



# **CURRICULUM OUTLINE**

## **INDUSTRIAL ELECTRICIAN**



# STRUCTURE OF THE CURRICULUM OUTLINE

To facilitate understanding of the occupation, this standard contains the following sections:

**Description of the Industrial Electrician trade:** An overview of the trade's duties, work environment, job requirements, similar occupations and career progression

**Essential Skills Summary:** An overview of how each of the 9 essential skills is applied in this trade

**Trends in the Industrial Electrician trade:** Some of the trends identified by industry as being the most important for workers in this trade

**Task Matrix:** a chart which outlines graphically the major work activities, tasks and sub-tasks of this standard

**Elements of harmonization of apprenticeship training:** includes number of levels of apprenticeship, total training hour and recommended apprenticeship levels

**Sequencing of apprenticeship training topics and related subtasks:** a chart which outlines the model for apprenticeship training sequencing and a cross-reference of the sub-tasks covered by each topic

**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

**Task Descriptor:** a general description of the task

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

**Recommended apprenticeship level:** as part of the interprovincial discussions on harmonization, this is the recommended level of apprenticeship technical training where this sub-task would be trained

**Essential Skills:** The most relevant essential skills for this sub-task

## Knowledge

**Learning Outcomes:** describes what should be learned relating to a sub-task while participating in technical or in-school training

**Learning Objectives:** topics to be covered during technical or in-school training in order to meet the learning outcomes for the sub-task

**Range Variables:** elements that provide a more in-depth description of a term used in the learning outcomes, or learning objectives

**Appendix A – Acronyms:** a list of acronyms used in the standard with their full name

**Appendix B – Tools and Equipment:** a non-exhaustive list of tools and equipment used in this trade

**Appendix C – Glossary:** definitions or explanations of selected technical terms used in the standard

A complete version of the occupational standard, which provides additional detail for the trade activities, skills and knowledge can be found at [www.red-seal.ca](http://www.red-seal.ca)

# DESCRIPTION OF THE INDUSTRIAL ELECTRICIAN TRADE

“Industrial Electrician” is this trade’s official Red Seal occupational title approved by the CCDA. This standard covers tasks performed by an industrial electrician whose occupational title has been identified by some provinces and territories of Canada under the following names:

|                                | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|--------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Electrician (Non-Construction) |    |    |    |    | ■  |    |    |    |    |    |    |    |    |
| Industrial Electrician         | ■  | ■  | ■  | ■  |    | ■  | ■  |    |    | ■  | ■  | ■  |    |

Industrial electricians install, maintain, test, troubleshoot, service and repair industrial electrical equipment and associated electrical controls. These include equipment or components directly or indirectly exposed to electrical power such as motors, generators, pumps and lighting systems. Industrial electricians are employed by electrical contractors and maintenance departments of plants, mines, manufacturing facilities, government, and other industrial establishments.

Industrial electricians must read and interpret prints, drawings and codes for layout and installation of electrical equipment. They install, service and maintain electrical components such as lighting fixtures, switches, conduit and electrical controls. They test electrical systems and continuity of circuits using test equipment to ensure system safety and compatibility. They conduct preventative and predictive maintenance programs and keep maintenance records. Industrial electricians may specialize in maintenance functions in areas such as high voltage and process control.

Industrial electricians must possess manual dexterity, and good planning, organizational and communication skills. They also require strong analytical, mathematical and problem-solving skills in order to read and interpret schematics, drawings and specifications. They should have good mechanical aptitude to install, troubleshoot and repair equipment. It is important for industrial electricians to have a good grasp of digital technology because many of the skills and technology for an industrial electrician are computer based. They must also have good vision and hearing, the ability to distinguish colours and a willingness to upgrade their skills to adapt to new developments in the trade.

The work environment of industrial electricians can expose them to hazards. Their work is performed indoors or outdoors in extreme climate conditions, and may be at variable heights or in confined spaces. Occupational risks include electrical shocks, arc flashes, falls, and injury from lifting and kneeling.

This occupational standard recognizes similarities or overlaps with the work of construction electricians, powerline technicians, instrumentation and control technicians, electric motor systems technicians, heating, ventilation and air conditioning (HVAC) technicians, telecommunications technicians and industrial mechanics (millwrights). Industrial electricians also work with process operators, engineers and inspectors.

With experience, industrial electricians may act as mentors and trainers to apprentices in the trade. They may also advance to managerial, inspection, facilitation or teaching positions.

# 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: <https://www.canada.ca/en/employment-social-development/programs/essential-skills/tools.html>

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

In their daily work, industrial electricians read and comprehend several types of text. These include work orders, safety and workplace documents as well as more complex technical electrical codes, regulations and equipment manuals.

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## DOCUMENT USE

Industrial electricians must use workplace documents such as electrical diagrams and schematic drawings, Safety Data Sheets (SDS) and shift schedules. They must be familiar with electrical codes. It is necessary for industrial electricians to seek service and repair information from manuals and other sources.

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## WRITING

Industrial electricians use writing skills to record comments or notes in logbooks or work records. They write messages to colleagues or management to give work details or reply to requests for technical information. They also write longer service reports to describe problems and their solutions.

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## **ORAL COMMUNICATION**

Industrial electricians use oral communication skills to coordinate work with production crews and equipment operators. Clear communication of technical and complex information is very important to avoid injuries and promote efficiency. Industrial electricians also use communication skills when working with co-workers and supervisors, and mentoring apprentices in the trade. Good listening skills are also required of industrial electricians for comprehension and understanding such as the ability to repeat back clearly what has been stated or learned.

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## **NUMERACY**

Industrial electricians use a range of complex math skills in their day to day work. These include scheduling, measurement, conversions and calculations. They use electrical theory by applying formulas from electrical codes to determine equipment and wiring specifications and to analyze measurements.

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## **THINKING**

Industrial electricians require strong analytical skills to troubleshoot and diagnose malfunctions in equipment. They use logic and memory to determine the faults. They must use decision-making skills to perform work planning and prioritizing. Decisions about when to perform shut-downs have important implications on safety in their workplace.

Industrial electricians organize the most effective use of their time within the framework of assigned tasks. Routine tasks are generally assigned by supervisors or dictated by a procedure established by the employer. Much of their other work is in response to broken or malfunctioning equipment. They often have to re-prioritize tasks several times a day. Industrial electricians coordinate their work with other trades and production staff, all of whom have different needs and priorities.

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## **DIGITAL TECHNOLOGY**

Skills in digital technology are increasingly important for industrial electricians. They use general applications such as e-mails, Internet, word processing, databases and original equipment manufacturer (OEM) software to communicate, perform research, organize their work and configure and update electrical equipment operating parameters. More trade specific applications include computer assisted design (CAD) and computer-aided manufacturing (CAM) software and logic controllers.

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## **WORKING WITH OTHERS**

Industrial electricians work as part of a team that includes other tradespeople and professionals to install, repair and maintain industrial electrical systems and equipment. They most often work independently, coordinating their work with the work of others, but for large jobs they work with a partner or crew.

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## **CONTINUOUS LEARNING**

Industrial electricians often receive in-house safety training to update their certifications such as Workplace Hazardous Materials Information System (WHMIS), transportation of dangerous goods (TDG), First Aid and cardiopulmonary resuscitation (CPR). They also receive training so that they can safely operate equipment such as forklifts, scissor lifts and scaffolding. They learn about new equipment on the job by reading manuals, taking courses and through hands-on experience. They obtain computer training by taking courses off-site and through e-learning.

# TRENDS IN THE INDUSTRIAL ELECTRICIAN TRADE

## Technology

Technological advancements have improved the way industrial electricians perform their work on a daily basis. Digital technology is increasingly being used for research, communication, programming, ordering, record keeping and diagnostics. New types of test equipment, along with equipment becoming more user-friendly, has reduced the time it takes to diagnose and troubleshoot problems. Control and monitoring of electrical equipment is starting to migrate to both wired and wireless technology utilizing the platform of 'internet of things' (IoT).

In the maintenance of industrial electrical equipment and systems, inspection and evaluation is evolving into a more critical area of focus. In fact, inspection is gaining more importance in assuring the health and safety of employees and the continued reliable operation of machinery and components.

Predictive and preventative maintenance programs, using computerized maintenance management systems (CMMSs), are becoming more prevalent in the workplace. These systems have enhanced efficiency and organization of the tasks required for maintenance of electrical systems. They also centralize other functions such as trends, component ordering, project control, history, costing, work hours and tool cribs.

Programmable logic controllers (PLCs) and distributed control systems (DCSs) facilitate the monitoring and control of industrial processes and building controls. This equipment has become more pervasive. Smaller units are readily available for a variety of applications. Human machine interface (HMI) is becoming more integrated to the process control systems. Industrial electricians work increasingly less with hardwired devices.

Reliability centered maintenance and process safety management including safety instrumented systems (SIS) such as safety PLCs, light curtains and area scanners are becoming more common in industry causing a change in focus and duties of industrial electricians.

Digital technology has facilitated the use of new components, making the tracking of energy usage more reliable and efficient. It is simpler to replace many of the old parts and devices now that they are smaller and available in digital format. Data communications has evolved from multiple protocols (data highways, DeviceNet, Modbus) to being harmonized on a global ethernet protocol. Industrial electricians need to constantly upgrade their knowledge of this technology.

Industry in Canada is moving towards efficient and environmentally friendly techniques and energy saving devices such as light emitting diode (LED) lighting, automated lighting control and variable speed drives. Industrial electricians need to be aware of governmental programs and regulations and energy saving initiatives. Industrial electricians may also be involved in the installation and maintenance of renewable energy systems such as solar and wind, and their associated energy storage systems.

In many sectors of industry, robotic technology is being utilized. Therefore, some industrial electricians are now required to develop specialized skills to keep abreast of this new technology.

## **Safety**

The combination of various factors in the presence of a fault may cause an electrocution, arc flash and blast which could result in extreme burns, serious injury or death. Injuries caused by arc flash have led to heightened safety measures. New practices, procedures, safety equipment and jurisdictional regulations have been created and implemented in order to address the issue.

The parameters of work for industrial electricians has increased in process control, environmental control and building control systems. There is now an increased emphasis on accountability for safety in the workplace.



# INDUSTRIAL ELECTRICIAN

## TASK MATRIX

### A - PERFORMS COMMON OCCUPATIONAL SKILLS

|   |  |   |  |
|---|--|---|--|
| <b>Task A-1</b><br>Performs safety-related functions                | <b>A-1.01 Maintains safe work environment</b><br><br><b>1,2,3,4</b>                  | <b>A-1.02 Uses personal protective equipment (PPE) and safety equipment</b><br><br><b>1,2,3,4</b> | <b>A-1.03 Performs lock-out and tag-out procedures</b><br><br><b>1,2,3,4</b> |
|   | <b>A-1.04 Identifies environmental conditions</b><br><br><b>1,2,3,4</b>              |   |  |
| <b>Task A-2</b><br>Uses tools and equipment                         | <b>A-2.01 Uses common and specialty tools and equipment</b><br><br><b>1</b>          | <b>A-2.02 Uses access equipment</b><br><br><b>1</b>   | <b>A-2.03 Uses rigging, hoisting and lifting equipment</b><br><br><b>1</b>   |
|   | <b>A-3.01 Interprets plans, drawings and specifications</b><br><br><b>In context</b> | <b>A-3.02 Identifies hazardous locations</b><br><br><b>In context</b>                             | <b>A-3.03 Organizes materials and supplies</b><br><br><b>In context</b>      |
| <b>Task A-3</b><br>Organizes work                                   | <b>A-3.04 Plans project tasks and procedures</b><br><br><b>In context</b>            | <b>A-3.05 Prepares worksite</b><br><br><b>In context</b>  | <b>A-3.06 Finalizes required documentation</b><br><br><b>In context</b>      |
|   | <b>A-4.01 Fabricates support structures</b><br><br><b>1</b>                          | <b>A-4.02 Installs brackets, hangers and fasteners</b><br><br><b>1</b>                            | <b>A-4.03 Installs seismic restraint systems</b><br><br><b>1</b>             |
| <b>Task A-4</b><br>Fabricates and installs support components       | <b>A-5.01 Commissions systems</b><br><br><b>In context</b>                           | <b>A-5.02 Performs shutdown and startup procedures</b><br><br><b>In context</b>                   | <b>A-5.03 Decommissions systems</b><br><br><b>In context</b>                 |
|   | <b>A-6.01 Uses communication techniques</b><br><br><b>1</b>                          | <b>A-6.02 Uses mentoring techniques</b><br><br><b>4</b>   |  |
| <b>Task A-5</b><br>Commissions and decommissions electrical systems |  |   |  |
| <b>Task A-6</b><br>Uses communication and mentoring techniques      |  |   |  |

## B - INSTALLS AND MAINTAINS GENERATING, DISTRIBUTION AND SERVICE SYSTEMS

|  |   |  |  |
|--|---|--|--|
| <b>Task B-7</b><br>Installs and maintains consumer/supply services and metering equipment        | <b>B-7.01 Installs single-phase consumer/supply services and metering equipment</b><br><br><b>1</b>   | <b>B-7.02 Maintains single-phase consumer/supply services and metering equipment</b><br><br><b>1</b> | <b>B-7.03 Installs three-phase consumer/supply services and metering equipment</b><br><br><b>3</b>   |
|  | <b>B-7.04 Maintains three-phase consumer/supply services and metering equipment</b><br><br><b>3</b>   |  |  |
| <b>Task B-8</b><br>Installs and maintains protection devices                                     | <b>B-8.01 Installs overcurrent protection devices</b><br><br><b>In context</b>                        | <b>B-8.02 Maintains overcurrent protection devices</b><br><br><b>In context</b>                      | <b>B-8.03 Installs ground fault, arc fault and surge protection devices</b><br><br><b>In context</b> |
|  | <b>B-8.04 Maintains ground fault, arc fault and surge protection devices</b><br><br><b>In context</b> | <b>B-8.05 Installs under and over voltage protection devices</b><br><br><b>In context</b>            | <b>B-8.06 Maintains under and over voltage protection devices</b><br><br><b>In context</b>           |
| <b>Task B-9</b><br>Installs and maintains low voltage distribution systems                       | <b>B-9.01 Installs low voltage distribution equipment</b><br><br><b>1</b>                             | <b>B-9.02 Maintains low voltage distribution equipment</b><br><br><b>3</b>                           |  |
| <b>Task B-10</b><br>Installs and maintains power conditioning systems                            | <b>B-10.01 Installs power conditioning systems</b><br><br><b>4</b>                                    | <b>B-10.02 Maintains power conditioning systems</b><br><br><b>4</b>                                  |  |
| <b>Task B-11</b><br>Installs and maintains bonding, grounding and ground fault detection systems | <b>B-11.01 Installs grounding systems</b><br><br><b>2,3</b>   | <b>B-11.02 Maintains grounding systems</b><br><br><b>2,3</b>   | <b>B-11.03 Installs bonding systems</b><br><br><b>2,3</b>  |
|  | <b>B-11.04 Maintains bonding systems</b><br><br><b>2,3</b>  | <b>B-11.05 Installs ground fault detection systems</b><br><br><b>2,3</b>                             | <b>B-11.06 Maintains ground fault detection systems</b><br><br><b>4</b>                              |

|   |   |  |  |
|---|---|--|--|
| <b>Task B-12</b><br><b>Installs and maintains power generating systems</b>                        | <b>B-12.01 Installs alternating current (AC) generating systems</b><br><br><b>3</b>       | <b>B-12.02 Maintains AC generating systems</b><br><br><b>3</b>                             | <b>B-12.03 Installs direct current (DC) generating systems</b><br><br><b>2</b> |
|   | <b>B-12.04 Maintains DC generating systems</b><br><br><b>2</b>                            |  |  |
| <b>Task B-13</b><br><b>Installs and maintains renewable energy generating and storage systems</b> | <b>B-13.01 Installs renewable energy generating and storage systems</b><br><br><b>2,4</b> | <b>B-13.02 Maintains renewable energy generating and storage systems</b><br><br><b>2,4</b> |  |
|   |   |  |  |
| <b>Task B-14</b><br><b>Installs and maintains high voltage systems</b>                            | <b>B-14.01 Installs high voltage systems</b><br><br><b>4</b>                              | <b>B-14.02 Maintains high voltage systems</b><br><br><b>4</b>                              |  |
|   |   |  |  |
| <b>Task B-15</b><br><b>Installs and maintains transformers</b>                                    | <b>B-15.01 Installs extra-low voltage transformers</b><br><br><b>2</b>                    | <b>B-15.02 Maintains extra-low voltage transformers</b><br><br><b>2</b>                    | <b>B-15.03 Installs low voltage single-phase transformers</b><br><br><b>2</b>  |
|   | <b>B-15.04 Maintains low voltage single-phase transformers</b><br><br><b>2</b>            | <b>B-15.05 Installs low voltage three-phase transformers</b><br><br><b>3</b>               | <b>B-15.06 Maintains low voltage three-phase transformers</b><br><br><b>3</b>  |
|   | <b>B-15.07 Installs high voltage transformers</b><br><br><b>3</b>                         | <b>B-15.08 Maintains high voltage transformers</b><br><br><b>3</b>                         |  |
|   |   |  |  |
|   |   |  |  |

## C - INSTALLS AND MAINTAINS WIRING SYSTEMS

|   |  |  |  |
|---|--|--|--|
| <b>Task C-16</b><br>Installs and maintains raceways, cables, conductors and enclosures                            | <b>C-16.01 Installs conductors and cables</b><br><b>1,2</b>                        | <b>C-16.02 Maintains conductors and cables</b><br><b>1,2</b>               | <b>C-16.03 Installs conduit, tubing and fittings</b><br><b>1,2</b>                               |
|   | <b>C-16.04 Installs raceways</b><br><b>1,2</b>                                     | <b>C-16.05 Installs boxes and enclosures</b><br><b>1,2</b>                 | <b>C-16.06 Maintains conduit, tubing, fittings, raceways, boxes and enclosures</b><br><b>1,2</b> |
| <b>Task C-17</b><br>Installs and maintains branch circuitry and devices   | <b>C-17.01 Installs luminaires</b><br><b>1,2,3</b>                                 | <b>C-17.02 Maintains luminaires</b><br><b>1,2,3</b>                        | <b>C-17.03 Installs wiring devices</b><br><b>1,2,3</b>   |
|   | <b>C-17.04 Maintains wiring devices</b><br><b>1,2,3</b>                            |  |  |
| <b>Task C-18</b><br>Installs and maintains heating, ventilation and air-conditioning (HVAC) electrical components | <b>C-18.01 Connects power to HVAC systems and associated equipment</b><br><b>2</b> | <b>C-18.02 Installs HVAC controls</b><br><b>2</b>                          | <b>C-18.03 Maintains HVAC electrical components</b><br><b>2</b>                                  |
| <b>Task C-19</b><br>Installs and maintains electric heating systems and controls                                  | <b>C-19.01 Installs electric heating systems and controls</b><br><b>2</b>          | <b>C-19.02 Maintains electric heating systems and controls</b><br><b>2</b> |  |
| <b>Task C-20</b><br>Installs and maintains exit and emergency lighting systems                                    | <b>C-20.01 Installs exit and emergency lighting systems</b><br><b>2</b>            | <b>C-20.02 Maintains exit and emergency lighting systems</b><br><b>2</b>   |  |
| <b>Task C-21</b><br>Installs and maintains cathodic protection systems  | <b>C-21.01 Installs cathodic protection systems</b><br><b>2</b>                    | <b>C-21.02 Maintains cathodic protection systems</b><br><b>2</b>           |  |

