe optimum test points based on interpretation of schematic and symptoms

31.4 perform repair, replacement, or adjustment procedures as needed to restore operating or cosmetic integrity of washer.

- consult manufacturer's service literature as necessary to perform the following procedures:
  - removal, replacement, and or adjustment of body components such as:
    - console, top, front, lid, and or door assemblies
  - removal, replacement and or adjustment of, electrical switches or controls, agitators, tubs, belts, motors, bearings, clutches, transmissions, springs, snubbers, hoses, pumps, seals, pulleys
  - identify the purpose and use of special tools required for laundry service such as:
    - gear pullers (standard and model specific)
    - bearing removers or installers
    - hose crimp-off pliers
- explain the use of
  - lubricants as they apply to washers (type, where and when to use)
  - different types of sealants (where, when and what type for application)

31.5 identify post repair tests used to verify repairs were successful.

- explain the importance of performing a visual or practical inspection during and after reassembly to ensure:
  - air and water hoses are secure
  - electrical wires and components are intact
  - belt tensions are correct
  - tools are not left in machine
- identify or demonstrate methods of testing machine after repairs have been made, to verify operating integrity with customer.
  - fill machine (watching level closely)
  - ensure agitation takes place
  - check for leaks
  - ensure drain and spin cycles work as intende

Number:	32		
Title:	**Automatic Dishwashers Design, Installation and Operation**		
Duration:	Total Hours: 10	Theory: 9	Practical: 1
Prerequisite:	Unit 27		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to describe the installation procedures and the operating features/sequences of automatic dishwashers.

Learning Outcomes

Approx. hrs
Theory/Application

1/1 32.1 describe procedures for installation of an automatic dishwasher.

4/0 32.2 describe the operating principles of various types of automatic dishwashers.

3/0 32.3 explain the various cycles of operation.

1/0 32.4 identify factors which affect washablilty of a dishwasher.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

32.1 describe procedures for installation of an automatic dishwasher.

- review manufacturer's installation guide to explain or describe the following key points of installing a dishwasher
  - procedures for removal of old dishwasher where applicable to make way for new one
    - special tool requirements such as reciprocating saw to cut off legs off old dishwasher for removal where floor height in front of old washer has changed since originally installed
  - water supply requirements (hot in most cases, cold in units that have heated reservoir, type of tubing and fittings)
  - drain requirements (height, routing, connections to house system)
  - hole saws for new installations (plastic bushings for cabinet holes)
  - electrical requirements and proper methods of hard wiring
- explain the differences between built-in and portable dishwasher connections

32.2 describe the operating principles of various types of automatic dishwashers.

- use pictorial or cutaway views of various types of dishwashers to explain or describe:
  - the basic water system and components including filtration, pumps, and macerator systems
  - various designs and combinations of spray arms, upper and lower
  - drain operations (remote pumps or main motor drain valve systems)
  - typical location, wattage and purpose of internal water heating element
  - loading basics
  - door and door seals and latching
  - detergent and rinse aid dispensers
- explain the purpose and use of rinse aids

32.3 explain the various cycles of operation.

- use cycle charts and schematics from various dishwashers to describe or explain the various cycles of operation as controlled by the timer such as:
  - fill cycle
    - what controls the quantity of water entering the machine (timed fill and flow valves or washers)
    - float switch design and operation
    - siphon breaks or air gaps (location, design and purpose)
    - dual fill valves in series to prevent flooding
    - ideal water temperature
    - normal sounds during fill cycle
  - wash cycles
    - normal sounds to be expected
    - frequency (how many wash cycles for complete wash)
    - spray arms action
    - detergent dispensing (when, how and where)
    - motor and pump actions
    - differences between normal, delicate, and extended or high temp cycles
  - rinse and drain cycles
    - frequency
    - normal sounds
    - differences in drain cycle between various machines

32.4 identify factors which affect washablilty of a dishwasher.

