Construction Electrician
On-the-Job Training Guide

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Recognition:
To promote transparency and consistency, this document has been adapted from the 2021 Construction Electrician Red Seal Occupational Standard (Employment and Social Development Canada).

A complete version of the Occupational Standard can be found at www.red-seal.ca.

STRUCTURE OF THE ON-THE-JOB TRAINING GUIDE

To facilitate understanding of the occupation, this on-the-job training guide contains the following sections:

Task Matrix: a chart which outlines graphically the major work activities, tasks and sub-tasks of this standard detailing the essential skills and the level of training where the content is covered.

Major Work Activity (MWA): the largest division within the standard that is comprised of a distinct set of trade activities.

Task: distinct actions that describe the activities within a major work activity.

Sub-task: distinct actions that describe the activities within a task.

On-the-Job and In-school Training Content for the Construction Electrician Trade: a chart which outlines the topics of technical training with on-the-job examples for apprentices to achieve relevant experience at work.

TRAINING REQUIREMENTS FOR THE CONSTRUCTION ELECTRICIAN TRADE

Training Requirements: To graduate from each level of the apprenticeship program, an apprentice must successfully complete the required technical training and compile enough on-the-job experience to total at least 1800 hours each year. Total trade time required is 7200 hours and at least 4 years in the trade.

Journeyperson to apprentice ratio for this trade is: 1:2

The information contained in this document serves as a guide for employers and apprentices. Apprenticeship training is mutually beneficial to both employer and apprentice. The employer's investment in training apprentices' results in skilled and certified workers. The document summarizes the tasks to be covered by the apprentice during their on-the-job portion of apprenticeship training. An apprentice spends approximately 85% of their apprenticeship term training on-the-job.

It is the employer's or journeyperson's responsibility to supervise an apprentice's practical skills development until a satisfactory level of proficiency has been reached.

EMPLOYER TRAINING RESPONSIBILITY

- promote a safety-conscious workplace
- provide mentored, hands-on practice in the use of tools and equipment
- provide the opportunity for apprentices to service the commonly used systems and products
- allow the apprentice to apply procedures used for estimating materials, costing projects and supervising personnel
- further the apprentice's ability to interpret technical drawings
- ensure that the apprentice can evaluate the end product
- where possible, expose the apprentice to new technology in the Construction Electrician trade

Employers should make every effort to expose their apprentices to work experience in as many areas of the trade as possible.

In the On-the-Job Training Guide, in-school instruction is listed first; on-the-job suggestions to help employers assist the apprentice to prepare for in-school training are listed next.

The content of the training components is subject to change without notice.

CONSTRUCTION ELECTRICIAN
TASK MATRIX

This chart outlines the major work activities, tasks and sub-tasks from the 2021 Construction Electrician Red Seal Occupational Standard. Each sub-task details the corresponding essential skill and level of training where the content is covered. *

*Sub-tasks with numbers in the boxes is where the content will be delivered in training. Harmonization for the Construction Electrician trade has been fully implemented for each technical training level.

A - Performs Common Occupational Skills — 11%

A-1 Performs safety-related functions	1.01 Uses personal protective equipment (PPE) and safety equipment 1	1.02 Maintains safe work environment 1	1.03 Performs lock-out and tag-out procedures 1		
A-2 Uses tools and equipment	2.01 Uses common and specialty tools and equipment 1	2.02 Uses access equipment 1	2.03 Uses rigging, hoisting and lifting equipment 1		
A-3 Organizes work	3.01 Interprets plans, drawings and specifications (In Context 1, 2, 3, 4)	3.02 Organizes materials and supplies (In Context 1, 2, 3, 4)	3.03 Plans project tasks and procedures (In Context 1, 2, 3, 4)	3.04 Prepares worksite (In Context 1, 2, 3, 4)	3.05 Finalizes required documentation (In Context 1, 2, 3, 4)
A-4 Fabricates and installs support components	4.01 Fabricates support structures 1 (In Context 2, 3, 4)	4.02 Installs brackets, hangers and fasteners 1 (In Context 2, 3, 4)	4.03 Installs seismic restraint systems 1 (In Context 2, 3, 4)		