## D - INSTALLS AND MAINTAINS ROTATING AND NON-ROTATING EQUIPMENT AND CONTROL SYSTEMS

|   |  |   |   |
|---|--|---|---|
| <b>Task D-22</b><br>Installs and maintains motor starters and control devices             | <b>D-22.01 Installs motor starters</b><br><b>2,3</b>                               | <b>D-22.02 Maintains motor starters</b><br><b>2,3</b>                               | <b>D-22.03 Installs motor control devices</b><br><b>2,3</b> |
|   | <b>D-22.04 Maintains motor control devices</b><br><b>2,3</b>                       |   |   |
| <b>Task D-23</b><br>Installs and maintains drives   | <b>D-23.01 Installs AC drives</b><br><b>3</b>                                      | <b>D-23.02 Maintains AC drives</b><br><b>3</b>                                      | <b>D-23.03 Installs DC drives</b><br><b>3</b>               |
|   | <b>D-23.04 Maintains DC drives</b><br><b>3</b>                                     |   |   |
| <b>Task D-24</b><br>Installs and maintains non-rotating equipment and associated controls | <b>D-24.01 Installs non-rotating equipment and associated controls</b><br><b>4</b> | <b>D-24.02 Maintains non-rotating equipment and associated controls</b><br><b>4</b> |   |
| <b>Task D-25</b><br>Installs and maintains motors   | <b>D-25.01 Installs single-phase motors</b><br><b>3,4</b>                          | <b>D-25.02 Maintains single-phase motors</b><br><b>3,4</b>                          | <b>D-25.03 Installs three-phase motors</b><br><b>3,4</b>    |
|   | <b>D-25.04 Maintains three-phase motors</b><br><b>3,4</b>                          | <b>D-25.05 Installs DC motors</b><br><b>2,3,4</b>                                   | <b>D-25.06 Maintains DC motors</b><br><b>2,3,4</b>          |

# E - INSTALLS AND MAINTAINS SIGNALLING AND COMMUNICATION SYSTEMS

|  |  |  |   |
|--|--|--|---|
| <b>Task E-26</b><br>Installs and maintains signalling systems          | <b>E-26.01 Installs fire alarm systems</b><br><b>4</b>                 | <b>E-26.02 Maintains fire alarm systems</b><br><b>4</b>          | <b>E-26.03 Installs security and surveillance systems</b><br><b>4</b> |
|  | <b>E-26.04 Maintains security and surveillance systems</b><br><b>4</b> |  |   |
|  | <b>E-27.01 Installs communication systems</b><br><b>1,4</b>            | <b>E-27.02 Maintains communication systems</b><br><b>4</b>       |   |
|  | <b>E-28.01 Installs building automation systems</b><br><b>4</b>        | <b>E-28.02 Maintains building automation systems</b><br><b>4</b> |   |
| <b>Task E-27</b><br>Installs and maintains communication systems       |  |  |   |
| <b>Task E-28</b><br>Installs and maintains building automation systems |  |  |   |

## F - INSTALLS AND MAINTAINS PROCESS CONTROL SYSTEMS

|   |   |  |   |
|---|---|--|---|
| <b>Task F-29</b><br><b>Installs and maintains input/output (I/O) devices</b>              | <b>F-29.01 Installs discrete input/output (I/O) devices</b><br><b>4</b> | <b>F-29.02 Maintains discrete input/output (I/O) devices</b><br><b>4</b> | <b>F-29.03 Installs analog input/output (I/O) devices</b><br><b>4</b> |
|   | <b>F-29.04 Maintains analog input/output (I/O) devices</b><br><b>4</b>  |  |   |
| <b>Task F-30</b><br><b>Installs, programs and maintains automated control systems</b>     | <b>F-30.01 Installs automated control systems</b><br><b>4</b>           | <b>F-30.02 Maintains automated control systems</b><br><b>4</b>           | <b>F-30.03 Programs automated control systems</b><br><b>4</b>         |
|   | <b>F-30.04 Optimizes system performance</b><br><b>4</b>                 |  |   |
| <b>Task F-31</b><br><b>Installs and maintains pneumatic and hydraulic control systems</b> | <b>F-31.01 Installs pneumatic control systems</b><br><b>4</b>           | <b>F-31.02 Maintains pneumatic control systems</b><br><b>4</b>           | <b>F-31.03 Installs hydraulic control systems</b><br><b>4</b>         |
|   | <b>F-31.04 Maintains hydraulic control systems</b><br><b>4</b>          |  |   |

# ELEMENTS OF HARMONIZATION OF APPRENTICESHIP TRAINING

## **1.Trade name**

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

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

The number of levels of technical training recommended for this trade is 4.

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

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



# SEQUENCING OF APPRENTICESHIP TRAINING TOPICS AND RELATED SUBTASKS

These Topic Titles are accompanied by the subtasks and their reference number contained in this Curriculum Outline. The topics in the shaded cells represent those that are covered “in context” with other training.

| <b>Level 1</b>                        | <b>Level 2</b>                              | <b>Level 3</b>                              | <b>Level 4</b>                              |
|---------------------------------------|---|---|---|
| <b>Organizes Work</b>                 | <b>Organizes Work</b>                       | <b>Organizes Work</b>                       | <b>Organizes Work</b>                       |
| Protection Devices                    | Protection Devices                          | Protection Devices                          | Protection Devices                          |
| Plans, Drawings and Specifications    | Plans, Drawings and Specifications          | Plans, Drawings and Specifications          | Plans, Drawings and Specifications          |
|                                       | Support Components                          | Support Components                          | Support Components                          |
|                                       | Raceways, Cables, Conductors and Enclosures | Raceways, Cables, Conductors and Enclosures | Raceways, Cables, Conductors and Enclosures |
| Commissions and Decommissions Systems | Commissions and Decommissions Systems       | Commissions and Decommissions Systems       | Commissions and Decommissions Systems       |

| Level 1  | Level 2   | Level 3   | Level 4   |
|--|---|---|---|
| <p><b>Safety</b></p> <p>1.01 Maintains safe work environment</p> <p>1.02 Uses personal protective equipment (PPE) and safety equipment</p> <p>1.03 Performs lock out and tag out procedures</p> <p>1.04 Identifies environmental conditions.</p> |   |   |   |
| <p><b>Tools and Equipment</b></p> <p>2.01 Uses common and specialty tools and equipment</p> <p>2.02 Uses access equipment</p> <p>2.03 Uses rigging, hoisting and lifting equipment</p>   |   |   |   |
| <p><b>Support Components</b></p> <p>4.01 Fabricates support structures</p> <p>4.02 Installs brackets, hangers and fasteners</p> <p>4.03 Installs seismic restraint systems</p>   |   |   |   |
| <p><b>Communication and Mentoring Techniques</b></p> <p>6.01 Uses communication techniques</p>   |   |   | <p><b>Communication and Mentoring Techniques</b></p> <p>6.02 Uses mentoring techniques</p>                            |
| <p><b>Grounding, Bonding</b></p> <p>11.01 Installs grounding systems</p> <p>11.03 Installs bonding systems</p>   | <p><b>Grounding, Bonding (Single-Phase)</b></p> <p>11.01 Installs grounding systems</p> <p>11.02 Maintains grounding systems</p> <p>11.03 Installs bonding systems.</p> <p>11.04 Maintains bonding systems</p> <p>11.05 Installs ground fault detection systems</p> | <p><b>Grounding, Bonding (Three-Phase)</b></p> <p>11.01 Installs grounding systems</p> <p>11.02 Maintains grounding systems</p> <p>11.03 Installs bonding systems</p> <p>11.04 Maintains bonding systems</p> <p>11.05 Installs ground fault detection systems</p> | <p><b>Grounding, Bonding Ground Fault Detection Systems</b></p> <p>11.06 Maintains ground fault detection systems</p> |

| Level 1  | Level 2  | Level 3  | Level 4 |
|--|--|--|---------|
| <p><b>Raceways, Cables, Conductors and Enclosures</b></p> <p>16.01 Installs conductors and cables</p> <p>16.02 Maintains conductors and cables</p> <p>16.03 Installs conduit, tubing and fittings</p> <p>16.04 Installs raceways</p> <p>16.05 Installs boxes and enclosures</p> <p>16.06 Maintains conduit, tubing, fittings, raceways, boxes and enclosures</p> | <p><b>Raceways, Cables, Conductors and Enclosures</b></p> <p>16.01 Installs conductors and cables</p> <p>16.02 Maintains conductors and cables</p> <p>16.03 Installs conduits, tubing and fittings</p> <p>16.04 Installs raceways.</p> <p>16.05 Installs boxes and enclosures</p> <p>16.06 Maintains conduit, tubing, fittings, raceways, boxes and enclosures</p> |  |         |
| <p><b>Branch Circuitry and Devices (AC/DC introduction)</b></p> <p>17.01 Installs luminaires</p> <p>17.02 Maintains luminaires</p> <p>17.03 Installs wiring devices</p> <p>17.04 Maintains wiring devices</p>  | <p><b>Branch Circuitry and Devices (Single-Phase)</b></p> <p>17.01 Installs luminaires</p> <p>17.02 Maintains luminaires</p> <p>17.03 Installs wiring devices</p> <p>17.04 Maintains wiring devices</p>  | <p><b>Branch Circuitry and Devices (Three-Phase)</b></p> <p>17.01 Installs luminaires</p> <p>17.02 Maintains luminaires</p> <p>17.03 Installs wiring devices</p> <p>17.04 Maintains wiring devices</p>   |         |
| <p><b>Consumer/Supply Services and Metering Equipment (Single-Phase)</b></p> <p>7.01 Installs single-phase consumer/supply services and metering equipment</p> <p>7.02 Maintains single-phase consumer/supply services and metering equipment</p>  |  | <p><b>Consumer/Supply Services and Metering Equipment (Three-Phase)</b></p> <p>7.03 Installs three-phase consumer/supply services and metering equipment</p> <p>7.04 Maintains three-phase consumer/supply services and metering equipment</p> |         |
| <p><b>Distribution Equipment (Single-Phase)</b></p> <p>9.01 Installs low-voltage distribution equipment</p>  |  | <p><b>Distribution Equipment (Three-Phase)</b></p> <p>9.02 Maintains low voltage distribution equipment</p>  |         |
|  | <p><b>Power Generating Systems (DC)</b></p> <p>12.03 Installs DC (direct current) generating systems</p> <p>12.04 Maintains DC generating systems</p>  | <p><b>Power Generating Systems (AC)</b></p> <p>12.01 Installs AC (alternating current) generating systems</p> <p>12.02 Maintains AC generating systems</p>   |         |

| Level 1 | Level 2   | Level 3  | Level 4   |
|---------|---|--|---|
|         | <p><b>Transformers (Single-Phase)</b></p> <p>15.01 Installs extra-low voltage transformers<br/>           15.02 Maintains extra-low voltage transformers<br/>           15.03 Installs low voltage single-phase transformers<br/>           15.04 Maintains low voltage single-phase transformers</p> | <p><b>Transformers (Three-Phase)</b></p> <p>15.05 Installs low voltage three-phase transformers<br/>           15.06 Maintains low voltage three-phase transformers<br/>           15.07 Installs high voltage transformers<br/>           15.08 Maintains high voltage transformers</p> |   |
|         | <p><b>Exit and Emergency Lighting Systems</b></p> <p>20.01 Installs exit and emergency lighting<br/>           20.02 Maintains exit and emergency lighting systems</p>  |  |   |
|         | <p><b>Cathodic Protection Systems</b></p> <p>21.01 Installs cathodic protection systems<br/>           21.02 Maintains cathodic protection systems</p>  |  |   |
|         |   |  | <p><b>Signaling Systems</b></p> <p>26.01 Installs fire alarm systems<br/>           26.02 Maintains fire alarm systems<br/>           26.03 Installs security and surveillance systems<br/>           26.04 Maintains security and surveillance systems</p> |
|         | <p><b>Electric Heating Systems and Controls</b></p> <p>19.01 Installs electric heating systems and controls<br/>           19.02 Maintains electric heating systems and controls</p>  |  |   |
|         | <p><b>Heating, Ventilation and Air Conditioning (HVAC)</b></p> <p>18.01 Connects power to HVAC systems and associated equipment<br/>           18.02 Installs HVAC controls<br/>           18.03 Maintains HVAC electrical components</p>   |  |   |

| Level 1 | Level 2  | Level 3  | Level 4  |
|---------|--|--|--|
|         | <p><b>Motor Starters and Controls</b><br/>           22.01 Installs motor starters.<br/>           22.02 Maintains motor starters<br/>           22.03 Installs motor control devices<br/>           22.04 Maintains motor control devices</p> | <p><b>Motor Starters and Controls</b><br/>           22.01 Installs motor starters<br/>           22.02 Maintains motor starters<br/>           22.03 Installs motor control devices<br/>           22.04 Maintains motor control devices</p>  |  |
|         |  |  | <p><b>Non-Rotating Equipment and Controls</b><br/>           24.01 Installs non-rotating equipment and associated controls<br/>           24.02 Maintains non-rotating equipment and associated controls</p>   |
|         | <p><b>Motors (DC)</b><br/>           25.05 Installs DC motors<br/>           25.06 Maintains DC motors</p>   | <p><b>Motors (Single-Phase and Three-Phase)</b><br/>           25.01 Installs single-phase motors<br/>           25.02 Maintains single-phase motors<br/>           25.03 Installs three-phase motors<br/>           25.04 Maintains three-phase motors<br/>           25.05 Installs DC motors<br/>           25.06 Maintains DC motors</p> | <p><b>Motors (Install/Maintain)</b><br/>           25.01 Installs single-phase motors<br/>           25.02 Maintains single-phase motors<br/>           25.03 Installs three-phase motors<br/>           25.04 Maintains three-phase motors<br/>           25.05 Installs DC motors<br/>           25.06 Maintains DC motors</p> |
|         |  | <p><b>(Motor) Drives</b><br/>           23.01 Installs AC drives<br/>           23.02 Maintains AC drives<br/>           23.03 Installs DC drives<br/>           23.04 Maintains DC drives</p>   |  |
|         |  |  | <p><b>High Voltage Systems</b><br/>           14.01 Installs high voltage, equipment<br/>           14.02 Maintains high voltage systems</p>   |
|         |  |  | <p><b>Power Conditioning Systems</b><br/>           10.01 Installs power conditioning systems<br/>           10.02 Maintains power conditioning systems</p>  |

| Level 1  | Level 2  | Level 3 | Level 4  |
|--|--|---------|--|
| <p><b>Communication Systems</b><br/>27.01 Installs communication systems</p> | <p><b>Renewable Energy Generating and Storage Systems</b><br/>13.01 Installs renewable energy systems<br/>13.02 Performs servicing and maintenance of renewable energy</p> |         | <p><b>Renewable Energy Generating and Storage Systems</b><br/>13.01 Installs renewable energy systems<br/>13.02 Performs servicing and maintenance of renewable energy systems</p>   |
|  |  |         | <p><b>Communication Systems</b><br/>27.01 Installs communication systems<br/>27.02 Maintains communications systems</p>  |
|  |  |         | <p><b>Building Automation Systems</b><br/>28.01 Installs building automation systems<br/>28.02 Maintains building automation systems</p>   |
|  |  |         | <p><b>Input / Output Field Devices</b><br/>29.01 Installs discrete input/output devices<br/>29.02 Maintains discrete input/output devices<br/>29.03 Installs analog input/output devices<br/>29.04 Maintains analog input/output devices</p> |
|  |  |         | <p><b>Automated Control Systems</b><br/>30.01 Installs automated control systems<br/>30.02 Maintains automated control systems<br/>30.03 Programs automated control systems<br/>30.04 Optimizes system performance</p>                       |

**Level 1**

**Level 2**

**Level 3**

**Level 4**

**Pneumatic and Hydraulic Control Systems**

- 31.01 Installs pneumatic control systems
- 31.02 Maintains pneumatic control systems
- 31.03 Installs hydraulic control systems
- 31.04 Maintains hydraulic control systems

# MAJOR WORK ACTIVITY A

## Performs common occupational skills

### TASK A-1 Performs safety-related functions

#### TASK DESCRIPTOR

Industrial electricians are responsible for ensuring the safety of themselves and others in the work environment. They must use appropriate personal protective equipment (PPE) and follow workplace safety protocols according to their work, company, client and jurisdictional regulations.

It is critical that industrial electricians be constantly aware of their surroundings and the hazards they may encounter. They are required to perform lock-out and tag-out. Industrial electricians must ensure that equipment follows CEC and AHJ when installed in environmentally adverse and hazardous locations. Industrial electricians need to be aware and follow proper disposal methods for environmentally hazardous materials.

#### A-1.01 Maintains safe work environment

|                      |         |
|----------------------|---------|
| Apprenticeship Level | 1,2,3,4 |
|----------------------|---------|

|                  |  |
|------------------|--|
| Essential Skills | Thinking, Document Use, Oral Communication |
|------------------|--|

#### KNOWLEDGE

|            | Learning Outcomes   | Learning Objectives   |
|------------|---|---|
| A-1.01.01L | demonstrate knowledge of safe work practices  | identify <b>hazards</b> and describe safe work practices  |
|            |   | describe the procedures used in <b>emergency situations</b>   |
| A-1.01.02L | demonstrate knowledge of regulatory requirements pertaining to <b>hazards</b> and <b>emergency situations</b> | identify and interpret the regulatory requirements pertaining to <b>hazards</b> and <b>emergency situations</b> |
| A-1.01.03L | demonstrate knowledge of containment methods  | describe containment methods for <b>hazardous materials</b>   |

#### RANGE OF VARIABLES

**hazards** include: arc flashes/blasts, liquid spills (flammable, corrosive, toxic), electric shocks, designated substance (asbestos, mercury, lead, silica), combustible dust, radiation, open holes, confined space, fire, tripping hazards, overhead work, working at heights, hazardous locations as defined by the CEC

**emergency situations** include: explosions, fire, hazardous product release

**hazardous materials** include: PCB, mercury, CFC, asbestos



**A-1.02****Uses personal protective equipment (PPE) and safety equipment**

|                             |   |
|-----------------------------|---|
| <b>Apprenticeship Level</b> | 1,2,3,4                                     |
| <b>Essential Skills</b>     | Thinking, Document Use, Continuous Learning |

**KNOWLEDGE**

|            | <b>Learning Outcomes</b>  | <b>Learning Objectives</b>   |
|------------|---|--|
| A-1.02.01L | demonstrate knowledge of <b>PPE</b> and <b>safety equipment</b> , their <b>applications</b> , maintenance, storage and procedures for use | identify types of <b>PPE</b> and <b>safety equipment</b>   |
|            |   | describe <b>applications</b> and limitations of <b>PPE</b> and <b>safety equipment</b>                       |
|            |   | describe the procedures used to care for, inspect, maintain and store <b>PPE</b> and <b>safety equipment</b> |
| A-1.02.02L | demonstrate knowledge of regulatory requirements pertaining to <b>PPE</b> and <b>safety equipment</b>                                     | identify and interpret the regulatory requirements and responsibilities                                      |

**RANGE OF VARIABLES**

**PPE** includes: shock hazard PPE, arc flash hazard PPE, hard hats, safety glasses, safety footwear, gloves, hearing protection

**safety equipment** includes: fall protection (fall arrest and fall restraint), confined space equipment, respiratory protection, tag-out and lock-out equipment, fire extinguishers, first aid equipment, eye wash stations, signage, fume and toxic gas detectors

**applications** include: hazardous locations, height, confined space

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**A-1.03** Performs lock-out and tag-out procedures

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|                             |   |
|-----------------------------|---|
| <b>Apprenticeship Level</b> | 1,2,3,4   |
| <b>Essential Skills</b>     | Thinking, Oral Communication, Working with Others |

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**KNOWLEDGE**

|            | <b>Learning Outcomes</b>   | <b>Learning Objectives</b>  |
|------------|--|---|
| A-1.03.01L | demonstrate knowledge of lock-out and tag-out procedures and legislation governing minimum standards | describe lock-out and tag-out procedures and legislation  |
| A-1.03.02L | demonstrate knowledge of safety checks of equipment  | describe safety checks to be performed to ensure zero energy state  |
| A-1.03.03L | demonstrate knowledge of procedures for voltage testing  | describe how to determine if the testing equipment to be used is matched to the voltage and energy rating |

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**A-1.04** Identifies environmental conditions

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|                             |                                 |
|-----------------------------|---------------------------------|
| <b>Apprenticeship Level</b> | 1,2,3,4                         |
| <b>Essential Skills</b>     | Reading, Document Use, Thinking |

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**KNOWLEDGE**

|            | <b>Learning Outcomes</b>   | <b>Learning Objectives</b>  |
|------------|--|---|
| A-1.04.01L | demonstrate knowledge of <b>environmental conditions</b> and installation procedures | identify types of <b>environmental conditions</b> and describe safe work procedures                       |
|            |  | identify equipment designed for installation and operation in areas according to environmental conditions |
|            |  | identify and describe wiring procedures and methods for areas according to environmental conditions       |

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**RANGE OF VARIABLES**

**environmental conditions** include: wet, dusty, icy, corrosive, hot and cold temperatures

## TASK A-2 Uses tools and equipment

### TASK DESCRIPTOR

Industrial electricians must be able to select, use and maintain tools and equipment in a safe and effective manner relevant to the task being performed.