- identify or review factors other than a problem in the dishwasher that will adversely affect the wash results such as:
  - poor water quality
  - water level to low
  - water temperature to low
  - no rinse aid being used
  - incorrect loading
  - use of dishwashing detergent not recommended for dishwashers
  - insufficient detergent

Number:	33		
Title:	**Trouble Shooting and Repairing Automatic Dishwashers**		
Duration:	Total Hours: 25	Theory: 5	Practical: 20
Prerequisite:	Unit 32		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to diagnose common faults that can occur in automatic dishwashers to recommend and apply repair procedures.

Learning Outcomes

Approx. hrs Theory/Application		
1/0	33.1	identify common operational problems that can occur in dishwashers.
1/1	33.2	analyze operational complaints to aid in diagnosis of problem in dishwasher.
2/3	33.3	interpret schematic of dishwasher to isolate and locate electrical faults.
1/16	33.4	perform repair, replacement, or adjustment procedures as needed to restore operating or cosmetic integrity of dishwasher.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

33.1 identify common operational problems that can occur in dishwashers.

- identify some of the most common mechanical and electrical problems that can occur in an automatic dishwasher that may warrant a service call such as:
  - mechanical failures of pump
    - seized pump motor
    - broken, worn or obstructed impeller
    - leaking pump seals
  - spray arm failures
    - split or broken
    - seal broke or disintegrated
    - obstructions in spray arm (fish bones, paper, etc.)
  - obstructions in drain hose, drain valve, remote drain pump, fill valve(s) or screens, filters, dispensers
  - open, shorted or grounded electrical circuitry or components including:
    - motor(s), switches, timers, relays, heating elements, thermostats, dispensers, electronic controllers
  - door
    - seal or gasket worn or leaking
    - springs broken or weak
    - hinges worn or broken
    - door panels or deflectors rusted or leaking
  - tubs and racks
    - rusted or cracked
    - stained from water impurities
    - leaking tubs (plastic or steel)

33.2 analyze operational complaints to aid in diagnosis of problem in dishwasher.

- review service manual for typical complaints, to analyze possible causes given, such as:
  - machine will not work at all (possible cause: fuse blown, open circuit at main terminal connections, open door or timer switch)
  - poor wash results machine working but quieter than normal (possible cause: low water level, plugged filter or pump, impeller broken or worn)
  - can’t program timer no display (possible cause: blown fuse or open at main terminal connections, defective circuit board) etc.

33.3 interpret schematic of dishwasher to isolate and locate electrical faults.

- review schematic of washer outlining current flow during various cycles of operation
- describe hypothetical open circuits and operation symptoms experienced by user
- explain use of schematic to narrow search grid
- describe optimum test points based on interpretation of schematic and symptoms

33.4 perform repair, replacement, or adjustment procedures as needed to restore operating or cosmetic integrity of dishwasher.

- consult manufacturer's service literature as necessary to perform the following procedures:
  - removal, replacement, and or adjustment of body components and related hardware such as:
    - door assemblies, springs, hinges, door seals, racks, rollers, glides, pulleys, cables, latching mechanisms, dispensers
  - removal, replacement and or adjustment of, electrical/electronic switches or controls, motors, pumps, seals, hoses, impellers, filters, spray arms, diffusers, elements, fill or drain valves,
  - identify the purpose and use of special tools required for dishwasher service such as:
    - impeller gauges
    - pump repair tools (diffuser removal tool)

Number:	34		
Title:	**Mechanical Cooling Cycle Fundamentals**		
Duration:	Total Hours: 20	Theory: 15	Practical: 5
Prerequisite:	Unit 20		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to explain in detail the fundamentals of refrigeration and air conditioning.

Learning Outcomes

Approx. hrs
Theory/Application

8/3 34.1 explain the fundamental physical concepts of refrigeration.

3/2 34.2 explain pressure and its effect on the boiling point of a liquid.

2/0 34.3 explain various types, characteristics and uses of refrigerants and oils.

2/0 34.4 explain the basic, mechanical cooling cycle.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

34.1 explain the fundamental physical concepts of refrigeration.