A-5 Commissions and decommissions electrical systems	5.01. Performs startup and shutdown procedures (In Context 1, 2, 3, 4)	5.02 Performs commissioning and decommissioning of systems (In Context 1, 2, 3, 4)
A-6 Uses communication and mentoring techniques	6.01 Uses communication techniques 1	6.02 Uses mentoring techniques 4

B – Installs, Services and Maintains Generating, Distribution and Service Systems

28%

B-7 Installs, services and maintains consumer/supply services and metering equipment	7.01 Installs single-phase consumer/supply services and metering equipment 1	7.02 Installs three-phase consumer/supply services and metering equipment 4	7.03 Performs servicing and maintenance of single-phase services and metering equipment 1	7.04 Performs servicing and maintenance of three-phase services and metering equipment 4
B-8 Installs, services and maintains protection devices	8.01 Installs overcurrent protection devices (In Context 1, 2, 3, 4)	8.02 Installs ground fault, arc fault and surge protection devices (In Context 1, 2, 3, 4)	8.03 Performs servicing and maintenance of protection devices (In Context 1, 2, 3, 4)	
B-9 Installs, services and maintains power distribution equipment	9.01 Installs power distribution equipment 1, 4	9.02 Performs servicing and maintenance of power distribution equipment 1, 4		

B-10 Installs, services and maintains power conditioning, uninterruptible power supply (UPS) and surge suppression systems	**10.01 Installs power conditioning, UPS and surge suppression systems** **4**	**10.02 Performs servicing and maintenance of power conditioning, UPS and surge suppression systems** **4**		
B-11 Installs, services and maintains bonding and grounding and ground fault protection and detection systems	**11.01 Installs grounding and bonding systems** **1, 2, 3, 4**	**11.02 Installs ground fault and protection and detection systems** **1, 2, 3, 4**	**11.03 Installs lightning protection systems** **1, 2, 3, 4**	**11.04 Performs servicing and maintenance of bonding and grounding systems** **1, 4**
B-12 Installs, services and maintains power generation and conversion systems	**12.01 Installs AC (alternating current) generating systems** **3**	**12.02 Performs servicing and maintenance of AC generating systems** **3**	**B-12.03 Installs DC (direct current) generating and conversion systems** **2**	**12.04 Performs servicing and maintenance of DC generating and conversion systems** **2**
B-13 Installs, services and maintains renewable energy generating and storage systems	**13.01 Installs renewable energy generating and storage systems** **4**	**13.02 Performs servicing and maintenance of renewable energy generating and storage systems** **4**		
B-14 Installs, services and maintains high voltage systems	**14.01 Installs high voltage equipment** **4**	**14.02 Installs high voltage cables** **4**	**14.03 Performs servicing and maintenance of high voltage systems** **4**	

B-15 Installs, services and maintains transformers	15.01 Installs extra-low voltage transformers 2	15.02 Installs low-voltage single-phase transformers 2	15.03 Installs low-voltage three-phase transformers 3	15.04 Installs high voltage transformers 3	15.05 Performs servicing and maintenance of transformers 3

C – Installs, Services and Maintains Wiring Systems — 31%

C-16 Installs, services and maintains raceways, conductors, cables and enclosures	16.01 Installs conductors and cables 1, 2 (In Context 3, 4)	16.02 Installs conduit and fittings 1, 2 (In Context 3, 4)	16.03 Installs raceways 1, 2 (In Context 3, 4)	16.04 Installs boxes and enclosures 1, 2 (In Context 3, 4)	16.05 Performs servicing and maintenance of raceways, conductors, cables and enclosures 1, 2 (In Context 3, 4)
C-17 Installs, services and maintains branch circuitry and devices	C-17.01 Installs luminaires 1, 2, 3	17.02 Installs wiring devices 1, 2, 3	17.03 Installs lighting controls 1, 2, 3	17.04 Installs lighting standards 1, 2, 3	17.05 Performs servicing of branch circuitry 1, 2, 3
	17.06 Installs, services and maintains airport visual aid systems 4	17.07 Installs, services and maintains traffic signal lights and controls 4			
C-18 Installs, services and maintains heating, ventilating and air-conditioning (HVAC) systems	18.01 Connects HVAC systems and associated equipment 2	18.02 Installs HVAC controls 2	18.03 Performs servicing and maintenance of HVAC systems and controls 2		