#### A-2.01 Uses common and specialty tools and equipment

|                      |   |
|----------------------|---|
| Apprenticeship Level | 1   |
| Essential Skills     | Thinking, Document Use, Continuous Learning |

#### KNOWLEDGE

|            | Learning Outcomes   | Learning Objectives  |
|------------|---|--|
| A-2.01.01L | demonstrate knowledge of <b>tools and equipment</b> , their applications and procedures for use | identify types of <b>tools and equipment</b> and describe their applications and procedures for use                  |
|            |   | describe operating and maintenance procedures of <b>tools and equipment</b> according to manufacturers' requirements |
| A-2.01.02L | demonstrate knowledge of inspection procedures  | describe the procedures used to inspect <b>tools and equipment</b>   |
| A-2.01.03L | demonstrate knowledge of limitations and ratings of electrical measuring equipment              | describe limitations of measuring equipment and identify measuring equipment for task at hand                        |
|            |   | identify the categories of electrical measuring equipment  |
| A-2.01.04L | demonstrate knowledge of certification requirements to operate powder-actuated tools            | describe certification requirements to use powder-actuated tools   |

### RANGE OF VARIABLES

**tools and equipment** include: standard hand tools, power tools and equipment, specialty tools and equipment, measuring equipment

## A-2.02 Uses access equipment

|                      |                                 |
|----------------------|---------------------------------|
| Apprenticeship Level | 1                               |
| Essential Skills     | Thinking, Document Use, Reading |

### KNOWLEDGE

|            | Learning Outcomes   | Learning Objectives   |
|------------|---|---|
| A-2.02.01L | demonstrate knowledge of <b>access equipment</b> , their applications, limitations and procedures for use | identify types of <b>access equipment</b> and describe their characteristics and applications                 |
|            |   | identify hazards and describe safe work practices pertaining to <b>access equipment</b>                       |
|            |   | describe the procedures used to erect and dismantle ladders and scaffolding, according to AHJ                 |
|            |   | describe the procedures used to inspect, maintain and store <b>access equipment</b>                           |
|            |   | identify certification for use of <b>access equipment</b>   |
| A-2.02.02L | demonstrate knowledge of <b>regulatory requirements</b> pertaining to <b>access equipment</b>             | identify and interpret the regulatory requirements and responsibilities pertaining to <b>access equipment</b> |

### RANGE OF VARIABLES

**access equipment** includes: ladders, scissor-lifts, scaffoldings, articulating booms and fall protection (fall arrest and fall restraint)

**regulatory requirements** include: inspection documentation, training and certification

## A-2.03 Uses rigging, hoisting and lifting equipment

|                      |   |
|----------------------|---|
| Apprenticeship Level | 1                                       |
| Essential Skills     | Thinking, Working with Others, Numeracy |

### KNOWLEDGE

|            | Learning Outcomes  | Learning Objectives   |
|------------|--|---|
| A-2.03.01L | demonstrate knowledge of hoisting, lifting and rigging equipment, their applications, limitations and procedures for use | identify types of rigging equipment and accessories and describe their applications and procedures for use              |
|            |  | identify types of hoisting and lifting equipment and accessories and describe their applications and procedures for use |

|            |   |   |
|------------|---|---|
|            |   | identify <b>potential hazards</b> and describe safe work practices pertaining to hoisting, lifting and rigging          |
|            |   | describe the procedures used to inspect, maintain and store hoisting, lifting and rigging equipment                     |
| A-2.03.02L | demonstrate knowledge of <b>regulatory requirements</b> pertaining to hoisting, lifting and rigging equipment | identify and interpret codes and regulations pertaining to hoisting, lifting and rigging                                |
| A-2.03.03L | demonstrate knowledge of basic hoisting and lifting operations  | identify types of knots, hitches, splices and bends and describe their applications and the procedures used to tie them |
|            |   | describe the <b>considerations</b> when rigging material/equipment for lifting  |
|            |   | identify and describe <b>procedures used to communicate</b> during hoisting, lifting and rigging operations             |

## RANGE OF VARIABLES

**potential hazards** include: overhead hazards, overhead power hazards, dropped loads, damaged rigging hardware, congested worksites, confined spaces, trenches, uneven surfaces, weather conditions

**regulatory requirements** include: inspection documentation, training, certification

**considerations** include: load characteristics, working load limit (WLL), equipment and accessories, environmental factors, anchor points, sling angles

**procedures used to communicate** include: hand signals, electronic communications, audible/visual

## TASK A-3 Organizes work

### TASK DESCRIPTOR

Industrial electricians organize projects in order to safely and efficiently use material, labour, tools and equipment. They interpret drawings, plans and specifications to identify required resources. Prior to starting they must plan their tasks, identify environmental conditions, identify hazardous locations, prepare the worksite and organize the materials and supplies needed. Industrial electricians must document their work, prepare as-built drawings and operations and maintenance (O&M) manuals.

#### A-3.01 Interprets plans, drawings and specifications

|                      |                                 |
|----------------------|---------------------------------|
| Apprenticeship Level | In context                      |
| Essential Skills     | Document Use, Reading, Numeracy |

#### KNOWLEDGE

|            | Learning Outcomes   | Learning Objectives  |
|------------|---|--|
| A-3.01.01L | demonstrate knowledge of <b>drawings, schematics and specifications</b> and their applications                              | identify types of <b>drawings, schematics and specifications</b> , and describe their applications<br><br>identify documentation requirements for modifying drawings and specifications<br><br>describe the procedures used to document changes made to equipment and wiring |
| A-3.01.02L | demonstrate knowledge of imperial and système international (SI) units in trade documentation                               | interpret imperial and SI units of measurement<br><br>convert between SI and imperial units of measurement   |
| A-3.01.03L | demonstrate knowledge of interpreting and extracting <b>information</b> from <b>drawings, schematics and specifications</b> | interpret and extract <b>information</b> from <b>drawings, schematics and specifications</b>   |

#### RANGE OF VARIABLES

**drawings, schematics and specifications** include: civil/site, architectural, mechanical, structural, electrical, shop, sketches, as-builts, logic, single line

**information** includes: elevations, scales, legends, symbols and abbreviations, notes and specifications, addendums, Construction Specifications Canada (CSC) Specifications

## A-3.02 Identifies hazardous locations

|                      |                                 |
|----------------------|---------------------------------|
| Apprenticeship Level | In context                      |
| Essential Skills     | Document Use, Thinking, Reading |

### KNOWLEDGE

|            | Learning Outcomes  | Learning Objectives   |
|------------|--|---|
| A-3.02.01L | demonstrate knowledge of <b>hazardous locations</b>                | identify types of <b>hazardous locations</b> and describe safe work procedures  |
|            |  | identify types of potentially hazardous materials present and the procedures to designate an area to be a <b>hazardous location</b> |
|            |  | identify equipment and fittings designed for installation and operation in <b>hazardous locations</b>                               |
| A-3.02.02L | demonstrate knowledge of <b>hazardous locations</b> wiring methods | identify and describe wiring methods in <b>hazardous locations</b>  |

### RANGE OF VARIABLES

**hazardous locations** may contain: explosive gas, explosive and combustible dust, combustible fibers and flyings

## A-3.03 Organizes materials and supplies

|                      |                                 |
|----------------------|---------------------------------|
| Apprenticeship Level | In context                      |
| Essential Skills     | Document Use, Reading, Numeracy |

### KNOWLEDGE

|            | Learning Outcomes  | Learning Objectives  |
|------------|--|--|
| A-3.03.01L | demonstrate knowledge of the procedures used to plan and organize <b>materials</b> and <b>supplies</b> | identify <b>sources of information</b> relevant to organize <b>materials</b> and <b>supplies</b> |
|            |  | describe the <b>considerations</b> to organize <b>materials</b> and <b>supplies</b>              |

## RANGE OF VARIABLES

**materials** include: wires and cables, luminaires, panel boards, starters and contactors, transformers, distribution equipment, fittings, raceways, support hardware, wire connectors, fasteners

**supplies** (consumables) include: pulling compounds, tape, thread compounds

**sources of information** include: drawings, specifications, company, client and manufacturer requirements, SDS

**considerations** include: available space, schedule, storage location

### A-3.04 Plans project tasks and procedures

**Apprenticeship Level** In context

**Essential Skills** Thinking, Document Use, Working with Others

#### KNOWLEDGE

##### Learning Outcomes

##### Learning Objectives

|            |   |  |
|------------|---|--|
| A-3.04.01L | demonstrate knowledge of the procedures used to plan and organize job tasks | identify <b>sources of information</b> relevant to planning job tasks and procedures |
|            |   | describe the <b>considerations</b> to plan and organize job tasks and procedures     |
|            |   | describe the function of project schedule tools                                      |

## RANGE OF VARIABLES

**sources of information** include: drawings, specifications, company, client and manufacturer requirements

**considerations** include: available space, schedule/sequence, permits, hazards assessment, personnel, tools and equipment, materials and supplies, storage location

### A-3.05 Prepares worksite

**Apprenticeship Level** In context

**Essential Skills** Thinking, Document Use, Reading

#### KNOWLEDGE

##### Learning Outcomes

##### Learning Objectives

|            |  |   |
|------------|--|---|
| A-3.05.01L | demonstrate knowledge of the procedures used to prepare worksite | identify <b>sources of information</b> relevant to prepare worksite |
|            |  | identify <b>potential hazards</b> relevant to prepare worksite      |



|            |  |  |
|------------|--|--|
|            |  | describe the <b>considerations</b> to prepare worksite   |
| A-3.05.02L | demonstrate knowledge of the procedures used to locate <b>elements</b> | identify types of surveying equipment used to locate <b>elements</b> in concrete walls and floors, slab on grade and direct buried |
|            |  | describe the safety requirements taken when x-ray surveying equipment is used  |

## RANGE OF VARIABLES

**sources of information** include: drawings, specifications, AHJ, company, client and manufacturer requirements

**potential hazards** include: confined spaces and trenches, overhead hazards, uneven ground, high traffic area, elevated work areas

**considerations** include: available space, schedule/sequence, permits, hazards assessment, personnel, tools and equipment, materials and supplies, storage location

**elements** include: conduits, heating cables, pipes, reinforcement bar, post-tensioned cables, utility services

## A-3.06 Finalizes required documentation

|                             |                                 |
|-----------------------------|---------------------------------|
| <b>Apprenticeship Level</b> | In context                      |
| <b>Essential Skills</b>     | Document Use, Writing, Thinking |

### KNOWLEDGE

|            | Learning Outcomes  | Learning Objectives  |
|------------|--|--|
| A-3.06.01L | demonstrate knowledge of <b>documentation</b> , its purpose, application and use | describe and identify types of <b>documentation</b> developed from tasks |
|            |  | describe procedures for finalizing <b>documentation</b>                  |

## RANGE OF VARIABLES

**documentation** includes: meeting records, manufacturers' specifications, as-built drawings (civil/site, architectural, mechanical, structural, shop, electrical, single line), sketches, logic diagram

## TASK A-4 Fabricates and installs support components

### TASK DESCRIPTOR

Industrial electricians fabricate support structures to protect and support electrical equipment and components. They use various methods to secure equipment to structures in order to maintain a safe installation, and reduce hazards and unwanted movements. Seismic restraint systems are used as a secondary support when required.

#### A-4.01 Fabricates support structures

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 1                                |
| Essential Skills     | Numeracy, Document Use, Thinking |

#### KNOWLEDGE

|            | Learning Outcomes   | Learning Objectives   |
|------------|---|---|
| A-4.01.01L | demonstrate knowledge of interpreting, creating and extracting information from sketches, drawings and specifications | create, interpret and extract information from sketches, drawings and specifications                                  |
|            |   | identify support <b>materials</b> , their characteristics and application   |
|            |   | identify <b>fasteners</b> , their characteristics and application according to job specifications and site conditions |
| A-4.01.02L | demonstrate knowledge of procedures for fabricating support structures  | describe procedures used to fabricate support structures  |

### RANGE OF VARIABLES

**materials** include: wood, steel, aluminum

**fasteners** include: screws, straps, inserts, nuts, bolts, anchors, wedge clamps, seismic restraints, insulators

---

**A-4.02**   **Installs brackets, hangers and fasteners**

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|                             |                                  |
|-----------------------------|----------------------------------|
| <b>Apprenticeship Level</b> | 1                                |
| <b>Essential Skills</b>     | Document Use, Thinking, Numeracy |

---

**KNOWLEDGE**

|            | <b>Learning Outcomes</b>   | <b>Learning Objectives</b>  |
|------------|--|---|
| A-4.02.01L | demonstrate knowledge of <b>brackets</b> , <b>hangers</b> and <b>fasteners</b> , their applications, and their use | identify types of <b>brackets</b> , <b>hangers</b> and <b>fasteners</b> , their characteristics and application   |
|            |  | describe procedures for securing <b>brackets</b> , <b>hangers</b> and <b>fasteners</b> to structure   |
|            |  | identify <b>building materials</b> , their characteristics and application  |
| A-4.02.02L | demonstrate knowledge of measurement and layout techniques   | identify measurement and layout techniques to ensure <b>brackets</b> , <b>hangers</b> and <b>fasteners</b> are positioned and mounted according to job specifications, company, client, manufacturer and CEC requirements |

---

**RANGE OF VARIABLES**

**brackets** include: angle brackets, T brackets, L brackets, floor brackets, ceiling brackets

**hangers** include: trapezes, pipe clamps, beam clamps

**fasteners** include: spring nuts, bolts, screws, concrete anchors

**building materials** include: steel, concrete, brick, block, wood

## A-4.03 Installs seismic restraint systems

|                      |                                 |
|----------------------|---------------------------------|
| Apprenticeship Level | 1                               |
| Essential Skills     | Document Use, Reading, Thinking |

### KNOWLEDGE

|            | Learning Outcomes  | Learning Objectives   |
|------------|--|---|
| A-4.03.01L | demonstrate knowledge of <b>seismic restraint systems</b> , their applications and their use | identify types of <b>seismic restraint systems</b> , their characteristics and limitations  |
|            |  | describe procedures for mounting and securing <b>seismic restraint systems</b> to structure |
|            |  | identify materials to be installed  |

### RANGE OF VARIABLES

**seismic restraint systems** include: chains, cables, rods, wire rope

## TASK A-5 Commissions and decommissions electrical systems

### TASK DESCRIPTOR

Industrial electricians commission electrical systems to ensure safe and intended operation. Commissioning of electrical systems may require liaison with equipment manufacturers and health and safety committees. Industrial electricians also shut down and start up systems to perform maintenance or to replace defective equipment. They decommission systems to prepare them for removal and dispose of components according to codes and standards.

## A-5.01 Commissions systems

|                      |   |
|----------------------|---|
| Apprenticeship Level | In context                                  |
| Essential Skills     | Thinking, Working with Others, Document Use |

### KNOWLEDGE

|            | Learning Outcomes                                      | Learning Objectives   |
|------------|--|---|
| A-5.01.01L | demonstrate knowledge of commissioning and its purpose | identify <b>hazards</b> and describe safe work practices pertaining to commissioning systems or equipment |
|            |  | identify the purpose of commissioning and the types of systems and equipment requiring them               |

---

identify and interpret **information sources** and **documentation** pertaining to the commissioning of systems or equipment

---

identify **diagnostic and test equipment** for the purpose of commissioning systems

---

## RANGE OF VARIABLES

**hazards** include: arc flash/blast, moving and rotating equipment, electric shocks, potential

**information sources** include: O&M manuals, single line diagrams, schematics, panel schedules, CEC Z460, Z320, Z462 and Z463

**diagnostic and test equipment** includes: multimeters, voltage testers, ammeters, oscilloscopes, power quality analyzers, hi-pot testers, thermographic imaging devices, phase/motor rotation meters, insulation resistance testers, ground loop testers

**documentation** includes: AHJ reports, inspection reports, as-built drawings, panel schedules, site visit log, commissioning documents, design and manufacturers' specifications

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## A-5.02 Performs shutdown and startup procedures

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|                             |   |
|-----------------------------|---|
| <b>Apprenticeship Level</b> | In context                                  |
| <b>Essential Skills</b>     | Document Use, Thinking, Working with Others |

---

### KNOWLEDGE

|            | Learning Outcomes  | Learning Objectives  |
|------------|--|--|
| A-5.02.01L | demonstrate knowledge of shutdown and startup procedures and their purpose | <p>identify <b>hazards</b> and describe safe work practices pertaining to starting up and shutting down systems or equipment</p> <p>identify the purpose of starting up and shutting down and the types of systems and equipment requiring it</p> <p>identify and interpret <b>information sources</b> and documentation pertaining to the starting up and shutting down of systems or equipment</p> |

---

## RANGE OF VARIABLES

**hazards** include: arc flash/blast, moving and rotating equipment, electric shocks, uncontrolled release of energy

**information sources** include: O&M manuals, single line diagrams, schematics, panel schedules, CEC Z460, Z320, Z462 and Z463, AHJ

**A-5.03****Decommissions systems**

|                             |   |
|-----------------------------|---|
| <b>Apprenticeship Level</b> | In context                                  |
| <b>Essential Skills</b>     | Thinking, Working with Others, Document Use |

**KNOWLEDGE**

|            | <b>Learning Outcomes</b>                                 | <b>Learning Objectives</b>   |
|------------|--|--|
| A-5.03.01L | demonstrate knowledge of decommissioning and its purpose | identify <b>hazards</b> and describe safe work practices pertaining to decommissioning systems or equipment                                  |
|            |  | identify <b>energy sources</b> used in system or equipment being decommissioned  |
|            |  | identify the purpose of decommissioning and the types of systems and equipment requiring them  |
|            |  | identify, interpret and modify <b>information sources</b> and <b>documentation</b> pertaining to the decommissioning of systems or equipment |
|            |  | identify <b>diagnostic and test equipment</b> for the purpose of decommissioning systems   |

**RANGE OF VARIABLES**

**hazards** include: arc flash/blast, moving and rotating equipment, electric shocks

**information sources** include: O&M manuals, single line diagrams, schematics, panel schedules, CEC Z460, Z320, Z462 and Z463

**diagnostic and test equipment** includes: multimeters, voltage testers, thermographic imaging devices, Geiger counter

**documentation** includes: AHJ reports, inspection reports, as-built drawings, panel schedules, site visit log, commissioning documents, design and manufacturers' specifications

**energy sources** include: electrical, kinetic, mechanical, radio-active, thermal, hydraulic, pneumatic, gravity

## TASK A-6 Uses communication and mentoring techniques

### TASK DESCRIPTOR

Learning in the trades is done primarily in the workplace with tradespeople passing on their skills and knowledge to apprentices, as well as sharing knowledge among themselves. Apprenticeship is, and always has been about mentoring – learning workplace skills and passing them on. Because of the importance of this to the trade, this task covers the activities related to communication in the workplace and mentoring skills.