- describe the history of domestic refrigeration and air conditioning
- describe the three states of matter
  - solid
  - liquid
  - vapour
- define heat in its various forms
  - difference between heat and temperature
  - specific heats of substances
  - sensible heat
  - latent heat
- describe heat units and measurement
  - British thermal unit (Btu)
  - kilojoule (kJ)
- explain methods of heat transfer in solids, liquids and gases
  - law of heat flow
  - conduction
  - convection
  - radiation
- explain expansion or contraction of solids, liquids or gases
- describe or define
  - temperature
  - Fahrenheit scale
  - Celsius scale
  - effective use of temperature measuring devices
- perform calculations to convert Fahrenheit to Celsius or visa versa
- perform total heat calculations using Btu’s and kJ’s
- describe the changes that occur when a substance changes from a solid to a liquid then to a vapour and the reverse process.
- define following terms
  - absolute zero
  - saturation
  - evaporation
  - condensation
  - sublimation
  - superheating
  - subcooling
  - “1 Ton” of refrigeration

34.2 explain pressure and its effect on the boiling point of a liquid.

- define pressure, vacuum, and normal atmospheric pressure
- describe units of measurement of pressure and vacuum
  - pounds per square inch (psi)
  - kilopascals (kPa)
  - inches of mercury vacuum ("hg. vac.)
  - microns
- describe difference between gauge and absolute pressure scales
- describe effective use of pressure measuring devices
  - barometer
  - manometer
  - gauge
  - absolute gauge
  - micron gauge
- perform calculations to convert
  - (kPa) to (psi) or visa versa
  - gauge readings to absolute pressure scale or visa versa
- define gas laws
  - Dalton’s
  - Boyle’s
  - Charles’s
- identify and describe use of (temperature/pressure) chart for water

34.3 explain various types, characteristics and uses of refrigerants and oils.

- define refrigerant
- identify the desirable qualities of a good refrigerant with respect to
  - boiling temperature
  - availability
  - flammability
  - toxicity
  - miscibility with oils
  - condensing pressure
- identify the chemical name, chemical formula, cylinder color code, and boiling point at atmospheric pressure for refrigerants 12, 22, and 134a
- identify current alternative refrigerants for use in place of R12 or R134a
- define refrigerant oil terminology
  - viscosity
  - miscibility
  - wax content
  - flash point

34.4 explain the basic, mechanical cooling cycle.

- define refrigerant system
- identify the essential components of a basic domestic system
- describe the direction, state, and temperature of the refrigerant throughout the system during operation

Number:	35		
Title:	**Mechanical Cooling Cycle Components**		
Duration:	Total Hours: 20	Theory: 15	Practical: 5
Prerequisite:	Unit 34		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to explain the purpose, function, and general repair procedures of each of the major system components found in domestic refrigerating or air conditioning units.

Learning Outcomes

Approx. hrs
Theory/Application

10/0 35.1 describe the design, operation, and maintenance of system components.

1/2 35.2 describe the relationship between condensing pressure and cooling medium.

4/3 35.3 list the steps that must be taken to repair or replace system components.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

35.1 describe design, operation and maintenance of system components.

- describe the design, operation and maintenance (where applicable) of
  - hermetic compressors
    - reciprocating
    - rotary
  - condensers
    - static (internal and external mount)
    - forced air
  - evaporators
    - plate or chest type
    - bare tube
    - fin and tube
  - filter driers
    - liquid line
    - suction line
  - metering devices
    - automatic expansion valve
    - thermostatic expansion valve
    - capillary tube
  - heat exchangers
    - coaxial
    - conventional
  - accumulators
    - suction line
    - evaporator integrated
  - connecting tubing
    - copper
    - aluminium
    - steel

35.2 describe relationship between condensing pressure and cooling medium.

- define ambient
- describe temperature differential between ambient air and condensing temperature
- calculate condensing pressure for various ambient temperatures and refrigerants using pressure/temperature chart

35.3 list the steps that must be taken to repair or replace system components.

