

# Construction Electrician On-the-Job Training Guide

2021



Online: [www.saskapprenticeship.ca](http://www.saskapprenticeship.ca)

*Recognition:*

*To promote transparency and consistency, portions of this document has been adapted from the 2015 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](http://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:

**Description of the Construction Electrician trade:** an overview of the trade's duties and training requirements.

**Essential Skills Summary:** an overview of how each of the nine essential skills is applied in this trade.

**Harmonization:** a brief description on the pan-Canadian Harmonization Initiative for the Construction Electrician trade.

**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 on-the-job examples for apprentices to achieve relevant work experience to prepare for topics of technical training.

# DESCRIPTION OF THE CONSTRUCTION ELECTRICIAN TRADE

*Construction electricians install, repair, test and maintain wiring, controls, motors and other electrical devices in a variety of locations and includes all “work of electrical installation.”*

Construction electricians plan, design, assemble, install, alter, repair, inspect, verify, commission, connect, operate, maintain and decommission electrical systems. Electrical systems provide heating, lighting, power, alarm, security, communication and control in residential, commercial, institutional, industrial, transportation and entertainment environments. Construction electricians may be self-employed or employed by electrical contractors, utilities, and operations and maintenance departments of various facilities and municipalities.

Construction electricians must read and interpret electrical, mechanical, civil and architectural drawings and specifications such as electrical, building, fire, and jurisdictional codes to complete electrical installations. They use electrical test equipment and digital technology to ensure system safety, functionality and compatibility.

Construction electricians require good communication skills to negotiate, coordinate and facilitate work with clients, co-workers, jurisdictional authorities and other trades. Organizational skills are required to successfully plan and execute their work. They also require strong analytical and problem-solving skills in order to read and interpret diagrams, drawings and specifications. They require mechanical aptitude to install, diagnose and repair systems and components. It is beneficial for construction electricians to have good vision, the ability to distinguish colours, manual dexterity and a willingness to keep up with new developments in the trade. With changing technologies, digital and computer skills are necessary to this trade for job performance, learning methods and updating skills.

Their work may be performed indoors or outdoors, at heights, in confined spaces and in hazardous environments. They require stamina as construction electricians spend much of their time performing static and physical tasks such as climbing. Occupational risks include shocks, industrial diseases, arc flashes, falls and injury from repetitive motion, lifting and kneeling.

Construction electricians play a crucial role as mentors and trainers to apprentices in the trade. They may also advance to positions such as foremen, instructors, project managers, superintendents, estimators, technicians, system designers, electrical inspectors or start their own contracting business. Construction electricians may enhance their skills in different fields such as restorative, service or retrofit work rather than new construction.

**Training Requirements:** 7200 hours (4 years) with 4 8-week training sessions at Saskatchewan Polytechnic in Moose Jaw and Prince Albert. Level one training is also available in Regina.

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 above systems and products
- further the apprentice’s ability to interpret technical drawings
- ensure that the apprentice can evaluate the end product.

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.

**Entrance Requirements for Apprenticeship Training**

Your grade twelve transcripts (with no modified classes) or GED 12 is your guarantee that you meet the educational entrance requirements for apprenticeship in Saskatchewan. In fact, employers prefer and recommend apprentices who have completed high school. This ensures the individual has all of the necessary skills required to successfully complete the apprenticeship program, and receive journeyperson certification.

Individuals with “modified” or “general” classes in math or science do not meet our entry requirements. These individuals are required to take an entrance assessment prescribed by the SATCC.

English is the language of instruction in all apprenticeship programs and is the common language for business in Saskatchewan. Before admission, all apprentices and/or “upgraders” must be able to understand and communicate in the English language. Applicants whose first language is not English must have a minimum Canadian Language Benchmark Assessment of six (CLB6).

Note: A CLB assessment is valid for a one-year period from date of issue.

Designated Trade Name	Math Credit at the Indicated Grade Level <sup>❶</sup>	Science Credit at Grade Level
Construction Electrician	Grade 11	Grade 10
<p><sup>❶</sup> - (One of the following) WA – Workplace and Apprenticeship; or F – Foundations; or P – Pre-calculus, or a Math at the indicated grade level (Modified and General Math credits are not acceptable.).</p> <p>*Applicants who have graduated in advance of 2015-2016, or who do not have access to the revised Science curricula will require a Science at the minimum grade level indicated by trade.</p> <p>For information about high school curriculum, including Math and Science course names, please see:  <a href="http://www.curriculum.gov.sk.ca/#">http://www.curriculum.gov.sk.ca/#</a></p> <p><b>Individuals not meeting the entrance requirements will be subject to an assessment and any required training</b></p>		

# ESSENTIAL SKILLS SUMMARY

Essential skills are needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change.