#### A-6.01 Uses communication techniques

|                             |  |
|-----------------------------|--|
| <b>Apprenticeship Level</b> | 1  |
| <b>Essential Skills</b>     | Oral Communication, Working with Others, Continuous Learning, Digital Technology |

#### KNOWLEDGE

|            | Learning Outcomes  | Learning Objectives  |
|------------|--|--|
| A-6.01.01L | demonstrate knowledge of trade terminology                 | define terminology used in the trade   |
| A-6.01.02L | demonstrate knowledge of effective communication practices | describe the importance of using effective verbal and non-verbal communication with <b>people in the workplace</b> |
|            |  | identify <b>sources of information</b> to effectively communicate  |
|            |  | identify communication and <b>learning styles</b>  |
|            |  | identify <b>personal responsibilities and attitudes</b> that contribute to on-the-job success                      |
|            |  | identify communication that constitutes <b>harassment</b> and <b>discrimination</b>                                |

## RANGE OF VARIABLES

**people in the workplace** include: other tradespeople, colleagues, apprentices, supervisors, clients, AHJ, manufacturers

**sources of information** include: regulations, codes, occupational health and safety requirements, AHJ requirements, prints, drawings, specifications, company and client documentation

**learning styles** include: seeing it, hearing it, trying it

**personal responsibilities and attitudes** include: asking questions, working safely, accepting constructive feedback, time management and punctuality, respect for authority, good stewardship of materials, tools and property, efficient work practice

**harassment** includes: objectionable conduct, comment or display made either on a one-time or continuous basis that demeans, belittles, or causes personal humiliation or embarrassment to the recipient

**discrimination** is prohibited based on: race, national or ethnic origin, colour, religion, age, sex, sexual orientation, marital status, family status, disability or conviction for which a pardon has been granted

### A-6.02 Uses mentoring techniques

|                      |  |
|----------------------|--|
| Apprenticeship Level | 4  |
| Essential Skills     | Oral Communication, Working with Others, Continuous Learning |

#### KNOWLEDGE

|            | Learning Outcomes   | Learning Objectives  |
|------------|---|--|
| A-6.02.01L | identify, explain and demonstrate strategies for learning skills in the workplace | describe the importance of individual experience   |
|            |   | describe the shared responsibilities for workplace learning                                  |
|            |   | determine one's own learning preferences and explain how these relate to learning new skills |
|            |   | describe the importance of different types of skills in the workplace                        |
|            |   | describe the importance of <b>essential skills</b> in the workplace                          |
|            |   | identify different ways of learning  |
|            |   | identify different <b>learning needs</b> and strategies to meet <b>learning needs</b>        |
|            |   | identify <b>strategies to assist in learning a skill</b>                                     |
| A-6.02.02L | identify, explain and demonstrate <b>strategies for teaching</b> workplace skills | identify different roles played by a workplace mentor  |
|            |   | describe the <b>steps</b> involved in teaching skills  |



|  |  |
|--|--|
|  | explain the importance of identifying the point of a lesson            |
|  | identify how to choose a good time to present a lesson                 |
|  | explain the importance of linking the lessons                          |
|  | identify the components of the skill (the context)                     |
|  | describe considerations in setting up opportunities for skill practice |
|  | explain the importance of providing feedback                           |
|  | identify techniques for giving effective feedback                      |
|  | describe a skills assessment   |
|  | identify methods of assessing progress                                 |
|  | explain how to adjust a lesson to different situations                 |

## RANGE OF VARIABLES

**essential skills** are: reading, writing, document use, oral communication, numeracy, thinking, working with others, digital technology, continuous learning

**learning needs** include: learning disabilities, learning preferences, language proficiency

**strategies to assist in learning a skill** include: understanding the basic principles of instruction, developing coaching skills, being mature and patient, providing feedback

**steps for teaching skills** include: identifying the point of the lesson, linking the lesson, demonstrating the skill, providing practice, giving feedback, assessing skills and progress

# MAJOR WORK ACTIVITY B

## Installs and maintains generating, distribution and service systems

### TASK B-7 Installs and maintains consumer/supply services and metering equipment

#### TASK DESCRIPTOR

Service entrance equipment provides power for single-phase and three-phase electrical systems and equipment. Consumer services can provide normal, emergency and temporary power. This equipment allows for the safe utilization of electricity.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

Industrial electricians maintain single-phase and three-phase consumer/supply services and metering equipment by troubleshooting, diagnosing faults, and repairing them. They also perform maintenance to ensure the consumer/supply services and metering equipment are in good operating condition.

For the purpose of this standard, maintain includes inspections, preventative/predictive maintenance, troubleshooting, replacing and repairing activities.

#### **B-7.01** Installs single-phase consumer/supply services and metering equipment

|                             |                                  |
|-----------------------------|----------------------------------|
| <b>Apprenticeship Level</b> | 1                                |
| <b>Essential Skills</b>     | Numeracy, Thinking, Document Use |

#### KNOWLEDGE

|            | Learning Outcomes  | Learning Objectives   |
|------------|--|---|
| B-7.01.01L | demonstrate knowledge of <b>single-phase services</b> and their applications | interpret codes and regulations pertaining to <b>single-phase services</b>  |
|            |  | interpret information pertaining to <b>single-phase services</b> found on drawings and specifications                   |
|            |  | interpret <b>supply authority</b> single-phase standards  |
|            |  | identify types of <b>single-phase services</b> and describe their characteristics and applications                      |
|            |  | identify <b>service components, service conductors</b> and <b>fasteners</b> and describe their purpose and applications |

|            |   |   |
|------------|---|---|
|            |   | identify the considerations and requirements for selecting the type of <b>single-phase services, service components</b> and <b>service conductors</b> |
| B-7.01.02L | demonstrate knowledge of <b>single-phase service</b> installation methods           | identify sources of information and documentation required for the installation of <b>single-phase services</b>                                       |
|            |   | identify and describe the methods used to install <b>single-phase services, service components</b> and <b>service conductors</b>                      |
|            |   | identify and describe the methods used to connect <b>service conductors</b>   |
|            |   | identify the methods of grounding and bonding <b>single-phase services</b>  |
| B-7.01.03L | demonstrate knowledge of demand load calculations for a <b>single-phase service</b> | identify the method used to calculate demand load   |
|            |   | calculate demand load for a <b>single-phase service</b>   |
| B-7.01.04L | demonstrate knowledge of the theory of single-phase systems                         | describe theory of single-phase three-wire system   |
|            |   | describe single-phase circuit fundamentals  |

## RANGE OF VARIABLES

**single-phase services** include: temporary service, overhead, underground, single and multiple metering

**service conductors** include: wire, cables, conductors

**service components** include: supports, enclosures, raceways, conduit, meter sockets, panels, service mast, point of attachment

**supply authority** includes: local supply authority (single or three-phase standards), electrical inspectors

**fasteners** include: screws, straps, inserts, anchors, wedge clamps, seismic restraints, insulators

## **B-7.02** Maintains single-phase consumer/supply services and metering equipment

Apprenticeship Level

1

Essential Skills

Oral Communication, Thinking, Digital Technology

### KNOWLEDGE

|            | Learning Outcomes   | Learning Objectives  |
|------------|---|--|
| B-7.02.01L | demonstrate knowledge of the methods used to maintain single-phase services | describe the methods used to maintain single-phase services and their components |
| B-7.02.02L | demonstrate knowledge of the theory of single-phase systems                 | describe theory of single phase three-wire system                                |

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describe single-phase circuit fundamentals

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**B-7.03**    **Installs three-phase consumer/supply services and metering equipment**

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Apprenticeship Level            3

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Essential Skills                    Numeracy, Thinking, Document Use

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**KNOWLEDGE**

|            | Learning Outcomes  | Learning Objectives  |
|------------|--|--|
| B-7.03.01L | demonstrate knowledge of <b>three-phase services</b> and their applications        | interpret codes and regulations pertaining to <b>three-phase services</b>  |
|            |  | interpret information pertaining to <b>three-phase services</b> found on drawings and specifications   |
|            |  | identify types of <b>three-phase services</b> and describe their characteristics and applications  |
|            |  | identify <b>service components, service conductors</b> and <b>fasteners</b> and describe their purpose and applications                              |
|            |  | interpret <b>supply authority</b> three-phase standards  |
| B-7.03.02L | demonstrate knowledge of <b>three-phase service</b> installation methods           | identify the considerations and requirements for selecting the type of <b>three-phase services, service components</b> and <b>service conductors</b> |
|            |  | identify sources of information and documentation required for the installation of <b>three-phase services</b>                                       |
|            |  | identify and describe the methods used to install <b>three-phase services, service components</b> and <b>service conductors</b>                      |
|            |  | identify and describe the methods used to connect <b>service conductors</b>  |
|            |  | identify the methods of grounding and bonding <b>three-phase services</b>  |
| B-7.03.03L | demonstrate knowledge of demand load calculations for a <b>three-phase service</b> | identify ground fault and ground detection type protection systems   |
|            |  | identify the method used to calculate demand load  |

|            |  |  |
|------------|--|--|
|            |  | calculate demand load for a <b>three-phase service</b> |
| B-7.03.04L | demonstrate knowledge of the theory of three-phase systems | describe three-phase circuit fundamentals              |

## RANGE OF VARIABLES

**three-phase services** include: temporary service, overhead, underground, single and multiple metering

**service components** include: metering equipment, supports, enclosures, raceways, conduits, meter sockets, panels, switchgear, service entrance equipment, service mast, point of attachment

**service conductors** include: wire, cables, conductors

**fasteners** include: screws, straps, inserts, anchors, wedge clamps, seismic restraints, insulators

## **B-7.04** Maintains three-phase consumer/supply services and metering equipment

|                      |  |
|----------------------|--|
| Apprenticeship Level | 3  |
| Essential Skills     | Oral Communication, Thinking, Digital Technology |

### KNOWLEDGE

|            | Learning Outcomes   | Learning Objectives   |
|------------|---|---|
| B-7.04.01L | demonstrate knowledge of the methods used to maintain three-phase service | describe the methods used to maintain three-phase services and their components |
| B-7.04.02L | demonstrate knowledge of the theory of three-phase systems                | describe three-phase circuit fundamentals                                       |

## TASK B-8 Installs and maintains protection devices

### TASK DESCRIPTOR

Overcurrent protection devices provide protection against excessive currents and short circuits to service entrance, feeder and branch circuit conductors, and equipment. Ground fault protection devices provide protection against shock and current leakage and are usually used in conjunction with overcurrent devices. Arc fault protection devices provide protection from the effects of arc faults by de-energizing the circuit when an arc fault is detected. These devices also have overcurrent protection for the circuit. Surge protection devices prevent transient voltages from entering or leaving the system. Under and over voltage devices prevent under and over voltage condition to protect the downstream equipment.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

Industrial electricians maintain overcurrent, ground fault, arc fault, surge protection devices and under/over voltage devices by troubleshooting, diagnosing faults, replacing devices and repairing them. They also perform maintenance on these devices to ensure they are in good operating condition.

For the purpose of this standard, “maintain” includes inspection, preventative/predictive maintenance, troubleshooting, replacing and repairing activities.

### B-8.01 Installs overcurrent protection devices

|                             |                                  |
|-----------------------------|----------------------------------|
| <b>Apprenticeship Level</b> | In context                       |
| <b>Essential Skills</b>     | Document Use, Numeracy, Thinking |

#### KNOWLEDGE

|            | Learning Outcomes   | Learning Objectives  |
|------------|---|--|
| B-8.01.01L | demonstrate knowledge of <b>overcurrent protection devices</b> , their applications and operation | interpret codes and regulations pertaining to <b>overcurrent protection devices</b>                            |
|            |   | interpret information pertaining to <b>overcurrent protection devices</b> found on drawings and specifications |
|            |   | explain the purpose and operation of <b>overcurrent protection devices</b>                                     |
|            |   | explain the effects of short-circuit current and describe the associated damage to the circuit                 |
|            |   | identify types of <b>overcurrent protection devices</b> and describe their characteristics and applications    |
|            |   | identify the considerations and requirements for selecting <b>overcurrent protection devices</b>               |
|            |   | explain the purpose of coordination studies  |

|            |   |   |
|------------|---|---|
| B-8.01.02L | demonstrate knowledge of the procedures used to install <b>overcurrent protection devices</b> | describe the procedures used to install <b>overcurrent protection devices</b> |
|            |   | explain the purpose of updating <b>documentation</b>                          |
|            |   | explain the procedures used to adjust trip settings                           |

## RANGE OF VARIABLES

**overcurrent protection devices** include: fuses, breakers, relay protection

**documentation** includes: as-builts, schematics, panel schedules, log sheets, drive drawings, shop drawings

## B-8.02 Maintains overcurrent protection devices

|                             |  |
|-----------------------------|--|
| <b>Apprenticeship Level</b> | In context                                       |
| <b>Essential Skills</b>     | Oral Communication, Thinking, Digital Technology |

### KNOWLEDGE

|            | Learning Outcomes   | Learning Objectives   |
|------------|---|---|
| B-8.02.01L | demonstrate knowledge of the methods and theory used to maintain overcurrent protection devices | describe the methods and theory used to maintain overcurrent protection devices |

## B-8.03 Installs ground fault, arc fault and surge protection devices

|                             |                                  |
|-----------------------------|----------------------------------|
| <b>Apprenticeship Level</b> | In context                       |
| <b>Essential Skills</b>     | Numeracy, Thinking, Document use |

### KNOWLEDGE

|            | Learning Outcomes  | Learning Objectives   |
|------------|--|---|
| B-8.03.01L | demonstrate knowledge of <b>ground fault, arc fault</b> and <b>surge protection devices</b> , their applications and operation | interpret codes and regulations pertaining to <b>ground fault, arc fault</b> and <b>surge protection devices</b>                            |
|            |  | interpret information pertaining to <b>ground fault, arc fault</b> and <b>surge protection devices</b> found on drawings and specifications |

|            |  |  |
|------------|--|--|
|            |  | explain the purpose and operation of <b>ground fault, arc fault</b> and <b>surge protection devices</b>                                  |
|            |  | identify types of <b>ground fault, arc fault</b> and <b>surge protection devices</b> and describe their characteristics and applications |
|            |  | identify the considerations and requirements for selecting <b>ground fault, arc fault</b> and <b>surge protection devices</b>            |
| B-8.03.02L | demonstrate knowledge of the procedures used to install <b>ground fault, arc fault</b> and <b>surge protection devices</b> | describe the procedures used to install <b>ground fault, arc fault</b> and <b>surge protection devices</b>                               |
|            |  | explain the purpose of updating <b>documentation</b>   |

## RANGE OF VARIABLES

**ground fault protection devices** include: GFCI receptacles, GFCI breakers

**arc fault protection devices** include: AFCI receptacles, AFCI breakers

**surge protection devices** include: MOV, zener diodes, thyristors, surge suppressors

**documentation** includes: as-builts, schematics, panel schedules, log sheets, drive drawings, shop drawings

## B-8.04 Maintains ground fault, arc fault and surge protection devices

|                             |   |
|-----------------------------|---|
| <b>Apprenticeship Level</b> | In context                                      |
| <b>Essential Skills</b>     | Oral Communication, Digital Technology, Writing |

### KNOWLEDGE

|            | Learning Outcomes   | Learning Objectives  |
|------------|---|--|
| B-8.04.01L | demonstrate knowledge of the methods and theory used to maintain ground fault, arc fault and surge protection devices | describe the methods and theory used to maintain ground fault protection devices |
|            |   | describe the methods and theory used to maintain arc fault protection devices    |
|            |   | describe the methods and theory used to maintain surge protection devices        |



**B-8.05****Installs under and over voltage protection devices**

|                             |                                 |
|-----------------------------|---------------------------------|
| <b>Apprenticeship Level</b> | In context                      |
| <b>Essential Skills</b>     | Document Use, Reading, Numeracy |

**KNOWLEDGE**

|            | <b>Learning Outcomes</b>  | <b>Learning Objectives</b>   |
|------------|---|--|
| B-8.05.01L | demonstrate knowledge of <b><i>under and over voltage protection devices</i></b> , their applications and operation | interpret information pertaining to <b><i>under and over voltage protection devices</i></b> found on drawings and specifications |
|            |   | explain the purpose and operation of <b><i>under and over voltage protection devices</i></b>                                     |
|            |   | identify types of <b><i>under and over voltage protection devices</i></b> and describe their characteristics and applications    |
|            |   | identify the considerations and requirements for selecting <b><i>under and over voltage protection devices</i></b>               |
| B-8.05.02L | demonstrate knowledge of the procedures used to install <b><i>under and over voltage protection devices</i></b>     | describe the procedures used to install <b><i>under and over voltage protection devices</i></b>                                  |
|            |   | explain the purpose of updating <b><i>documentation</i></b>  |

**RANGE OF VARIABLES**

***under and over voltage protection devices*** include: under voltage devices, over voltage devices  
***documentation*** includes: as-builts, schematics, panel schedules, log sheets, drive drawings, shop drawings, terminal identification

**B-8.06****Maintains under and over voltage protection devices**

|                             |   |
|-----------------------------|---|
| <b>Apprenticeship Level</b> | In context                                      |
| <b>Essential Skills</b>     | Oral Communication, Digital Technology, Writing |

**KNOWLEDGE**

|            | <b>Learning Outcomes</b>   | <b>Learning Objectives</b>  |
|------------|--|---|
| B-8.06.01L | demonstrate knowledge of the procedures used to maintain under and over voltage protection devices | describe the procedures used to maintain under voltage protection devices |
|            |  | describe the procedures used to maintain over voltage protection devices  |
|            |  | explain the purpose of updating <b>documentation</b>                      |

**RANGE OF VARIABLES**

**documentation** includes: as-builts, schematics, panel schedules, log sheets, drive drawings, shop drawings, terminal identification

## TASK B-9 Installs and maintains low voltage distribution systems

### TASK DESCRIPTOR

Distribution equipment provides power for all electrical systems and equipment. Low voltage is over 30 and up to 750 volts. This equipment allows for safe utilization of electricity. This task does not include distribution systems for Class 1 and Class 2 systems.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

Industrial electricians maintain distribution equipment by troubleshooting, diagnosing faults, and repairing them. They also perform maintenance on the equipment to ensure it is in good operating condition.

For the purpose of this standard, “maintain” includes inspection, preventative/predictive maintenance, troubleshooting, replacing and repairing activities.