- create a list of the general procedures or steps for repairing(where applicable) or replacing the following system components:
  - filter drier
  - compressor
  - evaporator
  - condenser
  - heat exchanger
  - capillary tube

Number:	36		
Title:	**Refrigeration Tools and Test Equipment**		
Duration:	Total Hours: 25	Theory: 5	Practical: 20
Prerequisite:	Unit 35		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to use brazing, pressure testing, and evacuation equipment to perform (simulated) sealed system service.

Learning Outcomes

Approx. hrs
Theory/Application

3/1	36.1	identify the purpose, use, care, and selection of refrigeration tools, equipment, tubing and supplies used in sealed system service.
.5/2	36.2	recognize the safety issues related to the use, storage, and transportation of explosive or high pressure gases.
1/15	36.3	connect refrigeration tubing using brazing, soldering and flaring techniques
.5/2	36.4	perform vacuum and pressure leak tests on sealed system to verify that no leaks exist.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

36.1 identify the purpose, use, care, and selection of refrigeration tools, equipment, tubing and supplies used in sealed system service.

- explain or demonstrate the various types, sizes, wall thickness and applications of refrigeration and air conditioning tubing and various fittings used in the appliance industry including:
  - soft copper tubing
  - steel tubing
  - aluminium tubing
  - brass fittings (flare and sweat type)
  - copper fittings
  - saddle valves
- identify the selection process, use, and or care of tools and supplies used in preparing tubing for brazing, soldering, or flaring operations, including:
  - tube cutters and reamers
  - sand cloth (non use of emery cloth as it contains oil)
  - brazing and soldering alloys
  - fluxes
  - heat shields or mats
  - tubing benders (lever and spring)
  - swaging tools
  - faring tool and block or anvil
- identify or describe equipment and accessories used to produce flame for brazing or soldering operations, such as:
  - propane
  - acetylene
  - butane and oxygen
  - oxygen and acetylene
- explain the purpose, use, care, selection and applications or operating principles as appropriate, of pressure and temperature testing, and evacuation equipment such as:
  - gauge manifold and hose set
  - various types of charging cylinders (glasses)
  - vacuum pumps
  - electronic weigh scales
  - micron gauges
  - nitrogen (gas, tanks, and gauges)
  - electronic and conventional temperature testing instruments or gauges
  - various types of leak detectors or detection equipment

36.2 recognize the safety issues related to the use, storage, and transportation of explosive or high- pressure gases.

- identify safety issues related to the use, storage, and transportation of gases such as:
  - acetylene, oxygen, propane, and butane gases
  - discuss:
    - tank (sizes, valves, fusible plugs and pressures)
    - odour
    - pressure regulators and gauges
    - hoses
    - torch handles and tips (types and sizes, filters)
    - back-flow preventors
    - flame characteristics
  - list safety rules to be followed when dealing with acetylene such as:
    - checking regulator and hose system for leaks before use
    - igniting with friction lighter not butane lighter
    - securing tanks in upright position when using or during transit
    - do not drop explosive on impact
    - use precautions to prevent combustion or damaging of materials in area of flame
    - confirming depressurization of system pressure before applying heat
    - use of eye protection when brazing with oxygen and acetylene mix
    - open tank valve no more than ¼ of a turn so that it can be shut off in case of emergency
    - bleeding of hoses when finished using
  - use the (diesel engine operating principles) to explain why high pressure gases such as nitrogen and oxygen can cause an explosion when they come in contact with oil
  - nitrogen gas
  - discuss
    - tank (sizes, valves, fusible plugs and pressures)
    - pressure regulators and gauges
    - hoses
    - maximum allowable pressure in refrigeration system
  - demonstrate use of oxy/acetylene for brazing purposes on tubing of larger diameters (large room air conditioners)

36.3 connect refrigeration tubing using brazing, soldering and flaring techniques

- demonstrate brazing, soldering and flaring techniques
- design tubing project that will test brazing and flaring capabilities, should consist of ten or more brazed joints and at least two flare fittings and unions to attach refrigerant hoses for leak testing purposes
- design tubing project that will test soldering capabilities, such as a short section of heat exchanger
- construct tubing project following measurements from supplied pictorial diagram
- braze or flare joints as applicable to trade standards

36.4 perform vacuum and pressure leak tests on sealed system to verify that no leaks exist.