C-19 Installs, services and maintains electric heating systems	19.01 Installs electric heating systems 2	19.02 Installs electric heating system controls 2	19.03 Performs servicing and maintenance of electric heating systems and controls 2
C-20 Installs, services and maintains exit and emergency lighting systems	20.01 Installs exit and emergency lighting 2	20.02 Performs servicing and maintenance of exit and emergency lighting systems 2	
C-21 Installs, services and maintains cathodic protection systems	21.01 Installs cathodic protection systems 2	21.02 Performs servicing and maintenance of cathodic protection systems 2	

D – Installs, Services and Maintains Motors and Control Systems — 20%

D-22 Installs, services and maintains motor starters and controls	22.01 Installs motor starters 2, 3	22.02 Performs servicing and maintenance of motor starters 2, 3	D-22.03 Installs motor control devices 2, 3	22.04 Performs servicing and maintenance of motor controls 2, 3
D-23 Installs, services and maintains drives	23.01 Installs AC drives 3	23.02 Performs servicing and maintenance of AC drives 3	23.03 Installs DC drives 3	23.04 Performs servicing and maintenance of DC drives 3

D-24 Installs, services and maintains motors	**24.01 Installs single-phase motors** 3, 4	**24.02 Performs servicing and maintenance of single-phase motors** 3, 4	**24.03 Installs three-phase motors** 3, 4	**24.04 Performs servicing and maintenance of three-phase motors** 3, 4	**24.05 Installs DC motors** 2, 3, 4
	24.06 Performs servicing and maintenance of DC motors 2, 3, 4				
D-25 Installs, programs, services and maintains automated control systems	**25.01 Installs automated control systems** 4	**25.02 Performs servicing and maintenance of automated control systems** 4	**25.03 Programs and configures automated control systems** 4		

E – Installs, Services and Maintains Signalling and Communication Systems

10%

E-26 Installs, services and maintains signaling systems	**26.01 Installs fire alarm systems** 4	**26.02 Performs servicing and maintenance of fire alarm systems** 4	**26.03 Installs security and surveillance system** 1, 4	**26.04 Performs servicing and maintenance of security and surveillance systems** 1, 4
E-27 Installs, services and maintains communication systems	**27.01 Installs voice/data/video (VDV) and community antenna television (CATV) systems** 1, 4	**27.02 Installs public address (PA) and intercom systems** 1, 4	**27.03 Installs nurse call systems** 1, 4	**27.04 Performs servicing and maintenance of communication systems** 1, 4

E-28 Installs, services and maintains integrated control systems	28.01 Installs building automation systems	28.02 Installs building control systems	28.03 Performs servicing and maintenance of integrated control systems
	4	4	4

TRAINING PROFILE CHART

This Training Profile Chart represents Saskatchewan Apprenticeship and Trade Certification Commission (SATCC) technical training at the topic level.

Level One	Transcript Code	Hours
Safety and Personal Protective Equipment	SFTY 131	20
Introductory Electrical Theory and Practices	BT 131	48
Extra-Low Voltage, Magnetism and Meters	BWC 131	36
Wiring Methods	WM 130	34
Single Dwelling Plans, Lighting and Services	PLS 130	36
Solving DC Circuits	BT 130	36
Conductors and Branch Circuits	BWC 130	30
		240

Level Two	Transcript Code	Hours
DC Machines	EMC 225	30
Motor Starters and Controls	EMC 227	18
Electronic Instruments, Rectification, and Filtering	IE 222	36
Services Under 900 Square Meters	PLS 222	42
Transformers	TRNS 220	36
Residential Electric Heat	HC 220	6
Heating and Cooling Systems	HC 221	30
AC Theory and Meters	BT 220	24
Resistive, Inductive, and Capacitive Circuits	BT 224	18
		240