### **B-9.01** Installs low voltage distribution equipment

Apprenticeship Level 1

Essential Skills Document Use, Thinking, Numeracy

#### KNOWLEDGE

|            | Learning Outcomes   | Learning Objectives   |
|------------|---|---|
| B-9.01.01L | demonstrate knowledge of <b>low voltage power distribution equipment</b> , their applications and operation | interpret codes and regulations pertaining to <b>low voltage power distribution equipment</b>   |
|            |   | interpret information pertaining to <b>low voltage power distribution equipment</b> found on drawings and specifications                |
|            |   | identify types of <b>low voltage power distribution equipment</b> and describe their characteristics and applications                   |
| B-9.01.02L | demonstrate knowledge of the procedures used to install <b>low voltage power distribution equipment</b>     | identify the <b>considerations</b> and requirements for selecting <b>low voltage power distribution equipment</b> and <b>enclosures</b> |
|            |   | describe the procedures used to install <b>low voltage power distribution equipment</b>   |
|            |   | describe the procedures used to connect <b>low voltage power distribution equipment</b>   |
|            |   | describe procedures for transporting and moving electrical equipment  |

## RANGE OF VARIABLES

**low voltage power distribution equipment** includes: panels, sub-panels, PDCs, switchboards, breakers, fuses, disconnects, racking equipment, CTs, VTs, busbars, splitters, MCCs, transformers

**enclosures** include: CSA enclosures, enclosures for hazardous locations

**considerations** include: load, voltage ratings, required circuit capacity, arc fault study

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### **B-9.02** Maintains low voltage distribution equipment

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|                      |                                       |
|----------------------|---------------------------------------|
| Apprenticeship Level | 3                                     |
| Essential Skills     | Digital Technology, Thinking, Writing |

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#### KNOWLEDGE

|            | Learning Outcomes   | Learning Objectives   |
|------------|---|---|
| B-9.02.01L | demonstrate knowledge of the methods used to maintain <b>low voltage distribution equipment</b> | describe the methods to maintain <b>low voltage distribution equipment</b> and their components |

---

## RANGE OF VARIABLES

**low voltage distribution equipment** includes: panels, sub-panels, PDCs, switchboards, breakers, fuses, disconnects, racking equipment, CTs, VTs, busbars, splitters, MCCs, transformers

# TASK B-10 Installs and maintains power conditioning systems

## TASK DESCRIPTOR

Power conditioning systems include filters, capacitors and line reactors, and are used to provide a smooth sinusoidal alternating current (AC) wave thereby delivering a voltage of a constant level and power factor characteristics that enable load equipment to function as designed.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

Industrial electricians maintain power conditioning and uninterruptible power supply (UPS) by troubleshooting, diagnosing faults, and repairing them. They also perform maintenance to ensure these systems are in good operating condition.

For the purpose of this standard, “maintain” includes inspections, preventative/predictive maintenance, troubleshooting, replacing and repairing activities.

### B-10.01 Installs power conditioning systems

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 4                                |
| Essential Skills     | Thinking, Numeracy, Document Use |

#### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| B-10.01.01L | demonstrate knowledge of types of power conditioning and UPS and their applications | interpret codes and regulations pertaining to power conditioning and UPS systems   |
|             |   | explain power quality and its impact on equipment operation  |
|             |   | explain single-phase and three-phase power factor correction and its associated calculations   |
|             |   | identify the types of <b>power factor correction equipment</b> and describe their characteristics, applications and operation                        |
|             |   | identify <b>equipment used to reduce harmonics</b> in power distribution systems and describe their characteristics, applications and operation      |
|             |   | identify types of <b>UPS equipment</b> used in power distribution system conditioning and describe their characteristics, applications and operation |

|             |  |   |
|-------------|--|---|
| B-10.01.02L | demonstrate knowledge of procedures used to install power conditioning and UPS systems | describe the procedures used to install power conditioning and UPS systems                            |
|             |  | identify hazards with UPS systems when working with batteries, multiple energy sources and capacitors |

### RANGE OF VARIABLES

**power factor correction equipment** includes: synchronous condensers (motors), reactors, capacitors  
**equipment used to reduce harmonics** includes: passive and active filters, transformers and capacitors  
**UPS equipment** includes: online, offline, online interactive, maintenance bypass and static bypass, battery systems

## B-10.02 Maintains power conditioning systems

|                      |  |
|----------------------|--|
| Apprenticeship Level | 4                                      |
| Essential Skills     | Digital Technology, Thinking, Numeracy |

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| B-10.02.01L | demonstrate knowledge of the methods used to maintain power conditioning systems | describe the methods to maintain power conditioning systems and their <b>components</b> |

### RANGE OF VARIABLES

**components** include: batteries, transformers, capacitors, shunt coils, diodes, reactors, synchronous condensers (motors), filters

# TASK B-11 Installs and maintains bonding, grounding and ground fault detection systems

## TASK DESCRIPTOR

Bonding and grounding systems are used to protect life and equipment from transient and fault current. Ground fault detections systems are used to detect electrical current leakage and, in three phase systems, are also used to indicate a single phase ground.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard, “maintain” includes troubleshooting, maintaining and repairing activities.

### **B-11.01** Installs grounding systems

**Apprenticeship Level** 2,3

**Essential Skills** Thinking, Document Use, Numeracy

#### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| B-11.01.01L | demonstrate knowledge of grounding methods and equipment                  | interpret codes, drawings, specifications and regulations pertaining to grounding                                  |
|             |   | identify grounding methods   |
|             |   | identify grounding conductors, equipment and components, and describe their characteristics and applications       |
|             |   | identify the considerations and requirements for selecting grounding conductors, methods, equipment and components |
|             |   | explain the purpose of grounding   |
| B-11.01.02L | demonstrate knowledge of the procedures used to install grounding systems | explain the differences between grounding and bonding, and identify situations where interconnection is required   |
|             |   | describe the procedures used to install grounding systems  |
|             |   | describe the method used to determine grounding conductor size   |

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**B-11.02** Maintains grounding systems

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|                      |                                       |
|----------------------|---------------------------------------|
| Apprenticeship Level | 2,3                                   |
| Essential Skills     | Thinking, Digital Technology, Writing |

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**KNOWLEDGE**

|             | Learning Outcomes   | Learning Objectives   |
|-------------|---|---|
| B-11.02.01L | demonstrate knowledge of the methods used to maintain grounding systems | describe the methods used to maintain grounding systems and their <b>components</b> according to AHJ and CEC requirements |

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**RANGE OF VARIABLES**

*grounding system components* include: grounding electrodes, grounding conductors, grounding connectors

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**B-11.03** Installs bonding systems

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|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 2,3                              |
| Essential Skills     | Thinking, Document Use, Numeracy |

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**KNOWLEDGE**

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| B-11.03.01L | demonstrate knowledge of bonding methods and equipment                  | interpret codes, drawings, specifications and regulations pertaining to bonding  |
|             |   | identify bonding methods   |
|             |   | identify bonding conductors, equipment and components, and describe their characteristics and applications                   |
|             |   | identify the considerations and requirements for selecting bonding conductors, methods, equipment and components             |
| B-11.03.02L | demonstrate knowledge of the procedures used to install bonding systems | explain the purpose and differences between grounding and bonding, and identify situations where interconnection is required |
|             |   | describe the procedures used to install bonding systems  |
|             |   | describe the method used to determine bonding conductor size   |

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**B-11.04** Maintains bonding systems

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**Apprenticeship Level** 2,3

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**Essential Skills** Thinking, Digital Technology, Writing

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**KNOWLEDGE**

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**Learning Outcomes**

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**Learning Objectives**

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|             |   |  |
|-------------|---|--|
| B-11.04.01L | demonstrate knowledge of the methods used to maintain bonding systems | describe the methods used to maintain bonding systems and their components according to AHJ and CEC requirements |
|-------------|---|--|

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**B-11.05** Installs ground fault detection systems

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**Apprenticeship Level** 2,3

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**Essential Skills** Thinking, Document Use, Reading

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**KNOWLEDGE**

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**Learning Outcomes**

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**Learning Objectives**

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|             |   |  |
|-------------|---|--|
| B-11.05.01L | demonstrate knowledge of <b>ground fault detection systems</b> and their operation  | identify types of <b>ground fault detection systems</b> and describe their characteristics and applications            |
|             |   | explain the purpose of <b>ground fault detection systems</b>   |
|             |   | interpret codes, drawings, specifications and regulations pertaining to <b>ground fault detection systems</b>          |
| B-11.05.02L | demonstrate knowledge of <b>ground fault detection systems</b> installation methods | identify the considerations and requirements for selecting the type of <b>ground fault detection system components</b> |
|             |   | identify and describe the methods used to install <b>ground fault detection systems</b> and their components           |

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**RANGE OF VARIABLES**

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**ground fault detection systems** include: ground fault protection (solidly grounded systems), ground fault protection (impedance grounded systems), ground fault detection (ungrounded systems, mobile equipment)

**ground fault detection system components** include: CTs, VTs, resistors, relays, annunciators (horns, panels), indicators (pilot lights), reset buttons, breakers, interconnecting wiring, ground fault sensors (direct, residual or zero sequence)

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**B-11.06** Maintains ground fault detection systems

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|                      |                                       |
|----------------------|---------------------------------------|
| Apprenticeship Level | 4                                     |
| Essential Skills     | Thinking, Digital Technology, Writing |

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**KNOWLEDGE**

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| B-11.06.01L | demonstrate knowledge of the methods used to maintain <b>ground fault detection systems</b> | describe the methods used to maintain <b>ground fault detection systems</b> and their <b>components</b> according to manufacturers' specifications |

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**RANGE OF VARIABLES**

**ground fault detection systems** include: ground fault protection (solidly grounded systems), ground fault protection (impedance grounded systems), ground fault detection (ungrounded systems, mobile equipment)

**ground fault detection system components** include: CTs, VTs, resistors, relays, annunciators (horns, panels), indicators (pilot lights), reset buttons, breakers, interconnecting wiring, ground fault sensors (direct, residual or zero sequence)

## TASK B-12 Installs and maintains power generating systems

### TASK DESCRIPTOR

The purpose of generators is to convert kinetic energy into electricity. They can be used when power from the utility is unavailable or the system is isolated from the power grid.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard, “maintain” includes inspections, preventive/predictive maintenance, troubleshooting, replacing and repairing activities.

### **B-12.01** Installs alternating current (AC) generating systems

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 3                                |
| Essential Skills     | Thinking, Numeracy, Document Use |

#### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| B-12.01.01L | demonstrate knowledge of <b>AC generating systems</b> and <b>AC generating system components</b> , their applications and operation | describe <b>AC generating system components</b> and explain their operating principles   |
|             |   | identify types of <b>AC generating systems</b> and describe their characteristics and applications                                 |
|             |   | identify <b>AC generating system components</b> and describe their characteristics and applications                                |
|             |   | identify the considerations and requirements for selecting <b>AC generating systems</b> and <b>AC generating system components</b> |
|             |   | interpret information pertaining to <b>AC generating systems</b> found on drawings and specifications                              |
|             |   | interpret codes, standards and regulations pertaining to <b>AC generating systems</b>  |
| B-12.01.02L | demonstrate knowledge of the procedures used to install <b>AC generating systems</b>  | describe the procedures used to install <b>AC generating systems</b> and <b>AC generating system components</b>                    |

|             |  |   |
|-------------|--|---|
|             |  | describe the procedures used to control the output voltage, phase sequencing and frequency of AC generators |
| B-12.01.03L | demonstrate knowledge of the procedures used to interconnect <b>AC generating systems</b> with standalone or parallel operations | describe the procedure used to interconnect AC generating systems with stand-alone or parallel operations   |

## RANGE OF VARIABLES

**AC generating systems** include: single-phase, three-phase, portable, stationary, manually operated, automatically operated

**AC generating system components** include: shaft, armature and stator, bearings, frame, exciter windings, transfer switch, prime mover, cables, conductors, overcurrent devices, overload devices, fuel storage, protection devices, AVR, governor

## B-12.02 Maintains AC generating systems

|                      |                                 |
|----------------------|---------------------------------|
| Apprenticeship Level | 3                               |
| Essential Skills     | Reading, Thinking, Document Use |

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives  |
|-------------|--|--|
| B-12.02.01L | demonstrate knowledge of <b>AC generating systems</b> , their applications and operation | identify types of <b>AC generating systems</b> and describe their characteristics                                      |
|             |  | identify <b>AC generating system components</b> and describe their applications  |
|             |  | interpret codes and regulations pertaining to <b>AC generating systems</b>   |
|             |  | interpret information pertaining to <b>AC generating systems</b> found on drawings and specifications                  |
|             |  | explain operating principles of the <b>AC generating system components</b> and <b>AC generating systems</b>            |
|             |  | interpret information contained on AC generator nameplates   |
| B-12.02.02L | demonstrate knowledge of procedures used to maintain <b>AC generating systems</b>        | describe the procedures used to maintain <b>AC generating systems</b> and their <b>AC generating system components</b> |

## RANGE OF VARIABLES

**AC generating systems** include: single-phase, three-phase, portable, stationary, manually operated, automatically operated

**AC generating system components** include: shaft, armature and stator, bearings, frame, exciter windings, transfer switch, prime mover, cables, conductors, overcurrent devices, overload devices, fuel storage, AVR, governor

### **B-12.03** Installs direct current (DC) generating systems

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 2                                |
| Essential Skills     | Thinking, Numeracy, Document Use |

#### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| B-12.03.01L | demonstrate knowledge of <b>DC generating systems</b> and <b>DC generating system components</b> , their applications and operation | describe the components of <b>DC generating systems</b> and explain their operating principles                                     |
|             |   | identify types of <b>DC generators</b> and describe their characteristics and applications   |
|             |   | identify <b>DC generating system components</b> and describe their characteristics and applications                                |
|             |   | identify the considerations and requirements for selecting <b>DC generating systems</b> and <b>DC generating system components</b> |
|             |   | interpret information pertaining to <b>DC generating systems</b> found on drawings and specifications                              |
|             |   | interpret codes, standards and regulations pertaining to <b>DC generating systems</b>  |
| B-12.03.02L | demonstrate knowledge of the procedures used to install and connect <b>DC generating systems</b>                                    | describe the procedures used to install <b>DC generating systems</b> and <b>DC generating system components</b>                    |
|             |   | describe the procedures used to connect <b>DC generating systems</b> and <b>DC generating system components</b>                    |
|             |   | describe the procedures used to control the output voltage of <b>DC generators</b>   |

## RANGE OF VARIABLES

**DC generating systems** include: portable, stationary, manually operated, automatically operated, two wire, three wire

**DC generating system components** include: transfer switch, brushes and commutators, prime mover, cables, conductors, overcurrent devices, governors, disconnecting means, shaft, armature and stator, bearings, frame, exciter windings

**DC generators** include: series, shunt, compound

## B-12.04 Maintains DC generating systems

|                      |                                 |
|----------------------|---------------------------------|
| Apprenticeship Level | 2                               |
| Essential Skills     | Reading, Thinking, Document Use |

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives  |
|-------------|--|--|
| B-12.04.01L | demonstrate knowledge of <b>DC generating systems</b> , their applications and operation | identify types of <b>DC generating systems</b> and describe their characteristics                                |
|             |  | identify <b>DC generating system components</b> and describe their applications                                  |
|             |  | interpret codes and regulations pertaining to <b>DC generating systems</b>                                       |
|             |  | interpret information pertaining to <b>DC generating systems</b> found on drawings and specifications            |
|             |  | explain operating principles of <b>DC generating system components</b> and <b>DC generating systems</b>          |
| B-12.04.02L | demonstrate knowledge of procedures used to maintain <b>DC generating systems</b>        | interpret information contained on <b>DC generator</b> nameplates  |
|             |  | describe the procedures used to maintain <b>DC generating systems</b> and <b>DC generating system components</b> |

## RANGE OF VARIABLES

**DC generating systems** include: portable, stationary, manually operated, automatically operated, two wire, three wire

**DC generating system components** include: transfer switch, brushes and commutators, prime mover, cables, conductors, overcurrent devices, governors, shaft, armature and stator, bearings, frame, exciter windings

**DC generators** include: series, shunt, compound

## TASK B-13 Installs and maintains renewable energy generating and storage systems

### TASK DESCRIPTOR

Renewable energy generating systems can be used to supplement power when power from the utility is unavailable or the building is isolated from the power grid. These systems can also feed energy back to the power grid. For the purpose of this standard, alternative systems are considered non-utility systems. Renewable systems are systems such as solar, fuel cell, wind, tidal or hydrokinetic powered that use renewable sources of energy.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard, “maintain” includes inspections, preventive/predictive maintenance, troubleshooting, replacing and repairing activities.

### B-13.01 Installs renewable energy generating and storage systems

|                      |   |
|----------------------|---|
| Apprenticeship Level | 2,4   |
| Essential Skills     | Thinking, Continuous Learning, Document Use |

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| B-13.01.01L | demonstrate knowledge of <b>renewable energy generating systems</b> , their applications and operation                                     | identify types of <b>renewable energy generating systems</b> and describe their characteristics, applications and operation |
|             |  | identify renewable energy system components and describe their characteristics, applications and operation                  |
|             |  | identify types of <b>renewable energy generating system connections</b>   |
|             |  | identify types of renewable energy generating <b>storage system components</b>  |
|             |  | interpret codes and regulations pertaining to <b>renewable energy generating systems</b>                                    |
| B-13.01.02L | demonstrate knowledge of procedures to install and connect <b>renewable energy generating systems</b> and <b>control system components</b> | describe the procedures used to install <b>renewable energy generating systems</b> and <b>control system components</b>     |
|             |  | describe the procedures used to connect <b>renewable energy generating systems</b> and <b>control system components</b>     |

## RANGE OF VARIABLES

**renewable energy generating systems** include: fuel cells, wind turbines, photovoltaic array, hydrokinetic, hydraulic turbine, geothermal

**renewable energy generating system connections** include: grid dependent, grid independent (stand-alone)

**storage system components** include: pumped hydro, compressed air energy storage, batteries (various technologies)

**control system components** include: transfer switches, sun-tracking systems, batteries, charge controller, load bank, inverters, isolation disconnects

## **B-13.02** Maintains renewable energy generating and storage systems

|                      |   |
|----------------------|---|
| Apprenticeship Level | 2,4   |
| Essential Skills     | Thinking, Continuous Learning, Document Use |

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| B-13.02.01L | demonstrate knowledge of <b>renewable energy generating systems</b> , their applications and operation | identify types of <b>renewable energy generating systems</b> and describe their characteristics, applications and operation |
|             |  | identify renewable energy system components and describe their characteristics, applications and operation                  |
|             |  | identify renewable energy generating <b>storage system components</b>   |
|             |  | interpret codes and regulations pertaining to <b>renewable energy generating systems</b>                                    |
| B-13.02.02L | demonstrate knowledge of procedures to maintain <b>renewable energy generating systems</b>             | describe the procedures used to maintain <b>renewable energy generating systems</b> and their components                    |
|             |  | describe the procedures used to maintain renewable energy generating <b>storage system components</b>                       |

## RANGE OF VARIABLES

**renewable energy systems** include: fuel cells, wind turbines, photovoltaic modules, hydrokinetic, geothermal, hydraulic turbine, tidal

**storage system components** include: pumped hydro, compressed air energy storage, batteries (various technologies)



# TASK B-14 Installs and maintains high voltage systems

## TASK DESCRIPTOR

Industrial electricians assemble, install, erect and connect equipment and cables for high voltage applications (voltages above 750V) such as switchyards, sub-stations, electrical vaults, electrical equipment rooms and MCCs. They use specific equipment, tests and procedures to ensure the work is performed safely due to the inherent hazards regarding high voltage systems that can cause property damage, serious injury or death.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard, “maintains” includes inspection, troubleshooting, replacing and repairing activities.