- demonstrate use of vacuum pump, gauge/manifold set, and micron gauge to pull vacuum on brazed project
- demonstrate pressure testing procedures using nitrogen and liquid leak detection
- describe results of test in writing

Number:	37		
Title:	**Refrigerant Management**		
Duration:	Total Hours: 8	Theory: 8	Practical: 0
Prerequisite:	Unit 36		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to explain or perform procedures for dealing with ozone depleting substances in accordance with the Refrigeration Code of Practice.

Learning Outcomes

Approx. hrs
Theory/Application

1/0	37.1	describe the meaning, and history of use of ozone depleting substances
2/0	37.2	identify the meaning of the “Montreal Protocol” and how decisions made there affect the manufacturing, distribution, and use of refrigerants in North America.
1/0	37.3	identify the meaning and use of “ozone depleting substance emission control” forms.
1/0	37.4	identify various methods and equipment used for recovery of refrigerants.
3/0	37.5	explain in detail various methods of charging domestic refrigeration and air conditioning equipment.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

37.1 describe the meaning, and history of use of ozone depleting substances

- explain what CFCs are and provide a brief history of their use in the refrigeration and air conditioning industry
- describe how CFCs affect the earth's environment
- use pie chart to illustrate percentages of use of CFCs related to various industries such as Mobile a/c, Domestic Refrigeration, Solvents, Stationary Refrigeration, and Foam blowing
- list refrigerants by their classifications on the ozone depletion scale
- explain the responsibilities of the domestic appliance technician to keep pace with current and constantly changing regulations, alternative refrigerants, and methods of servicing sealed systems

37.2 identify the meaning of the "Montreal Protocol" and how decisions made there affect the manufacturing, distribution, and use of refrigerants in North America.

- define the meaning of the term "Montreal Protocol"
- describe the evolution of the "Canadian Code of Practice"
- explain the relationship between the "Canadian Code of Practice" and the Provincial laws and regulations related to the handling of refrigerants
- identify significant dates that affect various refrigerants with respect to:
  - last date of production
  - last date of importing
  - last date of use
- define the following terms as they relate to the "Code of Practice"
  - recovery
  - reuse
  - recycling
  - reclaiming

37.3 identify the meaning and use of "ozone depleting substance emission control" forms.

- explain the reasons for, and the use of "emission control forms"
- explain where generic forms can be obtained in the province
- use a generic emissions control form to demonstrate proper procedures for completing documentation
- explain technician's and company's responsibilities for retaining documentation after completion
- explain current fines for intentional release of refrigerants into atmosphere

37.4 identify various methods and equipment used for recovery of refrigerants.

- explain differences between, procedures to be followed, and equipment needed, for recovery methods such as:
  - passive (recovery bag)
  - active (pump and recovery tank)
  - absorption (silica sand)
- review equipment manufacturer's use and care guides for information related to maintenance of equipment
- explain what sweep charging is, and how it's related to the passive recovery system
- explain procedures for the storing and disposing of recovered refrigerants

37.5 explain in detail various methods of charging domestic refrigeration and air conditioning equipment.

- explain methods of charging system with refrigerant using the:
  - vapour method
    - tools and equipment necessary
    - preliminary work necessary
    - access to system
    - system operating pressures
    - frost pattern and superheat requirements
    - current flow or wattage expectations
  - liquid methods including, sweep charging and traditional
    - tools and equipment necessary (charging glass or electronic scale)
    - preliminary work necessary
    - access to system
    - system operating pressures
    - determining amount of charge
    - current flow or wattage expectations

Number:	38		
Title:	**Design and Operation of Domestic Refrigerating and Freezing Units**		
Duration:	Total Hours: 15	Theory: 15	Practical: 0
Prerequisite:	Unit 37		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to describe the operating characteristics, and basic component functions of domestic refrigerating and freezing units.