Level Three	Transcript Code	Hours
Motor Starters and Controls	EMC 325	42
Three-Phase Rectification and DC Power Supplies	IE 322	36
Sensors and Phase Control and Data Cabling	IE 323	36
Services for Occupancies Over 900 Square Metres	PLS 323	36
AC Motors	EMC 326	24
Three-Phase Theory/Alternators	BT 300	33
Three-Phase Transformers	TRNS 322	33
		240

Level Four	Transcript Code	Hours
Hazardous Locations	WM 420	18
Power Factor Correction	BT 426	24
Three-Phase Four-Wire Services and Code	PLS 424	42
Thyristors	IE 425	24
Programmable Logic Controllers	IE 427	36
Primary Metering and High Voltage	HVM 424	30
Building Systems	BLDG 400	36
Fire Alarm Systems	FA 420	30
		240

ON-THE JOB AND IN-SCHOOL TRAINING CONTENT FOR THE CONSTRUCTION ELECTRICIAN TRADE

This chart outlines on-the-job examples for apprentices to achieve relevant work experience to prepare for the topics of technical training. Topics of technical training are provided with the associated learning outcomes.

Level One — 8 weeks — 240 hours

Safety and Personal Protective Equipment — 20 hours

- describe *The Saskatchewan Employment Act* and *The Occupational Health and Safety Regulations* requirements in the electrical trade
- describe personal protective equipment
- describe arc flash
- describe rigging equipment
- describe applicable health and safety regulation and legislation in rigging applications
- describe safe hoisting operations
- describe safe hoisting or pulling operations without a crane
- communication and mentoring

Mentors can assist the apprentice to prepare for this section of technical training by:

- *ensuring familiarization with the scope and content of the OH&S Regulations*
- *making the use of personal protective equipment mandatory*
- *demonstrating the proper use and maintenance of fall protection equipment*
- *describing unsafe working conditions and industrial health hazards and monitoring for action appropriate to situations*
- *ensuring the use of site fire equipment is described and demonstrated*
- *describing the seriousness of confined space entry and methods to safely enter these areas*
- *identifying hazardous materials in the workplace and instruct in the use of the Material Safety Data Sheets (MSDS)*
- *ensuring the proper understanding of the Workplace Hazardous Material Information System (WHMIS) system and symbols*
- *ensuring exposure to various fasteners and fastening systems*
- *providing on-site demonstrations and training where available*

Introductory Electrical Theory and Practices — 48 hours

- describe the electrician trade in Saskatchewan
- describe the application of the Canadian Electrical Code
- describe basic principles of electricity
- describe basic electrical circuit concepts
- describe common electrical devices
- select common fasteners
- terminate conductors
- connect basic electrical circuits

Mentors can assist the apprentice to prepare for this section of technical training by:

- *ensuring the apprentice is exposed to layout and troubleshooting of basic DC circuits such as emergency lighting*
- *exposing the apprentice to industry standard tools, components and materials*
- *providing opportunities to verify CEC requirements during installation*
- *explaining the different types and applications of cables and terminations*
- *familiarizing the apprentice with typical installations and components and how they function*

Extra-Low Voltage, Magnetism, and Meters — 36 hours

- describe the principles of electromagnetism
- describe the operating principles of meters
- use meters for voltage measurement
- use meters for current measurement
- use meters for resistance measurement
- use meters for power and energy measurement
- install basic signal systems
- install remote control relay systems

Mentors can assist the apprentice to prepare for this section of technical training by:

- *having the apprentice install doorbells, thermostats, humidifier controls, security alarms and similar extra-low voltage circuits*
- *assisting the apprentice in trouble shooting low-voltage circuits*
- *providing the apprentice with opportunities to terminate and test low-voltage systems*
- *having the apprentice use a multi-meter to verify various measurements and discuss their meaning*