### B-14.01 Installs high voltage systems

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 4                                |
| Essential Skills     | Document Use, Thinking, Numeracy |

#### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| B-14.01.01L | demonstrate knowledge of <b>high voltage equipment</b> , their applications and operation | interpret codes, drawings, specifications and regulations pertaining to <b>high voltage equipment</b>        |
|             |   | identify grounding conductors, equipment and components, and describe their characteristics and applications |
|             |   | identify bonding conductors, equipment and components, and describe their characteristics and applications   |
|             |   | explain the purpose of grounding grids in relation to step and touch voltages                                |
|             |   | explain the function of <b>high voltage equipment</b>  |
| B-14.01.02L | demonstrate knowledge of the procedures used to install <b>high voltage equipment</b>     | describe the procedures used to install <b>high voltage equipment</b>  |
|             |   | describe the procedures used to size and install ground grid and grounding conductors                        |
|             |   | describe the procedures used to terminate and splice high voltage conductors                                 |
|             |   | identify sources of information and <b>documentation</b> for installation of <b>high voltage equipment</b>   |
|             |   | explain <b>hazards</b> associated with high voltage systems  |

|             |   |  |
|-------------|---|--|
|             |   | explain safety procedures to access high voltage environment   |
|             |   | describe procedure to isolate faults by de-energizing the source of energy   |
| B-14.01.03L | demonstrate knowledge of testing procedures | identify testing procedures  |
|             |   | describe the procedures used to perform ground resistance testing and <b>commissioning testing of high voltage equipment</b> |

## RANGE OF VARIABLES

**high voltage equipment** includes: distribution equipment, contactors, motor starters, transformers, MCC, capacitors, reactors, switches, disconnects, rectifiers, reclosers, VTs, CTs

**documentation** includes: as-builts, schematics (AC, DC), shop drawings, single-line drawings

**hazards** include: corona discharge, ozone gas, proximity to energized exposed equipment

**commissioning tests** include: polarity, ground grid resistance, hi-pot, phasing, functionality, timing, current injection, interlocking, ultra-sonic detectors, thermographic imaging device

## B-14.02 Maintains high voltage systems

|                      |                                 |
|----------------------|---------------------------------|
| Apprenticeship Level | 4                               |
| Essential Skills     | Thinking, Writing, Document Use |

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives  |
|-------------|--|--|
| B-14.02.01L | demonstrate knowledge of the procedures used to maintain <b>high voltage equipment</b> | describe the procedures used to maintain <b>high voltage equipment</b> and their <b>components</b> |
|             |  | interpret <b>documentation</b> related to high voltage equipment                                   |
| B-14.02.02L | demonstrate knowledge of the methods used to maintain <b>high voltage cables</b>       | describe the procedures used to maintain <b>high voltage cables</b> and their <b>components</b>    |
|             |  | explain <b>hazards</b> associated with high voltage systems  |
|             |  | explain safety procedures to access high voltage environment                                       |
|             |  | describe procedure to isolate faults by de-energizing the source of energy                         |

|             |   |  |
|-------------|---|--|
| B-14.02.03L | demonstrate knowledge of methods used to install and remove <b>temporary protective grounds</b> | describe methods used to install <b>temporary protective grounds</b> |
|             |   | describe methods used to remove <b>temporary protective grounds</b>  |

## RANGE OF VARIABLES

**high voltage equipment** includes: distribution equipment, contactors, motor starters, transformers, MCC, capacitors, reactors, switches, disconnects, rectifiers, reclosers, VTs, CTs

**high voltage cable components** include: potheads, stress relief terminations, strapping, bracing, splice kits

**documentation** includes: schematic diagrams and drawings, maintenance schedules, single line diagrams, drawings, as-built drawings, manufacturers' specifications

**high voltage cables** include: armoured cables (with or without shielded conductor), TC cable, trailing cables, shielded cables, bus ducts

**hazards** include: corona discharge, ozone gas, proximity to energized exposed equipment

**temporary protective grounds** include: ground clamps and straps, conductors

## TASK B-15 Installs and maintains transformers

### TASK DESCRIPTOR

Industrial electricians install extra-low, low and high voltage transformers to condition or change voltage and current values. Common transformer uses include signal control, isolation, power, distribution and transmission.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard, “maintain” includes inspection, preventive/predictive maintenance, troubleshooting, replacing and repairing activities.

### B-15.01 Installs extra-low voltage transformers

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 2                                |
| Essential Skills     | Thinking, Numeracy, Document Use |

### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| B-15.01.01L | demonstrate knowledge of <b>extra-low voltage transformers</b> , their applications and operation | explain the operating principles of <b>extra-low voltage transformers</b>      |
|             |   | identify code requirements pertaining to <b>extra-low voltage transformers</b> |

|             |   |  |
|-------------|---|--|
|             |   | interpret information contained on <b>extra-low voltage transformer</b> nameplates                           |
|             |   | identify types of <b>extra-low voltage transformers</b> and describe their characteristics and applications  |
|             |   | identify <b>extra-low voltage transformer components</b> and describe their characteristics and applications |
| B-15.01.02L | demonstrate knowledge of procedures used to install <b>extra-low voltage transformers</b> | describe the procedures used to install <b>extra-low voltage transformers</b>                                |

## RANGE OF VARIABLES

**extra-low voltage transformers** include: Class 1 and Class 2 circuits, control transformers

**extra-low voltage transformer components** include: casings, core, primary and secondary windings, taps

## B-15.02 Maintains extra-low voltage transformers

|                      |  |
|----------------------|--|
| Apprenticeship Level | 2  |
| Essential Skills     | Oral Communication, Digital Technology, Document Use |

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives  |
|-------------|--|--|
| B-15.02.01L | demonstrate knowledge of <b>extra-low voltage transformers</b> , their applications and procedures for use | describe the characteristics and applications of <b>extra-low voltage transformers</b>                         |
|             |  | identify <b>extra-low voltage transformer components</b> and describe their characteristics                    |
|             |  | interpret codes and regulations pertaining to <b>extra-low voltage transformers</b>                            |
|             |  | interpret information pertaining to <b>extra-low voltage transformers</b> found on drawings and specifications |
|             |  | explain the operating principles of <b>extra-low voltage transformers</b>                                      |
|             |  | interpret information contained on <b>extra-low voltage transformers</b> nameplates                            |
| B-15.02.02L | demonstrate knowledge of procedures used to maintain <b>extra-low voltage transformers</b>                 | describe the procedures used to maintain <b>extra-low voltage transformers</b> and their <b>components</b>     |

## RANGE OF VARIABLES

*extra-low voltage transformers* include: Class 1 and Class 2 circuits, control transformers

*extra-low voltage transformer components* include: casings, core, primary and secondary windings, taps

### **B-15.03** Installs low voltage single-phase transformers

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 2                                |
| Essential Skills     | Numeracy, Thinking, Document Use |

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| B-15.03.01L | demonstrate knowledge of <i>low voltage single-phase transformers</i> , their applications and operation | explain the operating principles of <i>low voltage single-phase transformers</i>  |
|             |  | interpret codes and regulations pertaining to <i>low voltage single-phase transformers</i>                                      |
|             |  | identify types of <i>low voltage single-phase transformers</i> and describe their characteristics, applications and connections |
|             |  | identify <i>low voltage single-phase transformer components</i> and describe their characteristics and applications             |
|             |  | interpret information contained on <i>low voltage single-phase transformer</i> nameplates                                       |
|             |  | explain <i>low voltage single-phase transformer</i> polarity and terminal markings  |
|             |  | identify the considerations and requirements for selecting <i>low voltage single-phase transformers</i>                         |
| B-15.03.02L | demonstrate knowledge of procedures used to install <i>low voltage single-phase transformers</i>         | describe the procedures used to install <i>low voltage single-phase transformers</i>  |
|             |  | describe the procedures used to install <i>low voltage single-phase transformers</i> in parallel                                |

## RANGE OF VARIABLES

**low voltage single-phase transformers** include: dry-type, liquid-filled, isolation, step-down, step-up, auto

**low voltage single-phase transformer components** include: casings and enclosures, core, primary and secondary windings, dielectric liquid, cooling fans, and on-line, off-line and automatic tap changers

### **B-15.04** Maintains low voltage single-phase transformers

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 2                                |
| Essential Skills     | Numeracy, Thinking, Document Use |

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| B-15.04.01L | demonstrate knowledge of <b>low voltage single-phase transformers</b> , their applications and operation | explain the operating principles of <b>low voltage single-phase transformers</b>                                    |
|             |  | identify types of <b>low voltage single-phase transformers</b> and describe their characteristics and applications  |
|             |  | interpret codes and regulations pertaining to <b>low voltage single-phase transformers</b>                          |
|             |  | identify <b>low voltage single-phase transformer components</b> and describe their characteristics and applications |
|             |  | interpret information contained on <b>low voltage single-phase transformer</b> nameplates                           |
|             |  | explain transformer polarity and terminal markings  |
|             |  | identify the considerations and requirements for selecting <b>low voltage single-phase transformers</b>             |
| B-15.04.02L | demonstrate knowledge of procedures used to maintain <b>low voltage single-phase transformers</b>        | describe the procedures used to maintain <b>low voltage single-phase transformers</b>                               |

## RANGE OF VARIABLES

**low voltage single-phase transformers** include: dry-type, liquid-filled, isolation, step-down, step-up, auto

**low voltage single-phase transformer components** include: casings and enclosures, core, primary and secondary windings, dielectric liquid, cooling fans, and on-line, off-line and automatic tap changers

## **B-15.05** Installs low voltage three-phase transformers

|                             |                                  |
|-----------------------------|----------------------------------|
| <b>Apprenticeship Level</b> | 3                                |
| <b>Essential Skills</b>     | Numeracy, Thinking, Document Use |

### **KNOWLEDGE**

|             | <b>Learning Outcomes</b>  | <b>Learning Objectives</b>  |
|-------------|---|---|
| B-15.05.01L | demonstrate knowledge of <b>low voltage three-phase transformers</b> , their applications and operation | explain the operating principles of <b>low voltage three-phase transformers</b>   |
|             |   | interpret codes and regulations pertaining to <b>low voltage three-phase transformers</b>                                       |
|             |   | identify types of <b>low voltage three-phase transformers</b> and describe their characteristics and applications               |
|             |   | identify <b>winding configurations</b> for <b>low voltage three-phase transformers</b>  |
|             |   | identify <b>low voltage three-phase transformer components</b> and describe their characteristics and applications              |
|             |   | interpret information contained on <b>low voltage three-phase transformer</b> nameplates  |
|             |   | explain <b>low voltage three-phase transformer</b> polarity and terminal markings   |
| B-15.05.02L | demonstrate knowledge of procedures used to install <b>low voltage three-phase transformers</b>         | identify the considerations and requirements for selecting <b>low voltage three-phase transformers</b>                          |
|             |   | describe the procedures used to install <b>low voltage three-phase transformers</b>   |
|             |   | describe the procedures used to install <b>low voltage three-phase transformers</b> in parallel                                 |
|             |   | describe the procedures used to install <b>low voltage three-phase transformers</b> using various <b>winding configurations</b> |

## RANGE OF VARIABLES

**low voltage three-phase transformers** include: dry-type, liquid-filled, isolation, step-down, step-up, auto, wye, delta

**winding configurations** include: wye-wye, wye-delta, delta-wye, open-delta, delta-delta, zig-zag

**low voltage three-phase transformer components** include: ventilation fans, casings and enclosures, core, primary and secondary windings, bushings, on-line and off-line tap changers, dielectric liquid

### B-15.06 Maintains low voltage three-phase transformers

Apprenticeship Level 3

Essential Skills Oral Communication, Thinking, Document Use

#### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| B-15.06.01L | demonstrate knowledge of <b>low voltage three-phase transformers</b> , their applications and operation | explain the operating principles of <b>low voltage three-phase transformers</b>                                    |
|             |   | identify types of <b>low voltage three-phase transformers</b> and describe their characteristics and applications  |
|             |   | identify <b>winding configurations</b> for <b>low voltage three-phase transformers</b>                             |
|             |   | interpret codes and regulations pertaining to <b>low voltage three-phase transformers</b>                          |
|             |   | identify <b>low voltage three-phase transformer components</b> and describe their characteristics and applications |
|             |   | interpret information contained on <b>low voltage three-phase transformer</b> nameplates                           |
|             |   | explain <b>low voltage three-phase transformer</b> polarity and terminal markings                                  |
| B-15.06.02L | demonstrate knowledge of procedures used to maintain <b>low voltage three-phase transformers</b>        | describe the procedures used to maintain <b>low voltage three-phase transformers</b>                               |



## RANGE OF VARIABLES

**low voltage three-phase transformers** include: dry-type, liquid-filled, isolation, step-down, step-up, auto, wye, delta

**winding configurations** include: wye-wye, wye-delta, delta-wye, open-delta, delta-delta, zig-zag

**low voltage three-phase transformer components** include: ventilation fans, casings and enclosures, core, primary and secondary windings, bushings, on-line and off-line tap changers, dielectric liquid

### B-15.07 Installs high voltage transformers

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 3                                |
| Essential Skills     | Numeracy, Thinking, Document Use |

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| B-15.07.01L | demonstrate knowledge of <b>high voltage transformers</b> , their applications and operation | explain the operating principles of <b>high voltage transformers</b>                                    |
|             |  | identify terminology associated with <b>high voltage transformers</b>                                   |
|             |  | interpret codes and regulations pertaining to <b>high voltage transformers</b>                          |
|             |  | identify types of <b>high voltage transformers</b> and describe their characteristics and applications  |
|             |  | identify <b>winding configurations</b> for <b>high voltage transformers</b>                             |
|             |  | identify <b>high voltage transformer components</b> and describe their characteristics and applications |
|             |  | interpret information contained on <b>high voltage transformer</b> nameplates                           |
|             |  | explain <b>high voltage transformer</b> polarity and terminal markings                                  |
| B-15.07.02L | demonstrate knowledge of procedures used to install <b>high voltage transformers</b>         | identify the considerations and requirements for selecting <b>high voltage transformers</b>             |
|             |  | describe the procedures used to install <b>high voltage transformers</b>                                |

## RANGE OF VARIABLES

**high voltage transformers** include: liquid-filled, dry

**winding configurations** include: wye-wye, wye-delta, delta-wye, open-delta, delta-delta, zig-zag

**high voltage transformer components** include: oil pumps, ventilation fans, casings and enclosures, core, primary and secondary windings, desiccant breather, bushings, on-line and off-line tap changers, oil temperature, pressure and level gauges, phase indicators

### B-15.08 Maintains high voltage transformers

Apprenticeship Level 3

Essential Skills Oral Communication, Working with Others, Document Use

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives  |
|-------------|--|--|
| B-15.08.01L | demonstrate knowledge of <b>high voltage transformers</b> , their applications and operation | explain the operating principles of <b>high voltage transformers</b>                                     |
|             |  | identify types of <b>high voltage transformers</b> and describe their characteristics and applications   |
|             |  | identify <b>winding configurations</b> for <b>high voltage transformers</b>                              |
|             |  | identify high voltage conductors and describe their characteristics and application                      |
|             |  | interpret codes and regulations pertaining to <b>high voltage transformers</b>                           |
|             |  | identify <b>high voltage transformers components</b> and describe their characteristics and applications |
|             |  | interpret information contained on <b>high voltage transformers</b> nameplates                           |
|             |  | explain <b>high voltage transformer</b> polarity and terminal markings                                   |
| B-15.08.02L | demonstrate knowledge of procedures used to maintain <b>high voltage transformers</b>        | identify the considerations and requirements for selecting <b>high voltage transformers</b>              |
|             |  | describe the procedures used to maintain <b>high voltage transformers</b>                                |

## **RANGE OF VARIABLES**

***high voltage transformers*** are: liquid-filled, dry

***winding configurations*** include: wye-wye, wye-delta, delta-wye, open-delta, delta-delta, zig-zag

***high voltage transformer components*** include: oil pumps, ventilation fans, casings and enclosures, core, primary and secondary windings, bushings, on-line and off-line tap changers, dielectric liquid, indicators (pressure gauges, level gauges, temperature gauges), cooling fins, conservator, desiccant breather

# MAJOR WORK ACTIVITY C

## Installs and maintains wiring systems

### TASK C-16 Installs and maintains raceways, cables, conductors and enclosures

#### TASK DESCRIPTOR

Raceways contain and protect conductors and cables. Enclosures may be used to access and terminate the content of the raceway, and to facilitate the installation of conductors and the interconnection of components. Raceways and cables are installed in various environments. Industrial electricians install, and maintain raceways, cables and conductors.

It is understood that conduits and tubing are raceways, however for the purpose of this standard, raceways are separated from conduits and tubing to identify the different skills needed to install and maintain them.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard, “maintain” includes inspection, preventative/predictive maintenance, troubleshooting, replacing and repairing activities.

#### C-16.01 Installs conductors and cables

Apprenticeship Level 1,2

Essential Skills Thinking, Numeracy, Document Use

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives  |
|-------------|--|--|
| C-16.01.01L | demonstrate knowledge of types of conductors, cables and their associated <b>components</b>                              | identify terminology associated with conductors, cables and their associated <b>components</b>                       |
|             |  | identify types of conductors, cables and <b>components</b> and describe their characteristics and applications       |
|             |  | interpret codes, standards and regulations pertaining to conductors and cables                                       |
|             |  | interpret information pertaining to conductors and cables found on drawings and specifications                       |
| C-16.01.02L | demonstrate knowledge of procedures used to remove and install conductors, cables and their associated <b>components</b> | identify the considerations and requirements for selecting conductors, cables and their associated <b>components</b> |

|  |   |
|--|---|
|  | describe the procedures used to remove conductors, cables and their associated <b>components</b>                      |
|  | describe the procedures used to prepare and install conductors, cables and their associated <b>components</b>         |
|  | describe the procedures used to terminate conductors and cables   |
|  | identify the considerations and requirements for removal of conductors, cables and their associated <b>components</b> |

## RANGE OF VARIABLES

**components** include: mechanical fittings, compression fittings, supports, straps, connectors, hangers, heat shrink, anti-oxidant compound

## C-16.02 Maintains conductors and cables

|                      |   |
|----------------------|---|
| Apprenticeship Level | 1,2                                       |
| Essential Skills     | Digital Technology, Reading, Document Use |

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| C-16.02.01L | demonstrate knowledge of the different types of conductors, cables and their associated components     | identify environmental conditions, hazards, incidents, situations and inside/outside conditions that can cause faults in specific types of conductors, cables and their associated components |
|             |  | interpret information pertaining to conductors and cables found on manufacturers' specifications and previous records   |
|             |  | interpret codes, standards and regulations pertaining to conductors and cables  |
| C-16.02.02L | demonstrate knowledge of the procedures to maintain conductors, cables and their associated components | identify the <b>considerations</b> when maintaining conductors, cables and their associated components  |
|             |  | describe the <b>procedures</b> to maintain conductors, cables and their associated components   |

## RANGE OF VARIABLES

**considerations** include: integrity of the insulation, tightness of the terminations, odours, colour, physical protection, supports, movement due to temperature or vibration

**procedures** include: thermographic surveys, multimeter testing, megohmmeter testing (resistance testing), hi-pot testing, sensory testing (visual, smell and touch)

### C-16.03 Installs conduit, tubing and fittings

Apprenticeship Level 1,2

Essential Skills Numeracy, Thinking, Working with Others

#### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| C-16.03.01L | demonstrate knowledge of types of conduit, tubing and <b>fittings, their components</b> and applications  | identify types of conduit, tubing, <b>fittings and components</b> and describe their characteristics, applications and limitations |
|             |   | identify <b>tools and equipment</b> related to conduit, tubing and fittings and describe their applications and procedures for use |
|             |   | interpret information pertaining to conduit, tubing and fittings found on drawings and specifications                              |
|             |   | interpret codes and regulations pertaining to conduit, tubing, <b>fittings and components</b>                                      |
| C-16.03.02L | demonstrate knowledge of procedures to remove and install conduit, tubing, <b>fittings and components</b> | describe the procedures used to cut, thread (if applicable) and bend conduit and tubing  |
|             |   | describe the procedures used to install and support conduit and tubing, <b>fittings and components</b>                             |
|             |   | identify the considerations and requirements for removal of conduit, tubing and <b>fittings and components</b>                     |
|             |   | describe the procedures used for the removal of conduit and tubing, <b>fittings and components</b>                                 |
|             |   | interpret codes and regulations pertaining to conduit, tubing, <b>fittings and components</b>                                      |
|             |   | identify considerations of other trades within the same project  |

## RANGE OF VARIABLES

**fittings and components** include: mechanical fittings, rain-tight fittings, EYS, supports, straps, connectors, couplings, reducers, bushings, LB, LR, LL, Tee, close nipple, chase nipple, terminal adapters, offset, 90 degrees, 45 degrees, long and short sweeps, PVC cement, expansion joints, lock nuts, unions