Learning Outcomes

Approx. hrs Theory/Application		
10/0	38.1	describe the general construction, different types and operating characteristics of domestic refrigerating and freezing units.
3/0	38.2	describe normal operation of electrical systems in various types of refrigerating and freezing units.
2/0	38.3	describe optional features or components that can be found on refrigerating units.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

38.1 describe the general construction, different types and operating characteristics of domestic refrigerating and freezing units

- describe briefly the evolution of refrigerating cabinets starting at ice box refrigerators to current production models
- explain the general cabinet construction, design, and operating characteristics of the following types of cabinets:
  - chest and upright manual defrost freezers
  - upright self defrosting freezers
  - manual defrost single door refrigerators
  - two door off cycle defrost refrigerators
  - beverage coolers
  - frost free refrigerators
  - combination refrigerators (frost free freezer, cold plate refrigerator section)
  - under counter ice makers
- explain clearance requirements of various units to allow for adequate cooling of the condenser and compressor

38.2 describe normal operation of electrical systems in various types of refrigerating and freezing units

- explain or review electrical requirements for various types of refrigerating and freezing equipment
- explain in detail the design and operation of different types of defrosting systems including electronic control models where applicable
  - manual defrost
  - off cycle defrost
  - hot gas defrost
  - electric defrost
- explain the location, purpose and function of cabinet heaters, and controlling switches
- explain what condensate water is and where it goes after leaving the evaporator
- explain the purpose and function of condenser and evaporator fans and controlling switches
- demonstrate normal noise levels of compressor and fan motors during operation
- explain normal sounds that may be heard during a defrost cycle in various self-defrosting models
- review compressor and relay circuitry
- interpret schematic of a traditional frost free refrigerator to trace flow of electricity through various components in the refrigeration and defrost cycles

38.3 describe optional features or components that can be found on refrigerating units.

- explain the basic purpose and operating principles of optional equipment such as:
  - ice makers and related hardware to dispense or chip ice
  - water coolers and related hardware to filter or dispense
  - self-diagnostic electronic control circuitry
  - reach through doors
  - anti-short cycle or compressor lock out after power interruption

Number:	39		
Title:	**Diagnosing and Servicing Domestic Refrigerating and Freezing Units**		
Duration:	Total Hours: 30	Theory: 5	Practical: 25
Prerequisite:	Unit 38		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to diagnose common problems that can occur in domestic refrigerating and freezing units to recommend or perform corrective action.

Learning Outcomes

Approx. hrs Theory/Application		
1/2	39.1	identify common problems that can occur in domestic refrigeration equipment that may warrant a service call on the appliance
1/1	39.2	analyze operational complaints to aid in diagnosis of problem in refrigerators.
1/2	39.3	interpret schematic of refrigerator to isolate and locate electrical faults.
2/20	39.4	perform repair, replacement, or adjustment procedures as needed to restore operating or cosmetic integrity of refrigerators.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

39.1 identify common problems that can occur in domestic refrigeration equipment that may warrant a service call on the appliance

- identify some of the most common mechanical and electrical faults that may occur in refrigerators to necessitate a service call such as:
  - system problems
    - restrictions
    - leaks
    - separated heat exchanger
    - compressor related (inefficient, seized, open circuited)
  - insufficient air flow over condenser due to:
    - externally plugged with dirt or debris
    - inoperative condenser fan
    - insufficient clearances for air circulation
  - insufficient air flow over evaporator due to:
    - excessive frost or ice build up (defrost problems)
    - inoperative evaporator fan motor or blade needing adjustment
    - baffles missing or broken
  - controls set incorrectly
  - door seals, panels or gaskets
  - open, shorted, or grounded electrical circuitry
  - water leaks (various sources)

39.2 analyze operational complaints to aid in diagnosis of problem in refrigerators.

- review service manual for typical complaints to analyze possible causes given, such as:
  - manual defrost refrigerator not keeping ice cream in summer (possible causes, door not sealing properly, light staying on, excessive frost build up on evaporator, ambient temperature to high)
  - frost free refrigerator both sections warmer than normal (defrost problem, light staying on, door gasket not sealing, system problem, dirty condenser or inoperative fan)etc.

39.3 interpret schematic of refrigerator to isolate and locate electrical faults.