Through extensive research, the Government of Canada and other national and international agencies have identified and validated nine essential skills. These skills are used in nearly every occupation and throughout daily life in different ways.

A series of CCDA-endorsed tools have been developed to support apprentices in their training and to be better prepared for a career in the trades. The tools can be used independently or with the assistance of a tradesperson, trainer, employer, teacher or mentor to:

- understand how essential skills are used in the trades;
- learn about individual essential skills strengths and areas for improvement; and
- improve essential skills and increase success in an apprenticeship program.

The tools are available online or for order at: [www.esdc.gc.ca/eng/jobs/les/profiles/index.shtml](http://www.esdc.gc.ca/eng/jobs/les/profiles/index.shtml)

The application of these skills may be described throughout this document within the skills and knowledge which support each sub-task of the trade. The most important essential skills for each sub-task have also been identified. The following are summaries of the requirements in each of the essential skills, taken from the essential skills profile. A link to the complete essential skills profile can be found at [www.red-seal.ca](http://www.red-seal.ca).

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## READING

Construction electricians read several types of documents such as purchase order agreements and instructions for installing systems and components. They also need to read and understand the Canadian Electrical Code (CEC), which contains legal and highly technical language. They also read other tradespersons' plans and specifications to understand the sequences of installation and locations of apparatus.

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## DOCUMENT USE

Construction electricians apply document use skills when they read, interpret and collate information from several documents such as plans, specifications, diagrams and schematics. They reference and interpret these documents when installing, assembling, diagnosing and repairing electrical components and systems. The translation of two-dimensional and three-dimensional drawings into three-dimensional applications also requires strong document use skills.

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## WRITING

Writing skills are required for construction electricians to record information about their daily work, including hours worked, job locations and details of conversations about the job. They may also be required to record details on an incident or an accident report. They also make notations on as-built drawings to indicate changes from the original drawings, accurately describing the current installation. Labelling and identifying electrical systems also require this skill.

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## ORAL COMMUNICATION

Strong oral communication skills are needed for construction electricians as they often need to relay messages, give directions, coordinate tasks with co-workers and discuss electrical code requirements with safety or building inspectors. They also regularly interact with supervisors, engineers, owners, architects, inspectors and other tradespersons to solve technical problems, to discuss work progress, and to ensure that work can meet scheduling and code requirements. They also exchange opinions with co-workers regarding critical safety issues related to complex installations.

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## NUMERACY

Construction electricians use their numeracy skills to size and place electrical systems and components, ensuring that installations meet electrical code requirements. They take measurements and perform complex calculations using principles of mathematics such as geometry and trigonometry. Construction electricians also use numeracy skills to design or modify electrical installations.

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## THINKING SKILLS

Construction electricians use thinking skills when they plan their work in order to ensure efficient use of time and resources. These skills also entail resolving issues such as system routing, and equipment placement and interconnection taking into account client specifications and code requirements. Additionally, these skills are called upon when consulting with other experienced tradespersons, manufacturers' representatives or engineers to solve technical problems.

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## WORKING WITH OTHERS

Construction electricians often work with co-workers, other trades, supervisors, owner representatives, architects, engineers, inspectors and suppliers. They may be required to demonstrate how to perform a task to other workers, mentor and orient or train new employees. They also participate in discussions about work processes or product improvement.

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## DIGITAL TECHNOLOGY

Construction electricians use different types of hand-held digital devices such as oscilloscopes, multimeters and Power Quality Analyzers (PQA) to aid in diagnosing system and component failure. They also use different types of software to interface with these devices. They use their computer skills to improve the efficiency of product research, communication, record keeping, job tracking and information exchange with co-workers, other trades, supervisors, owner representatives, architects, engineers, inspectors and suppliers.

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## CONTINUOUS LEARNING

It is important for construction electricians to stay up-to-date with changing requirements of the electrical code or with changes in technology, such as computer controls. They must be adaptable to change to advance their skills and increase their knowledge. These learning skills are applied when attending classes offered through unions, employers and other groups.

# HARMONIZATION

At the request of industry, the Harmonization Initiative was launched in 2013 to *substantively align* apprenticeship systems across Canada by making training requirements more consistent in the Red Seal trades. Harmonization aims to improve the mobility of apprentices, support an increase in their completion rates and enable employers to access a larger pool of apprentices.