**tools and equipment** include: PVC benders, heat guns, pipe benders, pipe threading machines, power pipe benders, equipment for specialized conduit systems

### C-16.04 Installs raceways

Apprenticeship Level 1,2

Essential Skills Numeracy, Thinking, Working with Others

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives  |
|-------------|--|--|
| C-16.04.01L | demonstrate knowledge of types of <b>raceways</b> and their <b>components</b>              | identify types of <b>raceways</b> and <b>components</b> , and describe their characteristics, applications and limitations |
|             |  | interpret codes, standards and regulations pertaining to <b>raceways</b>   |
|             |  | interpret information pertaining to <b>raceways</b> found on drawings and specifications                                   |
| C-16.04.02L | demonstrate knowledge of procedures used to remove and install and support <b>raceways</b> | identify the considerations and requirements for selecting <b>raceways</b> and their <b>components</b>                     |
|             |  | describe the procedures used to install and support <b>raceways</b> and their <b>components</b>                            |
|             |  | identify the considerations and requirements for removal of <b>raceways</b> and their <b>components</b>                    |
|             |  | describe the procedures used to remove <b>raceways</b> and their <b>components</b>   |
|             |  | identify considerations of other trades within the same project  |

## RANGE OF VARIABLES

**raceways**, in this sub-task include: cable tray, ladder tray, wire trays, underfloor raceways, busways, cellular raceways, surface raceways

**raceways** in this sub-task, do not include: conduit and tubing as these are covered in sub-task 16.03

**raceway components** include: fittings (couplings and connectors), supports, expansion joints

## C-16.05 Installs boxes and enclosures

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 1,2                              |
| Essential Skills     | Thinking, Numeracy, Document Use |

### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| C-16.05.01L | demonstrate knowledge of boxes and <b>enclosures</b>  | identify types of boxes and <b>enclosures</b> and describe their characteristics, applications and limitations |
|             |   | interpret codes, standards and regulations pertaining to boxes and <b>enclosures</b>                           |
|             |   | interpret information pertaining to boxes and <b>enclosures</b> found on drawings and specifications           |
| C-16.05.02L | demonstrate knowledge of procedures used to remove, install and support boxes and <b>enclosures</b> | identify the <b>considerations</b> and requirements for selecting boxes and <b>enclosures</b>                  |
|             |   | describe the procedures used to determine placement and to mount boxes and <b>enclosures</b>                   |
|             |   | identify the <b>considerations</b> and requirements for removal of boxes and <b>enclosures</b>                 |
|             |   | describe the procedures used to remove boxes and <b>enclosures</b>   |
|             |   | identify <b>considerations</b> of other trades within the same project   |

### RANGE OF VARIABLES

**considerations** include: materials, volume, dimensions, positioning, environment, accessibility, size of raceway or cable entering the box or enclosure, CSA types, Ingress Protection (IP) types

**enclosures** do not include: enclosure types for specific electrical equipment such as rotating equipment, transformers, panel boards, motor starters and other fixed equipment



## C-16.06 Maintains conduit, tubing, fittings, raceways, boxes and enclosures

|                      |   |
|----------------------|---|
| Apprenticeship Level | 1,2                                       |
| Essential Skills     | Reading, Document Use, Oral Communication |

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| C-16.06.01L | demonstrate knowledge of the types of conduit, tubing, fittings, raceways, boxes and enclosures and their associated <b>components</b>               | <p>identify environmental conditions, hazards, incidents, situations and inside/outside conditions that can cause damage in specific types of conduit, tubing, fittings, raceways, boxes and enclosures and their associated <b>components</b></p> <p>interpret codes, standards and regulations pertaining to conduit, tubing, fittings, raceways, boxes and enclosures and their associated <b>components</b></p>   |
| C-16.06.02L | demonstrate knowledge of the procedures to maintain conduit, tubing, fittings, raceways, boxes and enclosures and their associated <b>components</b> | <p>identify the <b>considerations</b> when maintaining conduit, tubing, fittings, raceways, boxes and enclosures and their associated <b>components</b></p> <p>describe the procedures to repair or replace conduit, tubing, fittings, raceways, boxes and enclosures and their associated <b>components</b></p> <p>describe the procedures to tighten or adjust conduit, tubing, fittings, raceways, boxes and enclosures and their associated <b>components</b></p> <p>describe the <b>procedures</b> to clean conduit, tubing, fittings, raceways, boxes and enclosures and their associated <b>components</b></p> |

### RANGE OF VARIABLES

**considerations** include: corrosion, condition of supports, tightness and presence of mounting screws, tightness of locknuts, physical damage, cleanliness

**components** include: supports, expansion joints, straps, connectors, couplings, screws, bolts, locknuts

## TASK C-17 Installs and maintains branch circuitry and devices

### TASK DESCRIPTOR

Various devices and luminaires are installed to meet the power and lighting requirements of the end user. Branch circuitry components are installed in a manner which makes the power safe and convenient to use. Lighting systems are used to illuminate specified areas according to consumer needs. Lighting controls operate light functions, adjust lighting levels and optimize efficiency. Industrial electricians install and maintain branch circuitry.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard, “maintain” includes inspection, preventative/predictive maintenance, troubleshooting, replacing and repairing activities.

### C-17.01 Installs luminaires

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 1,2,3                            |
| Essential Skills     | Numeracy, Thinking, Document Use |

#### KNOWLEDGE

##### Learning Outcomes

##### Learning Objectives

|             |  |   |
|-------------|--|---|
| C-17.01.01L | demonstrate knowledge of <b><i>luminaires</i></b> , their applications and operation                             | identify types of <b><i>luminaires</i></b> and describe their applications and operation                      |
|             |  | identify <b><i>luminaires</i></b> components and describe their characteristics and applications              |
|             |  | interpret codes, standards and regulations pertaining to <b><i>luminaires</i></b>                             |
|             |  | interpret information pertaining to <b><i>luminaires</i></b> found on drawings and specifications             |
| C-17.01.02L | demonstrate knowledge of the procedures used to remove, install, dispose of and support <b><i>luminaires</i></b> | identify the considerations and requirements for the removal of <b><i>luminaires</i></b> and their components |
|             |  | identify the considerations and requirements for selecting <b><i>luminaires</i></b> and their components      |
|             |  | describe the procedures to remove <b><i>luminaires</i></b> and their components                               |
|             |  | describe the procedures to retrofit <b><i>luminaires</i></b> and their components                             |
|             |  | describe the procedures used to install and support <b><i>luminaires</i></b> and their components             |

---

describe the procedures used to perform tests related to **luminaires**

---

describe the procedures for disposal of **luminaires** and their components

---

## RANGE OF VARIABLES

**luminaires** include: HID, LED, incandescent, fluorescent, lighting standards

---

### **C-17.02** Maintains luminaires

---

**Apprenticeship Level** 1,2,3

---

**Essential Skills** Document Use, Thinking, Reading

---

#### KNOWLEDGE

##### Learning Outcomes

##### Learning Objectives

|             |   |  |
|-------------|---|--|
| C-17.02.01L | demonstrate knowledge of branch circuitry and <b>luminaire</b> components                                 | identify types of branch circuitry and components of the <b>luminaires</b> and describe their applications and operation |
| C-17.02.02L | demonstrate knowledge of the procedures used to maintain branch circuitry and <b>luminaire</b> components | describe the procedures used to maintain branch circuitry and <b>luminaire</b> components                                |

---

## RANGE OF VARIABLES

**luminaires** include: HID, LED, incandescent, fluorescent, lighting standards

---

### **C-17.03** Installs wiring devices

---

**Apprenticeship Level** 1,2,3

---

**Essential Skills** Thinking, Numeracy, Document Use

---

#### KNOWLEDGE

##### Learning Outcomes

##### Learning Objectives

|             |   |  |
|-------------|---|--|
| C-17.03.01L | demonstrate knowledge of <b>wiring devices</b> , their applications and operation | identify types of <b>wiring devices</b> and describe their applications and operation          |
|             |   | interpret codes, standards and regulations pertaining to <b>wiring devices</b>                 |
|             |   | interpret information pertaining to <b>wiring devices</b> found on drawings and specifications |

---

|             |  |   |
|-------------|--|---|
| C-17.03.02L | demonstrate knowledge of the procedures used to remove and install <b>wiring devices</b> | identify the considerations and requirements for the removal of <b>wiring devices</b> |
|             |  | identify the considerations and requirements for selecting <b>wiring devices</b>      |
|             |  | describe the procedures to install and remove <b>wiring devices</b>                   |

## RANGE OF VARIABLES

**wiring devices** include: switches, timers, sensors, relays, controllers, disconnects, power outlets, receptacles

## C-17.04 Maintains wiring devices

|                             |                                 |
|-----------------------------|---------------------------------|
| <b>Apprenticeship Level</b> | 1,2,3                           |
| <b>Essential Skills</b>     | Document Use, Thinking, Reading |

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| C-17.04.01L | demonstrate knowledge of branch circuitry and wiring device components                                 | identify types of branch circuitry and wiring device components and describe their applications and operation |
| C-17.04.02L | demonstrate knowledge of the procedures used to maintain branch circuitry and wiring device components | describe the procedures used to maintain branch circuitry and wiring device components                        |

## TASK C-18 Installs and maintains heating, ventilation and air-conditioning (HVAC) electrical components

### TASK DESCRIPTOR

Heating, ventilation and cooling systems (in this task, that is, systems where electricity is not the sole source of energy) are typically installed by other trades, but are electrically connected by industrial electricians. Industrial electricians connect power to HVAC systems, HVAC associated equipment and controls. They also install HVAC system controls as well as repair or replace HVAC components, controls and associated equipment.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard, “maintain” includes inspections, preventative/predictive maintenance, troubleshooting, replacing and repairing activities.

### C-18.01 Connects power to HVAC systems and associated equipment

|                      |  |
|----------------------|--|
| Apprenticeship Level | 2  |
| Essential Skills     | Reading, Working with Others, Oral Communication |

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| C-18.01.01L | demonstrate knowledge of <b>HVAC systems</b> , their applications and operation                      | identify terminology associated with <b>HVAC systems</b> , controls and <b>associated equipment</b>       |
|             |  | identify types of <b>HVAC systems</b> and describe their characteristics and applications                 |
|             |  | interpret information pertaining to <b>HVAC systems</b> found on drawings, specifications and nameplates  |
|             |  | interpret codes, standards and regulations pertaining to the electrical components of <b>HVAC systems</b> |
| C-18.01.02L | demonstrate knowledge of the procedures used to connect <b>HVAC systems and associated equipment</b> | identify considerations and requirements for connecting <b>HVAC systems and associated equipment</b>      |
|             |  | describe the procedures used to connect <b>HVAC systems and associated equipment</b>                      |

### RANGE OF VARIABLES

**HVAC systems and associated equipment** includes: circulating pumps, dampers, boilers, air compressors, refrigeration compressors, condensers, evaporators, chillers

## C-18.02 Installs HVAC controls

|                      |  |
|----------------------|--|
| Apprenticeship Level | 2                                      |
| Essential Skills     | Reading, Working with Others, Numeracy |

### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives   |
|-------------|---|---|
| C-18.02.01L | demonstrate knowledge of types of HVAC <b>control components</b> , their applications and operation                 | identify types of HVAC <b>control components</b> and describe their characteristics and applications    |
|             |   | interpret information pertaining to HVAC <b>control components</b> found on drawings and specifications |
|             |   | interpret codes and regulations pertaining to HVAC <b>control components</b>                            |
| C-18.02.02L | demonstrate knowledge of the procedures used to install or replace, connect and test HVAC <b>control components</b> | identify the considerations and requirements for removal of HVAC <b>control components</b>              |
|             |   | identify considerations and requirements for selecting HVAC <b>control components</b>                   |
|             |   | describe the procedures used to isolate and remove HVAC <b>control components</b>                       |
|             |   | describe the procedures used to install HVAC <b>control components</b>                                  |
|             |   | describe the procedures used to connect HVAC <b>control components</b>                                  |
|             |   | describe the procedures used to test HVAC <b>control components</b>                                     |

### RANGE OF VARIABLES

**control components** include: time clocks, relays, sensors, thermostats, actuators, electrical interlocks, multiple function controllers, variable frequency drive (VFD), discrete and analog devices

## C-18.03 Maintains HVAC electrical components

|                      |  |
|----------------------|--|
| Apprenticeship Level | 2  |
| Essential Skills     | Reading, Working with Others, Oral Communication |

### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives   |
|-------------|---|---|
| C-18.03.01L | demonstrate knowledge of the complete <b>HVAC system</b> and <b>controls</b> and the individual <b>electrical components</b>            | <p>identify terminology associated with <b>HVAC system</b> and <b>controls</b> and the individual <b>electrical components</b></p> <p>identify types of <b>HVAC systems and controls</b> and describe their characteristics, applications and operation</p>   |
| C-18.03.02L | demonstrate knowledge of the interaction between the individual <b>electrical components</b> and their effect on the <b>HVAC system</b> | identify how the operation or failure of an individual component impacts other components or the complete system  |
| C-18.03.03L | demonstrate knowledge of the procedures used to maintain HVAC <b>electrical components</b>  | <p>describe the procedures used to troubleshoot faults in <b>electrical components</b></p> <p>describe the procedures used to repair and replace <b>electrical components</b></p> <p>describe the procedures used to adjust and reprogram <b>electrical components</b></p> <p>describe the procedures used to verify operation of the repaired <b>electrical components</b></p> |

### RANGE OF VARIABLES

**HVAC systems and associated equipment** include: circulating pumps, dampers, boilers, air compressors, refrigeration compressors, condensers, evaporators, chillers

**electrical components** include: motor, thermostat, pressure switch, temperature switch, flow switch, level switch, VFDs, discrete and analog sensors

## TASK C-19 Installs and maintains electric heating systems and controls

### TASK DESCRIPTOR

Electric heating systems and their associated control devices are sized, installed and connected by Industrial electricians.

Industrial electricians maintain electric heating systems and their associated controls by performing inspections, troubleshooting, diagnosing faults, and repairing them. They also perform maintenance to ensure electric heating systems and their associated control devices are in operating condition.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard, “maintain” includes inspection, preventative/predictive maintenance, troubleshooting, replacing and repairing activities.

### C-19.01 Installs electric heating systems and controls

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 2                                |
| Essential Skills     | Numeracy, Document Use, Thinking |

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives  |
|-------------|--|--|
| C-19.01.01L | demonstrate knowledge of <b>electric heating systems</b> and <b>controls</b> , their applications and operation        | identify terminology associated with <b>electric heating systems</b> and <b>controls</b>   |
|             |  | identify types of <b>electric heating systems</b> and describe their applications and operation  |
|             |  | identify types of electric heating <b>controls</b> and describe their applications and operation   |
|             |  | interpret codes, standards and regulations pertaining to sizing and installing <b>electric heating systems</b> and <b>controls</b>   |
| C-19.01.02L | demonstrate knowledge of the procedures used to remove and install <b>electric heating systems</b> and <b>controls</b> | identify the considerations and requirements for the removal of <b>electric heating systems</b> and <b>controls</b> including safety and loss of heating capacity  |
|             |  | identify the considerations and requirements for selecting <b>electric heating systems</b> and <b>controls</b> and their components including existing controls and systems, service capacity, and heating application |
|             |  | describe the procedures used to <b>calculate heat loss</b>   |



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describe the procedures to remove  
**electric heating systems and controls**

---

describe the procedures used to install  
**electric heating systems and controls**

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## RANGE OF VARIABLES

**electric heating systems** include: electric tanks and boiler, convection heaters, radiant heaters, heat tracing cables, heating cable sets, forced air unit heater, induction heaters and other industrial heaters

**controls** include: line voltage thermostats, low voltage thermostats, low voltage relays, temperature limit switches, temperature digital controllers

**heat loss calculations** include: volume of space being heated, thermal properties of surrounding structure, inside design temperature, outside design temperature

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## C-19.02 Maintains electric heating systems and controls

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Apprenticeship Level 2

Essential Skills Document Use, Numeracy, Digital Technology

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### KNOWLEDGE

#### Learning Outcomes

#### Learning Objectives

C-19.02.01L demonstrate knowledge of **electric heating systems and controls**

identify terminology associated with  
**electric heating systems and controls**

identify types of **electric heating systems and controls** and their components and describe their characteristics, applications and operation

describe the operation of the **electric heating system and controls**

C-19.02.02L demonstrate knowledge of the procedures used to maintain **electric heating systems and controls**

describe the procedures used to troubleshoot faults in **electric heating systems and controls**

describe the procedures used to repair or replace **electric heating systems and controls**

describe the procedures used to verify the operation of repaired **electrical heating systems and controls**

---

## RANGE OF VARIABLES

**electric heating systems** include: electric tanks and boiler, convection heaters, radiant heaters, heat tracing cables, heating cable sets, forced air unit heater, induction heaters and other industrial heaters

**controls** include: line voltage thermostats, low voltage thermostats, low voltage relays, temperature limit switches, temperature digital controllers

## TASK C-20 Installs and maintains exit and emergency lighting systems

### TASK DESCRIPTOR

Exit and emergency lighting systems are used to facilitate safe egress from buildings during emergency situations. The systems can be powered by back-up power supplies such as batteries or stand-by generators. The required size and placement are determined by AHJ and building codes. Industrial electricians install and maintain exit and emergency lighting systems.

Industrial electricians maintain exit and emergency lighting systems by performing inspections, troubleshooting, diagnosing faults, and repairing them. They also perform maintenance to ensure exit and emergency lighting systems are in operating condition. They also record all inspection and maintenance results according to AHJ.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard, “maintain” includes inspection, preventative/predictive maintenance, troubleshooting, replacing and repairing activities.

### C-20.01 Installs exit and emergency lighting systems

|                      |                                 |
|----------------------|---------------------------------|
| Apprenticeship Level | 2                               |
| Essential Skills     | Document Use, Reading, Numeracy |

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives  |
|-------------|--|--|
| C-20.01.01L | demonstrate knowledge of <b>exit and emergency lighting systems</b> , their applications and operation                             | identify terminology associated with <b>exit and emergency lighting systems</b>  |
|             |  | identify types of <b>exit and emergency lighting systems</b> and describe their applications and operation                               |
|             |  | interpret information pertaining to <b>exit and emergency lighting systems</b> found on drawings and specifications                      |
|             |  | identify exit and emergency lighting components and describe their characteristics and applications                                      |
| C-20.01.02L | demonstrate knowledge of the procedures used to remove and install <b>exit and emergency lighting systems</b> and their components | interpret codes, standards and regulations pertaining to <b>exit and emergency lighting systems</b>                                      |
|             |  | identify the considerations, calculations and requirements for selecting <b>exit and emergency lighting systems</b> and their components |

|  |  |
|--|--|
|  | describe the procedures to remove <b>exit and emergency lighting systems</b> and their components  |
|  | describe the procedure used to install <b>exit and emergency lighting systems</b> and their components                                       |
|  | describe the procedures used to test <b>exit and emergency lighting systems</b> and their components and complete the documentation          |
|  | identify the considerations and requirements for the removal and disposal of <b>exit and emergency lighting systems</b> and their components |

## RANGE OF VARIABLES

**exit and emergency lighting systems** include: unit equipment, normal and standby (emergency) powered, remote lighting units and associated wiring components and circuits

## C-20.02 Maintains exit and emergency lighting systems

|                      |                                 |
|----------------------|---------------------------------|
| Apprenticeship Level | 2                               |
| Essential Skills     | Document Use, Thinking, Writing |

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives  |
|-------------|--|--|
| C-20.02.01L | demonstrate knowledge of <b>exit and emergency lighting systems</b> , their applications and operation | identify terminology associated with <b>exit and emergency lighting systems</b>                            |
|             |  | identify types of <b>exit and emergency lighting systems</b> and describe their applications and operation |
|             |  | identify exit and emergency lighting system components and describe their applications and operation       |
| C-20.02.02L | demonstrate knowledge of the procedures used to maintain <b>exit and emergency lighting systems</b>    | describe the procedures used to maintain <b>exit and emergency lighting systems</b> and their components   |
|             |  | describe the requirements to record and document test results  |

## RANGE OF VARIABLES

**exit and emergency lighting systems** include: unit equipment, normal and standby (emergency) powered, remote lighting units and associated wiring components and circuits

## TASK C-21 Installs and maintains cathodic protection systems

### TASK DESCRIPTOR

Cathodic protection systems refer to impressed DC current cathodic protection systems that introduce an electrical current onto a tank, pipe or structure to limit corrosion and oxidization. Industrial electricians install these systems in various environments according to specifications.