- review schematic of refrigerator outlining current flow during various cycles of operation
- describe hypothetical open circuits and operation symptoms experienced by user
- explain use of schematic to narrow search grid
- describe optimum test points based on interpretation of schematic and symptoms

39.4 perform repair, replacement, or adjustment procedures as needed to restore operating or cosmetic integrity of refrigerators

- explain in detail how to move or work on refrigerating equipment without causing damage to customers property or the machine itself
- consult manufacturer's service literature as necessary to perform the following procedures:
  - removal, replacement, and or adjustment of body components such as:
    - door, panels and seals
    - cabinet levelers or rollers
    - shelves and shelf support systems
    - air baffles or diffusers
  - removal, replacement, and or adjustment of electrical or system components such as:
    - compressor
    - evaporator
    - condenser
    - drier
    - system tubing
    - controls (standard and electronic)
    - fan motors
    - electrical switches (light, fan, timer)
    - defrost components
    - optional equipment (ice makers, ice augers, water dispenser and filters)

Number:	40		
Title:	**Design, Operating Principles, and Repairs of Room Air Conditioners and Dehumidifiers**		
Duration:	Total Hours: 22	Theory: 10	Practical: 12
Prerequisite:	Unit 37		

General Learning Objective

Upon completion of this unit the apprentice will have demonstrated the ability to repair room air conditioners and dehumidifiers.

Learning Outcomes

Approx. hrs Theory/Application		
3/0	40.1	explain the operating principles of room air conditioners.
1/0	40.2	install a room air conditioner.
1/0	40.3	identify some of the more common problems that can occur in room air conditioners that may warrant a service call.
2/2	40.4	interpret schematic of a room air conditioner to isolate and locate electrical faults.
3/10	40.5	perform repair, replacement, or adjustment procedures as needed to restore operating or cosmetic integrity of room air conditioners.

Evaluation

Written Tests
Multiple Choice Tests
Practical Assignments
Observed Practical Performance
Written Assignments

Learning/Tasks Content

40.1 explain the operating principles of room air conditioners and dehumidifiers.

- explain the fundamentals of air conditioning and dehumidifiers including:
  - reasons for air conditioning or dehumidification
  - humidity control
  - humidity measurements, meters and controls
  - temperature control
  - sizing of air conditioning and dehumidifier units
  - cabinet designs
  - component names and their locations in cabinet
  - air flow through unit and conditioned space
  - condensate water removal
  - system:
    - refrigerant used
    - normal pressures high and low side
    - normal sounds or noise levels to be expected by user

40.2 install a room air conditioner.

- review installation manual for details on:
  - electrical requirements
  - mounting brackets and leveling procedures
  - optimum placements in residence
  - procedures for lifting air conditioners
  - demonstrating operations to customer

40.3 identify some of the more common problems that can occur in room air conditioners or dehumidifiers that may warrant a service call.

- explain in detail causes and symptoms of evaporator icing in both air conditioners and dehumidifiers
- describe common problems that can occur in relation to:
  - fan motors and blades or blowers
  - condensers (bent fins, plugged with debris, air circulation or re-circulation)
  - condensate water flow
  - electrical controls and switches
  - compressor or system
  - filters
  - capacitors

40.4 interpret schematic of a room air conditioner to isolate and locate electrical faults.

- review schematic of air conditioner outlining current flow during various modes and sequences of operation
- describe hypothetical open circuits and operation symptoms experienced by user
- explain use of schematic to narrow search grid
- describe optimum test points based on interpretation of schematic and symptoms

40.5 perform repair, replacement, or adjustment procedures as needed to restore operating or cosmetic integrity of room air conditioners.

- explain procedures for quick test of air conditioner charge (blocking off air flow over evaporator)
- explain procedures and reasons for pressure washing condensers and evaporators periodically
- demonstrate the use of fin straightening tools
- review service manual to perform procedures such as:
    - removal, replacement and or adjustment of :
        - electrical components
            - compressor
            - fan motor (blades or blowers, and lubrication)
            - selector switches
            - thermostats
            - humidistats
            - capacitors
        - system components

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