As part of this work, the Canadian Council of the Directors of Apprenticeship (CCDA) identified four main harmonization priorities in consultation with industry and training stakeholders:

## **1. Trade name**

The official Red Seal name for this trade is Construction Electrician.

## **2. Number of Levels of Apprenticeship**

The number of levels of technical training recommended for the Construction Electrician trade is four.

## **3. Total Training Hours during Apprenticeship Training**

The total hours of training, including both on-the-job and in-school training for the Construction Electrician trade is 7200.

## **4. Consistent sequencing of training content (at each level) using the most recent Occupational Standard**

Harmonization for the Construction Electrician trade has been fully implemented for each technical training level. See the “Technical Training Course Content” section of this guide for further details.

# CONSTRUCTION ELECTRICIAN

## TASK MATRIX CHART

This chart outlines the major work activities, tasks and sub-tasks from the 2015 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

<b>A-1 Performs safety-related functions.</b>	<b>1.01 Uses personal protective equipment (PPE) and safety equipment.</b>  1	<b>1.02 Maintains safe work environment.</b>  1	<b>1.03 Performs lock-out and tag-out procedures.</b>  1		
<b>A-2 Uses tools and equipment.</b>	<b>2.01 Uses common and specialty tools and equipment.</b>  1	<b>2.02 Uses access equipment.</b>  1	<b>2.03 Uses rigging, hoisting and lifting equipment.</b>  1		
<b>A-3 Organizes work</b>	<b>3.01 Interprets plans, drawings and specifications.</b>  1,2,3,4	<b>3.02 Organizes materials and supplies.</b>  1,2,3,4	<b>3.03 Plans project tasks and procedures.</b>  1,2,3,4	<b>3.04 Prepares worksite.</b>  1,2,3,4	<b>3.05 Finalizes required documentation.</b>  1,2,3,4
<b>A-4 Fabricates and installs support components.</b>	<b>4.01 Fabricates support structures.</b>  1	<b>4.02 Installs brackets, hangers and fasteners.</b>  1	<b>4.03 Installs seismic restraint systems.</b>  1		
<b>A-5 Commissions and decommissions electrical systems.</b>	<b>5.01. Performs startup and shutdown procedures.</b>  1,2,3,4	<b>5.02 Performs commissioning and decommissioning of systems.</b>  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**

**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.**  
  
1,2,3,4

**8.02 Installs ground fault, arc fault and surge protection devices.**  
  
1,2,3,4

**8.03 Performs servicing and maintenance of protection devices.**  
  
1,2,3,4

**B-9 Installs, services and maintains 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>B-11 Installs, services and maintains bonding and grounding protection systems.</b>	<b>11.01 Installs grounding and bonding systems.</b>  1,2,3,4	<b>11.02 Installs ground fault systems.</b>  1,2,3,4	<b>11.03 Installs lightning protection systems.</b>  1,2,3,4	<b>11.04 Performs servicing and maintenance of bonding and grounding systems.</b>  1,4	
<b>B-12 Installs, services and maintains power generation systems.</b>	<b>12.01 Installs AC (alternating current) generating systems.</b>  3	<b>12.02 Performs servicing and maintenance of AC generating systems.</b>  3	<b>B-12.03 Installs DC (direct current) generating systems. (NOT COMMON CORE)</b>  2	<b>12.04 Performs servicing and maintenance of DC generating systems. (NOT COMMON CORE)</b>  2	
<b>B-13 Installs, services and maintains renewable energy systems.</b>	<b>13.01 Installs renewable energy systems.</b>  4	<b>13.02 Performs servicing and maintenance of renewable energy systems.</b>  4			
<b>B-14 Installs, services and maintains high voltage systems.</b>	<b>14.01 Installs high voltage equipment.</b>  4	<b>14.02 Installs high voltage cables.</b>  4	<b>14.03 Performs servicing and maintenance of high voltage systems.</b>  4		
<b>B-15 Installs, services and maintains transformers.</b>	<b>15.01 Installs extra-low voltage transformers.</b>  2	<b>15.02 Installs low-voltage single-phase transformers.</b>  2	<b>15.03 Installs low-voltage three-phase transformers.</b>  3	<b>15.04 Installs high voltage transformers.</b>  3	<b>15.05 Performs servicing and maintenance of transformers.</b>  3