Wiring Methods — 34 hours

- install non-metallic sheathed cable
- install armoured cable
- describe aluminum sheathed cable
- describe mineral insulated cable
- describe raceways
- describe rigid and flexible conduit
- describe electrical metallic tubing
- describe rigid PVC conduit
- describe surface raceways
- describe installation requirements for data cabling
- terminate data cabling

Mentors can assist the apprentice to prepare for this section of technical training by:

- *ensuring the apprentice has access to the Canadian Electrical Code and by demonstrating a typical search for a code reference or requirement*
- *providing the apprentice with practical exposure to various raceway installations, including a discussion of the importance and a demonstration of typical bonding installation*
- *exposing the apprentice to overcurrent device installation*
- *demonstrating the operation of a hand and power bender*
- *ensuring the apprentice understands the limitations and uses for various types of cables*
- *exposing the apprentice to data cable installations, requirements and termination methods*

Single Dwelling Plans, Lighting, and Services — 36 hours

- describe common construction drawings
- describe electrical drawings, symbols and schedules
- determine lighting requirements
- determine single dwelling service requirements
- install single dwelling services

Mentors can assist the apprentice to prepare for this section of technical training by:

- *giving instruction in blueprint reading and CEC references*
- *explaining legends and identifying symbols*
- *referencing local building codes and permit requirements*
- *reviewing manufacturer and job specifications*
- *ensuring apprentice participation in a typical residential installation*

Conductors and Branch Circuits — 30 hours

- describe common conductors
- calculate conductor resistance and ampacity
- select overcurrent devices
- select bonding conductors
- determine branch circuit requirements

Mentors can assist the apprentice to prepare for this section of technical training by:

- *ensuring exposure to various fasteners and fastening systems*
- *providing on-site demonstrations and training where available*
- *discussion regarding the limitations of conductors and common installation practices*
- *stressing security and safety elements*

Solving DC Circuits — 36 Hours

- analyze series circuits
- analyze parallel circuits
- analyze combination circuits
- analyze three-wire circuits
- connect cells and batteries

Mentors can assist the apprentice to prepare for this section of technical training by:

- *ensuring the apprentice can identify and calculate current and resistance in a series and parallel circuit*
- *assisting the apprentice in planning a DC circuit such as an emergency light system*
- *assisting the apprentice in identifying combination circuits*

Level Two — 8 weeks — 240 hours

DC Machines — 30 hours

- describe typical DC machine construction
- describe common DC generator connections
- describe DC motor connections
- connect DC generators
- connect DC motors
- connect DC generators in parallel

Mentors can assist the apprentice to prepare for this section of technical training by:

- *ensuring the apprentice can connect and analyze a dc motor*
- *assisting the apprentice with inspection of a DC motor to determine if the brushes need replacement*
- *discussing the maintenance and installation requirements for DC motors*

Motor Starters and Controls — 18 hours

- connect manual motor control circuits
- connect overload protection
- connect electromagnetic motor control circuits
- determine motor control (installation standards)

Mentors can assist the apprentice to prepare for this section of technical training by:

- *identifying different motor types and applications and relevant basic control schematics*
- *assisting the apprentice in understanding a common stop/start button works*
- *discussing the differences between overload protection and overcurrent protection*
- *discuss the different connection configurations and their effect of the motor's operation*

AC Theory and Meters — 24 Hours

- use analog and digital meters to measure, resistance, voltage and current
- describe power meters
- describe the principles of electromagnetic induction
- describe the operation of an elementary AC generator
- calculate instantaneous, average, and RMS values for sine waves
- compare the effects of resistance, inductive reactance and capacitive reactance in an AC circuit
- draw sine wave and phasor diagrams for AC resistive, inductive, and capacitive circuits

Mentors can assist the apprentice to prepare for this section of technical training by:

- *familiarizing the apprentice with schematics and diagrams*
- *exposing the apprentice to various types of AC meters and their functions*
- *exposing the apprentice to different devices in R, L and C circuits*
- *explaining the differences and applications of single phase and three phase services*
- *providing examples of basic troubleshooting situations*