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## **C – INSTALLS, SERVICES AND MAINTAINS WIRING SYSTEMS**

<b>C-16 Installs, services and maintains raceways, cables and enclosures.</b>	<b>16.01 Installs conductors and cables.</b>  1,2	<b>16.02 Installs conduit, tubing and fittings.</b>  1,2	<b>16.03 Installs raceways.</b>  1,2	<b>16.04 Installs boxes and enclosures.</b>  1,2	<b>16.05 Performs servicing and maintenance of raceways, cables and enclosures.</b>  1,2
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<b>C-17 Installs, services and maintains branch circuitry.</b>	<b>C-17.01 Installs luminaires.</b>  <b>1,2,3</b>	<b>17.02 Installs wiring devices.</b>  <b>1,2,3</b>	<b>17.03 Installs lighting controls.</b>  <b>1,2,3</b>	<b>17.04 Installs lighting standards.</b>  <b>1,2,3</b>	<b>17.05 Performs servicing of branch circuitry.</b>  <b>1,2,3</b>
	<b>17.06 Installs, services and maintains airport runway lighting systems.</b>  <b>4</b>	<b>17.07 Installs, services and maintains traffic signal lights and controls.</b>  <b>4</b>			
<b>C-18 Installs, services and maintains heating, ventilating and air-conditioning (HVAC) systems.</b>	<b>18.01 Connects HVAC systems.</b>  <b>2</b>	<b>18.02 Installs HVAC controls.</b>  <b>2</b>	<b>18.03 Performs servicing and maintenance of HVAC systems and controls.</b>  <b>2</b>		
<b>C-19 Installs, services and maintains electric heating systems.</b>	<b>19.01 Installs electric heating systems.</b>  <b>2</b>	<b>19.02 Installs electric heating system controls.</b>  <b>2</b>	<b>19.03 Performs servicing and maintenance of electric heating systems and controls.</b>  <b>2</b>		
<b>C-20 Installs, services and maintains exit and emergency lighting systems.</b>	<b>20.01 Installs exit and emergency lighting.</b>  <b>2</b>	<b>20.02 Performs servicing and maintenance of exit and emergency lighting systems.</b>  <b>2</b>			
<b>C-21 Installs, services and maintains cathodic protection systems.</b>	<b>21.01 Installs cathodic protection systems.</b>  <b>2</b>	<b>21.02 Performs servicing and maintenance of cathodic protection systems.</b>  <b>2</b>			

## D – INSTALLS, SERVICES AND MAINTAINS MOTORS AND CONTROL SYSTEMS

<p><b>D-22 Installs, services and maintains motor starters and controls.</b></p>	<p><b>22.01 Installs motor starters.</b></p> <p>2,3</p>	<p><b>22.02 Performs servicing and maintenance of motor starters.</b></p> <p>2,3</p>	<p><b>D-22.03 Installs motor controls.</b></p> <p>2,3</p>	<p><b>22.04 Performs servicing and maintenance of motor controls.</b></p> <p>2,3</p>	
<p><b>D-23 Installs, services and maintains drives.</b></p>	<p><b>23.01 Installs AC drives.</b></p> <p>3</p>	<p><b>23.02 Performs servicing and maintenance of AC drives.</b></p> <p>3</p>	<p><b>23.03 Installs DC drives.</b></p> <p>3</p>	<p><b>23.04 Performs servicing and maintenance of DC drives.</b></p> <p>3</p>	
<p><b>D-24 Installs, services and maintains motors.</b></p>	<p><b>24.01 Installs single-phase motors.</b></p> <p>3,4</p>	<p><b>24.02 Performs servicing and maintenance of single-phase motors.</b></p> <p>3,4</p>	<p><b>24.03 Installs three-phase motors.</b></p> <p>3,4</p>	<p><b>24.04 Performs servicing and maintenance of three-phase motors.</b></p> <p>3,4</p>	<p><b>24.05 Installs DC motors.</b></p> <p>2,3,4</p>
	<p><b>24.06 Performs servicing and maintenance of DC motors.</b></p> <p>2,3,4</p>				
<p><b>D-25 Installs, programs, services and maintains automated control systems.</b></p>	<p><b>25.01 Installs automated control systems.</b></p> <p>4</p>	<p><b>25.02 Performs servicing and maintenance of automated control systems.</b></p> <p>4</p>	<p><b>25.03 Programs and configures automated control systems.</b></p> <p>4</p>		