Electronic Instruments, Rectification and Filtering — 36 hours

- select resistors for electronic circuits
- use voltmeters in electronic circuits
- use AC wave forms and DC
- describe semi-conductor junction diodes
- connect single phase 1/2 wave rectifier circuit
- connect single phase bi-phase rectifier circuit
- connect single phase bridge rectifier circuit
- describe resistive/capacitive (RC) time constants
- connect basic rectifier filter circuits

Mentors can assist the apprentice to prepare for this section of technical training by:

- *involving the apprentice in component, board and circuit identification and function*
- *assisting the apprentice in testing of individual components such as diodes, resistors and switches*

Services Under 900 Square Meters — 42 hours

- determine branch circuit requirements for single phase motors
- determine feeder requirements for groups of single-phase motors
- determine feeder requirements for motors and other loads combined.
- determine service entrance requirements (for institutional buildings up to and including 900 sq. meters, for common institutional and commercial buildings, and for row housing and apartment building complexes)
- renewable energy generating and storage systems
- cathodic protection
- exit and emergency lighting systems

Mentors can assist the apprentice to prepare for this section of technical training by:

- *providing instruction on code book issues and applications*
- *encouraging the apprentice to make isometric drawings to accompany any material lists*
- *providing opportunities for the apprentice to calculate motor demand requirements*
- *assist apprentice in identifying uncommon loads and how they apply to service requirements*

Transformers — 36 hours

- describe basic transformers
- describe single-phase transformer construction
- connect typical dual-secondary single-phase transformers
- calculate winding turns, voltages and currents using transformer ratio formulas
- describe basic instrument transformer circuits
- calculate transformer values
- identify unmarked transformer leads
- conduct transformer impedance tests
- connect transformers in parallel
- connect autotransformers

Mentors can assist the apprentice to prepare for this section of technical training by:

- *explaining the principles of operations and applications of control transformer*
- *demonstrate grounding and bonding procedures and discuss their importance*
- *provide opportunity for the apprentice to install and test various types and styles of transformer*

Residential Electric Heat — 6 hours

- determine residential electric heating requirements
- describe installation requirements for residential electric heating

Mentors can assist the apprentice to prepare for this section of technical training by:

- *having the apprentice calculate various load factors*
- *discussing applicable requirements and limitations of various types of electric heating*

Heating and Cooling Systems — 30 hours

- install residential heating and cooling systems
- service residential heating and cooling systems
- install commercial and industrial burner controls
- service commercial and industrial burner controls

Mentors can assist the apprentice to prepare for this section of technical training by:

- *explaining wiring diagrams and assisting the apprentice to analyze series and parallel circuits*
- *discussing the applications for different meters and demonstrating how they are used*
- *explaining how equipment controls are serviced*
- *supervising hands-on experience in electrical troubleshooting*
- *allowing the apprentice to attend manufacturer's seminars*

Resistive, Inductive and Capacitive Circuits — 18 hours

- sketch sine wave and phasors for parallel circuits
- solve AC parallel circuits
- calculate AC power units and power formulas
- solve AC series circuit problems

Mentors can assist the apprentice to prepare for this section of technical training by:

- *ensuring the apprentice can connect and analyze ac circuits containing inductive, resistive and capacitive load*
- *discuss the effects that the various types of loads can have on a circuit*
- *provide examples of inductive and capacitive loads common to your workplace*

Level Three — 8 weeks — 240 hours

Motor Starters and Controls — 42 hours

- interpret schematic and wiring diagrams (for various motor control applications)
- install motor control devices (for three phase motors in manual and automatic applications)
- install advanced motor control devices (for three phase motors in manual and automatic applications)
- determine regulatory standards (motor control)

Mentors can assist the apprentice to prepare for this section of technical training by:

- *reviewing different types of wiring diagrams*
- *utilizing wiring diagrams during troubleshooting*
- *assisting with the installation, set-up and testing of motor starters*
- *having the apprentice install and set motor overloads*
- *identifying motor control devices for three phase motors in manual and automatic applications*

Three – Phase Rectification and DC Power Supplies — 36 hours

- connect three-phase wye rectifier circuits
- connect three-phase full-wave bridge rectifier circuits
- describe zener diodes
- describe bi-polar transistors
- connect voltage regulator circuits

Mentors can assist the apprentice to prepare for this section of technical training by:

- *identifying various boards, components and instrument devices*
- *familiarizing the apprentice with their operation*
- *training in performing basic troubleshooting and function testing*

Sensors, Phase Control and Data Cabling — 36 hours

- describe temperature sensing devices
- describe optical devices
- describe proximity sensing switches
- connect SCR phase control circuits
- describe J-Fets and Mos-Fets
- terminate data cabling

Mentors can assist the apprentice to prepare for this section of technical training by:

- *instructing the apprentice in layout, installation and termination*
- *explaining the differences between the three types of cabling*
- *emphasizing the additional precautions and technical requirements for installation*
- *having the apprentice terminate and test data cabling*
- *demonstrating the installation and troubleshooting procedure of temperature sensing devices*

Services for Occupancies Over 900 Square Metres — 36 hours

- determine lighting requirements
- determine three-phase squirrel cage and synchronous motor branch circuits and feeders
- calculate wound rotor and continuous duty motor branch circuits and feeders
- calculate welder branch circuits and feeders
- determine services and feeders for buildings with an area exceeding 900 square metres

Mentors can assist the apprentice to prepare for this section of technical training by:

- *instructing the apprentice in layout, installation and termination*
- *emphasizing the additional precautions and technical requirements for installation*
- *reviewing the CEC service and installation requirements for occupancies over 900 square m*
- *assisting the apprentice in calculating demands for specialty equipment*

AC Motors — 24 hours

- describe the construction and operation of three-phase AC motors
- connect three-phase squirrel cage motors
- connect three-phase wound rotor motors
- connect three-phase synchronous motors
- describe the maintenance requirements of three-phase motors
- describe the construction and operation of single-phase AC motors
- connect single-phase squirrel cage, split phase, induction motors
- describe single-phase repulsion motors
- describe the maintenance requirements of single-phase motors

Mentors can assist the apprentice to prepare for this section of technical training by:

- *ensuring the apprentice can determine the type, minimum allowable ampacity and AWG size for motor conductors*
- *ensuring the apprentice can determine the minimum allowable ampacity and AWG size of feeder conductors required for a group of motors*

Three-Phase Theory/Alternators — 33 hours

- describe AC generator principles and configurations
- describe AC generators set components
- describe AC generator terminal markings and connections
- connect three-phase loads and solve three-phase load problems
- describe AC generator operation with mixed PF loads
- describe instruments used to find frequency, phase sequence, motor rotation, shaft speed (tachometers), and insulation resistance
- connect AC generator in parallel

Mentors can assist the apprentice to prepare for this section of technical training by:

- *ensuring the apprentice can connect and analyze a three-phase circuit using a power quality analyzer*
- *ensuring the apprentice can analyze power factor correction calculations*

Three-Phase Transformers — 33 hours

- describe transformers
- describe the characteristics of various three-phase transformer connections
- determine Canadian Electrical Code requirements for transformer installations
- connect three phase transformers

Mentors can assist the apprentice to prepare for this section of technical training by:

- *ensuring the apprentice understands the various components and configurations of three-phase transformers and their applications*
- *having the apprentice install and test various 3-phase transformers*
- *assist the apprentice in troubleshooting damaged 3-phase transformers*
- *reviewing the importance of grounding and bonding*

Level Four — 8 weeks — 240 hours

Power Factor Correction — 24 hours

- describe power factor correction
- apply AC induction motors
- describe power factor correction principles (using synchronous motors)

Mentors can assist the apprentice to prepare for this section of technical training by:

- *explaining the use and application of capacitor banks*
- *explaining the relationship between true and apparent power*