## E – INSTALLS, SERVICES AND MAINTAINS SIGNALLING AND COMMUNICATION SYSTEMS

<p><b>E-26</b> Installs, services and maintains signaling systems.</p>	<p><b>26.01</b> Installs fire alarm systems.</p> <p style="text-align: center;">4</p>	<p><b>26.02</b> Performs servicing and maintenance of fire alarm systems.</p> <p style="text-align: center;">4</p>	<p><b>26.03</b> Installs security and surveillance systems.</p> <p style="text-align: center;">1,4</p>	<p><b>26.04</b> Performs servicing and maintenance of security and surveillance systems.</p> <p style="text-align: center;">1,4</p>
<p><b>E-27</b> Installs, services and maintains communication systems.</p>	<p><b>27.01</b> Installs voice/data/video (VDV) and community antenna television (CATV) systems.</p> <p style="text-align: center;">1,4</p>	<p><b>27.02</b> Installs public address (PA) and intercom systems.</p> <p style="text-align: center;">1,4</p>	<p><b>27.03</b> Installs nurse call systems.</p> <p style="text-align: center;">1,4</p>	<p><b>27.04</b> Performs servicing and maintenance of communication systems.</p> <p style="text-align: center;">1,4</p>
<p><b>E-28</b> Installs, services and maintains integrated control systems.</p>	<p><b>28.01</b> Installs building automation systems.</p> <p style="text-align: center;">4</p>	<p><b>28.02</b> Installs building control systems.</p> <p style="text-align: center;">4</p>	<p><b>28.03</b> Performs servicing and maintenance of integrated control systems.</p> <p style="text-align: center;">4</p>	

# 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
<b>Safety and Personal Protective Equipment</b> <ul style="list-style-type: none"> <li>describe <i>The Saskatchewan Employment Act</i> and <i>The Occupational Health and Safety Regulations</i> requirements in the electrical trade</li> <li>describe personal protective equipment</li> <li>describe arc flash</li> <li>describe rigging equipment</li> <li>describe applicable health and safety regulation and legislation in rigging applications</li> <li>describe safe hoisting operations</li> <li>describe safe hoisting or pulling operations without a crane</li> </ul>		20 hours
<b>Mentors can assist the apprentice to prepare for this section of technical training by:</b> <ul style="list-style-type: none"> <li><i>ensuring exposure to various fasteners and fastening systems</i></li> <li><i>providing on-site demonstrations and training where available</i></li> <li><i>stressing security and safety elements</i></li> </ul>		
<b>Introductory Electrical Theory and Practices</b> <ul style="list-style-type: none"> <li>describe the electrician trade in Saskatchewan</li> <li>describe the application of the Canadian Electrical Code</li> <li>describe basic principles of electricity</li> <li>describe basic electrical circuit concepts</li> <li>describe common electrical devices</li> <li>select common fasteners</li> <li>terminate conductors</li> <li>connect basic electrical circuits</li> </ul>		48 hours
<b>Mentors can assist the apprentice to prepare for this section of technical training by:</b> <ul style="list-style-type: none"> <li><i>ensuring the apprentice is exposed to layout and troubleshooting of basic DC circuits such as emergency lighting</i></li> <li><i>exposing the apprentice to industry standard tools, components and materials</i></li> <li><i>providing hands-on experience</i></li> <li><i>explaining the different types and applications of cables and terminations</i></li> <li><i>familiarizing the apprentice with typical installations and components and how they function</i></li> </ul>		

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**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*

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**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 all of these installations, including a discussion of the importance and a demonstration of typical bonding and overcurrent device installation*
- *demonstrating the operation of a hand bender*

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**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*
- *ensuring apprentice participation in a typical residential installation*

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**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*
- *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 circuit*

## **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*

### **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*

### **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*
- 

### **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*
- 

### **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*

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**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*
- 

**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 inductance*
- 

**Level Three****8 weeks****240 hours**

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**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 wiring diagrams*
  - *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*

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**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*

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**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*
- *explaining the differences between the three types of cabling*
- *emphasizing the additional precautions and technical requirements for installation*
- *utilizing schematic diagrams, and where available, exposing the apprentice to the programming of programmable relays*

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**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*

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**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 connect and 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*
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**Level Four****8 weeks****240 hours**

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**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 and Code Review****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*

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**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*
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**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*
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**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*
  - *explaining the purpose and the use of the B149.3 Gas Code as it relates to domestic applications*
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**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*
  - *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 and grounding*
  - *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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