Three-Phase Four-Wire Services — 42 hours

- describe 3-phase 3-wire and 3-phase 4-wire circuits (three-phase circuit loading characteristics)
- calculate requirements for services and feeders (for buildings to be supplied with 3-phase energy)
- determine electrical requirements considering conductor voltage drop
- determine installation requirements for specialized wiring methods
- describe thermit weld conductor terminations

Mentors can assist the apprentice to prepare for this section of technical training by:

- *explaining the different transformer connections and applications and proper grounding techniques*
- *reviewing CEC installation requirements*

Building Systems — 36 hours

- describe building automation systems
- describe UPS and surge suppression systems
- describe renewable energy generating and storage systems
- describe automated control systems
- describe communication systems

Mentors can assist the apprentice to prepare for this section of technical training by:

- *ensuring the apprentice understands the basic concepts and reviews available literature*
- *assisting the apprentice in installing, servicing and maintaining building system components according to their specifications*
- *answering questions pertaining to the function of various building automation systems*

Thyristors — 24 hours

- connect semi-converter phase control circuit and components
- connect inverse-parallel SCR phase control circuit and components
- connect protective devices for transient voltages and rate-turn on
- connect ramp and pedestal firing circuit
- connect TRIAC phase control circuit and components
- connect solid-state contactors

Mentors can assist the apprentice to prepare for this section of technical training by:

- *ensuring the apprentice can read a schematic diagram and identify components and their application*
- *assisting in learning to predict voltages from circuits and use meters and scopes to test and confirm*

Programmable Logic Controllers — 36 hours

- connect standard logic gate control circuits
- connect inverted logic gate control circuits
- describe numbering systems used in programmable controllers
- program logic controller hardware, memory structure, addressing, and control sequence
- program logic controller (for digital and analog control)

Mentors can assist the apprentice to prepare for this section of technical training by:

- *ensuring the apprentice has basic computer literacy; understands the various PLC components, how input and output devices communicate*
- *where available, demonstrating how to upload/download and program devices, and how to troubleshoot and repair*
- *monitoring the apprentice in test firing and service procedures on domestic equipment*
- *having the apprentice commission, start and troubleshoot domestic category I to IV appliances and equipment*
- *utilizing schematic diagrams, and where available, exposing the apprentice to the programming of programmable relays*

Fire Alarm Systems — 30 hours

- describe fire alarm systems and components
- determine fire alarm system requirements
- determine wiring requirements for fire alarm systems
- connect typical fire alarm panels
- troubleshoot typical fire alarm systems

Mentors can assist the apprentice to prepare for this section of technical training by:

- *including apprentice at a commissioning*
- *having the apprentice instal various initiating and alarm devices*
- *encouraging the apprentice to obtain information on system devices from suppliers and the internet*
- *explaining how systems operate*

Primary Metering and High Voltage — 30 hours

- determine high voltage metering and installation requirements
- describe safe high voltage system practices including PPE and arc flash awareness

Mentors can assist the apprentice to prepare for this section of technical training by:

- *training the apprentice in safety aspects such as clearances, touch potential and grounding*
- *reviewing the class/category level of protective and metering equipment*
- *ensure safe work practices are followed such as left-hand switch operation, LOTTO, and test before touch*
- *where available, participating in a hands-on application*

Hazardous Locations — 18 hours

- describe installation requirements for hazardous locations
- describe installation requirements for flammable liquid and dispensing areas
- describe installation requirements for areas of harmful and corrosive liquids
- describe installation requirements for patient care specification areas

Mentors can assist the apprentice to prepare for this section of technical training by:

- *explaining how to identify hazardous locations and their levels and zones as specified in the CEC*
- *demonstrating appropriate methods and materials used for various applications*

Consider apprenticeship training as an investment in the future of your company and in the future of your workforce. Ultimately, skilled and certified workers increase your bottom line.

Get involved in the apprenticeship training system. Your commitment to training helps to maintain the integrity of the trade.

Do you have employees who have been working in the trade for a number of years but don't have trade certification? Contact your local apprenticeship office for details on how they might obtain the certification they need.

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