Industrial electricians maintain cathodic protection systems by performing visual inspections, troubleshooting, diagnosing faults, and repairing them. They also perform maintenance to ensure cathodic systems are in operating condition.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard, “maintain” includes inspection, preventative/predictive maintenance, troubleshooting, replacing and repairing activities.

### C-21.01 Installs cathodic protection systems

Apprenticeship Level 2

Essential Skills Working with Others, Document Use, Reading

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| C-21.01.01L | demonstrate knowledge of cathodic protection systems, their applications and operation | identify terminology associated with cathodic protection systems  |
|             |  | identify types of cathodic protection systems, and describe their characteristics, applications and operation                   |
|             |  | identify cathodic protection systems and their <b>components</b> and describe their characteristics, applications and operation |
|             |  | interpret information pertaining to cathodic protection systems found on drawings and specifications                            |
|             |  | interpret codes and regulations pertaining to cathodic protection systems   |

|             |  |   |
|-------------|--|---|
| C-21.01.02L | demonstrate knowledge of the procedures used to install, connect, and test cathodic protection systems | describe the procedures used to install cathodic protection systems and their <b>components</b> |
|             |  | describe the procedures used to test cathodic protection systems and their <b>components</b>    |

## RANGE OF VARIABLES

**cathodic protection system components** include: AC supply, disconnect, rectifiers, associated DC wiring, sacrificial anode, metering, indicators, remote reference points, tap settings in rectifier enclosure, insulation kits, breaker, cabling

## C-21.02 Maintains cathodic protection systems

|                      |                                 |
|----------------------|---------------------------------|
| Apprenticeship Level | 2                               |
| Essential Skills     | Document Use, Writing, Thinking |

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| C-21.02.01L | demonstrate knowledge of cathodic protection systems, their applications and operation | identify terminology associated with cathodic protection systems  |
|             |  | identify types of <b>cathodic protection systems and components</b> and describe their applications and operation |
| C-21.02.02L | demonstrate knowledge of the procedures used to maintain cathodic protection systems   | describe the procedures used to maintain cathodic protection systems  |

## RANGE OF VARIABLES

**cathodic protection system components** include: AC supply, disconnect, rectifiers, associated DC wiring, sacrificial anode, metering, indicators, remote reference points, tap settings in rectifier enclosure, insulation kits, breaker, cabling

# MAJOR WORK ACTIVITY D

## Installs and maintains rotating and non-rotating equipment and control systems

### TASK D-22 Installs and maintains motor starters and control devices

#### TASK DESCRIPTOR

All electrical motors need a method to be started, protected and controlled. These controls can be as simple as a single switch, or as complex as a starter assembly. Industrial electricians install and maintain these starters and controls in the motor circuits.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing motor starters, control devices and their components.

For the purpose of this standard “maintain” includes inspection, preventive/predictive maintenance, troubleshooting, replacing and repairing activities.

#### D-22.01 Installs motor starters

Apprenticeship Level 2,3

Essential Skills Thinking, Document Use, Numeracy

#### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives   |
|-------------|---|---|
| D-22.01.01L | demonstrate knowledge of <b>motor starters</b> and their applications                 | interpret information pertaining to <b>motor starters</b> found on motor nameplate, drawings and specifications |
|             |   | describe <b>motor starters</b> and their applications   |
|             |   | interpret codes and regulations pertaining to <b>motor starters</b>   |
| D-22.01.02L | demonstrate knowledge of procedures used to install and connect <b>motor starters</b> | describe the procedures used to install <b>motor starters</b> , their components and accessories                |
|             |   | describe the procedures used to connect <b>motor starters</b> , their components and accessories                |
|             |   | identify enclosures and wiring methods based on application   |

## RANGE OF VARIABLES

**motor starters** include: starters for AC/DC motors, single phase, three phase AC, line voltage starters, soft starters, reduced-voltage starters

### D-22.02 Maintains motor starters

Apprenticeship Level 2,3

Essential Skills Oral Communication, Digital Technology, Document Use

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives  |
|-------------|--|--|
| D-22.02.01L | demonstrate knowledge of <b>motor starters</b> and their applications      | interpret information pertaining to <b>motor starters</b> found on drawings and specifications<br>describe <b>motor starters</b> and their applications                  |
| D-22.02.02L | demonstrate knowledge of procedures used to maintain <b>motor starters</b> | interpret codes and regulations pertaining to <b>motor starters</b><br>describe the procedures used to maintain <b>motor starters</b> , their components and accessories |

## RANGE OF VARIABLES

**motor starters** include: starters for AC/DC motors, single phase, three phase AC, line voltage starters, soft starters, reduced-voltage starters

### D-22.03 Installs motor control devices

Apprenticeship Level 2,3

Essential Skills Thinking, Numeracy, Document Use

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| D-22.03.01L | demonstrate knowledge of <b>motor control devices</b> and their applications | interpret information pertaining to <b>motor control devices</b> found on drawings and specifications<br>describe <b>motor control devices</b> and their applications<br>interpret codes and regulations pertaining to <b>motor control devices</b> |

|             |   |  |
|-------------|---|--|
| D-22.03.02L | demonstrate knowledge of <b>motor control circuits</b> , their characteristics and applications | interpret codes and regulations pertaining to <b>motor control circuits</b>  |
|             |   | identify <b>circuit types</b> and describe their characteristics and applications                                  |
|             |   | describe <b>circuit functional features</b> of common hard wired or networked motor control circuits               |
|             |   | identify the methods used to determine the number of conductors required between controls and controller locations |
|             |   | identify <b>protection devices</b> for <b>motor control circuits</b> and describe characteristics and applications |

## RANGE OF VARIABLES

**motor control devices** include: emergency stop stations, start/stop stations, PLCs, pilot devices (limit switches, proximity switches, float switches, sail switches, photo detectors)

**motor control circuits** include: low-voltage release (two-wire control), low-voltage protection (three-wire control)

**circuit functional features** include: starting and stopping, forward/reverse, sequencing, jogging, quick stop (plugging), multiple location control, time function

**protection devices for control circuits** include: overcurrent devices

## D-22.04 Maintains motor control devices

Apprenticeship Level 2,3

Essential Skills Oral Communication, Digital Technology, Document Use

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| D-22.04.01L | demonstrate knowledge of <b>motor control devices</b> and their applications                           | interpret information pertaining to <b>motor control devices</b> found on drawings and specifications |
|             |  | describe <b>motor control devices</b> and their applications  |
|             |  | interpret codes and regulations pertaining to <b>motor control devices</b>                            |
| D-22.04.02L | demonstrate knowledge of procedures used to maintain <b>motor control devices</b> and their components | describe the procedures used to maintain <b>motor control devices</b> and their components            |



## RANGE OF VARIABLES

**motor control devices** include: emergency stop stations, start/stop stations, PLCs, pilot devices (limit switches, proximity switches, float switches, sail switches, photo detectors)

## TASK D-23 Installs and maintains drives

### TASK DESCRIPTOR

Electrical motors can be controlled by both AC and DC drives to achieve precision operation (e.g. speed, positioning) of the motors depending on the application. Industrial electricians install and maintain these drives in the motor circuits. They also perform maintenance to ensure motor drives and their controls are in good operating condition.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard, “maintain” includes inspection, preventive/predictive maintenance, troubleshooting, replacing and repairing activities.

Both installation and maintenance include programming and tuning.

### D-23.01 Installs AC drives

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 3                                |
| Essential Skills     | Document Use, Numeracy, Thinking |

### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| D-23.01.01L | demonstrate knowledge of types of AC drives, their applications and operation | identify types of AC drives and describe their characteristics, applications and operation                         |
|             |   | identify <b>AC drive components</b> and accessories and describe their characteristics, applications and operation |
|             |   | interpret information pertaining to AC drives found on drawings and specifications                                 |
|             |   | interpret codes and regulations pertaining to AC drives  |
| D-23.01.02L | demonstrate knowledge of procedures used to install and connect AC drives     | identify the considerations and requirements for selecting AC drives and their <b>components</b>                   |

---

describe the procedures used to install AC drives and their **components**

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describe the procedures used to program AC drives and their **components**

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## RANGE OF VARIABLES

**AC drive components** include: rectifiers, electro-magnetic compatibility (EMC) filters, DC circuits, inverters, reactors, field components (e.g. encoders, tachometers)

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## D-23.02 Maintains AC drives

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Apprenticeship Level 3

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Essential Skills Thinking, Digital Technology, Document Use

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### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| D-23.02.01L | demonstrate knowledge of types of AC drives, their applications and operation | identify types of AC drives and describe their characteristics, applications and operation         |
|             |   | identify <b>AC drive components</b> and describe their characteristics, applications and operation |
|             |   | interpret information pertaining to AC drives found on drawings and specifications                 |
|             |   | interpret codes and regulations pertaining to AC drives  |
| D-23.02.02L | demonstrate knowledge of procedures used to maintain AC drives                | explain operating principles of AC drives and their impact on motor performance                    |
|             |   | describe the procedures used to maintain AC drives and their <b>components</b>                     |

## RANGE OF VARIABLES

**AC drive components** include: rectifiers, EMC filters, DC circuits, inverters

## D-23.03 Installs DC drives

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 3                                |
| Essential Skills     | Document Use, Numeracy, Thinking |

### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| D-23.03.01L | demonstrate knowledge of types of DC drives, their applications and operation | identify types of DC drives and describe their characteristics, applications and operation         |
|             |   | identify <b>DC drive components</b> and describe their characteristics, applications and operation |
|             |   | interpret information pertaining to DC drives found on drawings and specifications                 |
|             |   | interpret codes and regulations pertaining to DC drives  |
| D-23.03.02L | demonstrate knowledge of procedures used to install and connect DC drives     | explain operating principles of DC drives and their impact on motor performance                    |
|             |   | identify the considerations and requirements for selecting DC drives and their <b>components</b>   |
|             |   | describe the procedures used to install DC drives and their <b>components</b>                      |
|             |   | describe the procedures used to connect DC drives and their <b>components</b>                      |
|             |   | describe the procedures used to program DC drives and their <b>components</b>                      |

### RANGE OF VARIABLES

**DC drive components** include: power supply, converters, speed controls, tension controls, torque controls, EMC filters, DC circuits, control boards, power semi-conductors, enclosure components, feedback loops, and field components (e.g. encoders and tachometers)

## D-23.04 Maintains DC drives

|                      |                                       |
|----------------------|---------------------------------------|
| Apprenticeship Level | 3                                     |
| Essential Skills     | Thinking, Digital Technology, Writing |

### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| D-23.04.01L | demonstrate knowledge of types of DC drives, their applications and operation | identify types of DC drives and describe their characteristics, applications and operation         |
|             |   | identify <b>DC drive components</b> and describe their characteristics, applications and operation |
|             |   | interpret information pertaining to DC drives found on drawings and specifications                 |
|             |   | interpret codes and regulations pertaining to DC drives  |
| D-23.04.02L | demonstrate knowledge of procedures used to maintain DC drives                | explain operating principles of DC drives and their impact on motor performance                    |
|             |   | describe the procedures used to maintain DC drives and their <b>components</b>                     |

### RANGE OF VARIABLES

**DC drive components** include: power supply, converters, speed controls, tension controls, torque controls, EMC filters, DC circuits, control boards, power semi-conductors, enclosure components, feedback loops, and field components (e.g. encoders and tachometers)

## TASK D-24 Installs and maintains non-rotating equipment and associated controls

### TASK DESCRIPTOR

Non-rotating equipment includes welding equipment, electro-magnets, electrostatic precipitators and other non-rotating devices not included elsewhere in this standard and their associated controls. Industrial electricians must install and maintain this equipment.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard “maintain” includes inspection, preventive/predictive maintenance, troubleshooting, replacing and repairing activities.

#### D-24.01 Installs non-rotating equipment and associated controls

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 4                                |
| Essential Skills     | Document Use, Numeracy, Thinking |

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives  |
|-------------|--|--|
| D-24.01.01L | demonstrate knowledge of <b>non-rotating equipment</b> and controls, their applications and procedures for use | identify types of <b>non-rotating equipment</b> and controls and describe their characteristics                            |
|             |  | identify <b>non-rotating equipment</b> components and describe their applications  |
|             |  | interpret codes and regulations for overcurrent protection, conductor sizing, disconnect locations                         |
|             |  | interpret information found on drawings and specifications   |
|             |  | explain operating principles of <b>non-rotating equipment</b> and controls   |
| D-24.01.02L | demonstrate knowledge of procedures used to install and connect <b>non-rotating equipment</b> and controls     | interpret information contained on <b>non-rotating equipment</b> nameplates  |
|             |  | describe procedures used to install <b>non-rotating equipment</b> and controls   |
|             |  | describe procedures used to connect <b>non-rotating equipment</b> and controls   |
|             |  | identify the considerations and requirements for selecting <b>non-rotating equipment</b> and controls and their components |

## RANGE OF VARIABLES

*non-rotating equipment* includes: welding equipment, electro-magnets, electrostatic precipitators

### D-24.02 Maintains non-rotating equipment and associated controls

Apprenticeship Level

4

Essential Skills

Digital Technology, Thinking, Document Use

#### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| D-24.02.01L | demonstrate knowledge of <i>non-rotating equipment</i> and controls, their applications and operation | identify types of <i>non-rotating equipment</i> and controls and describe their characteristics          |
|             |   | identify <i>non-rotating equipment</i> components and describe their applications                        |
|             |   | interpret codes and regulations  |
|             |   | interpret information found on drawings and specifications   |
| D-24.02.02L | demonstrate knowledge of procedures used to maintain of <i>non-rotating equipment</i> and controls    | explain the industrial and operating principles of <i>non-rotating equipment</i> and controls            |
|             |   | describe the procedures used to maintain <i>non-rotating equipment</i> and controls and their components |

## RANGE OF VARIABLES

*non-rotating equipment* includes: welding equipment, electro-magnets, electrostatic precipitators

## TASK D-25 Installs and maintains motors

### TASK DESCRIPTOR

Motors are used to convert electrical energy to mechanical energy. Industrial electricians install and maintain single-phase, three-phase and DC motors.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard “maintain” includes inspection, preventive/predictive maintenance, troubleshooting, replacing and repairing activities.

#### D-25.01 Installs single-phase motors

|                      |     |
|----------------------|-----|
| Apprenticeship Level | 3,4 |
|----------------------|-----|

|                  |                                  |
|------------------|----------------------------------|
| Essential Skills | Document Use, Thinking, Numeracy |
|------------------|----------------------------------|

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| D-25.01.01L | demonstrate knowledge of <b>single-phase motors</b> , their applications and operation     | identify types of <b>single-phase motors</b> and describe their characteristics   |
|             |  | identify terminology pertaining to <b>single-phase motors</b>   |
|             |  | identify single-phase motor components and describe their applications  |
|             |  | interpret codes and regulations   |
|             |  | interpret information on drawings and specifications  |
|             |  | explain operating principles of <b>single-phase motors</b>  |
| D-25.01.02L | demonstrate knowledge of procedures used to install and connect <b>single-phase motors</b> | describe procedures used to install <b>single-phase motors</b>  |
|             |  | describe procedures used to connect <b>single-phase motors</b>  |
|             |  | identify the <b>operating considerations</b> and requirements for selecting <b>single-phase motors</b> and their components |

## RANGE OF VARIABLES

**single-phase motors** include: universal, shaded pole, resistance-start-induction-run, capacitor-start-induction-run, capacitor-start-capacitor-run, hermetically sealed

**operating considerations** include: torque requirement, voltage availability, motor function, rotation, location

### D-25.02 Maintains single-phase motors

Apprenticeship Level 3,4

Essential Skills Oral Communication, Thinking, Document Use

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| D-25.02.01L | demonstrate knowledge of <b>single-phase motors</b> , their applications and operation | identify types of <b>single-phase motors</b> and describe their characteristics                 |
|             |  | identify terminology pertaining to <b>single-phase motors</b>                                   |
|             |  | identify <b>single-phase motor components</b> and describe their applications                   |
|             |  | interpret codes and regulations   |
|             |  | interpret information found on drawings and specifications                                      |
|             |  | explain the industrial and operating principles of <b>single-phase motors</b>                   |
| D-25.02.02L | demonstrate knowledge of procedures used to maintain <b>single-phase motors</b>        | interpret information contained on single-phase motor nameplates                                |
|             |  | describe the procedures used to maintain <b>single-phase motors</b> and their <b>components</b> |

## RANGE OF VARIABLES

**single-phase motors** include: universal, shaded pole, resistance-start-induction-run, capacitor-start-induction-run, capacitor-start-capacitor-run, hermetically sealed

**components** include: frame, centrifugal switch, armature, rotor, stator, end bells, fans, bearings, bushings, capacitors



## D-25.03 Installs three-phase motors

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 3,4                              |
| Essential Skills     | Document Use, Numeracy, Thinking |

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| D-25.03.01L | demonstrate knowledge of <b>three-phase motors</b> , their applications and procedures for use | identify types of <b>three-phase motors</b> and describe their characteristics                            |
|             |  | identify terminology pertaining to <b>three-phase motors</b>  |
|             |  | identify three-phase motor components and describe their applications                                     |
|             |  | interpret codes and regulations   |
|             |  | interpret information found on drawings and specifications  |
| D-25.03.02L | demonstrate knowledge of procedures used to install and connect <b>three-phase motors</b>      | explain the operating principles of <b>three-phase motors</b>   |
|             |  | interpret information contained on three-phase motor nameplates   |
|             |  | describe procedures used to install <b>three-phase motors</b>   |
|             |  | describe procedures used to connect <b>three-phase motors</b>   |
|             |  | identify the considerations and requirements for selecting <b>three-phase motors</b> and their components |

### RANGE OF VARIABLES

**three-phase motors** include: squirrel cage induction, synchronous, wound rotor induction, linear induction

## D-25.04 Maintains three-phase motors

|                      |  |
|----------------------|--|
| Apprenticeship Level | 3,4  |
| Essential Skills     | Oral Communication, Thinking, Document Use |

### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| D-25.04.01L | demonstrate knowledge of <b>three-phase motors</b> , their applications and operation | identify types of <b>three-phase motors</b> and describe their characteristics                 |
|             |   | identify terminology pertaining to <b>three-phase motors</b>                                   |
|             |   | identify <b>three-phase motor components</b> and describe their applications                   |
|             |   | interpret codes and regulations  |
|             |   | interpret information found on drawings and specifications                                     |
| D-25.04.02L | demonstrate knowledge of procedures used to maintain <b>three-phase motors</b>        | explain the operating principles of <b>three-phase motors</b>                                  |
|             |   | interpret information contained on three-phase motor nameplates                                |
|             |   | describe the procedures used to maintain <b>three-phase motors</b> and their <b>components</b> |

### RANGE OF VARIABLES

**three-phase motors** include: squirrel cage induction, wound rotor induction, synchronous

**three-phase motor components** include: frame, rotor, stator, end bells, fans, brushes, bearings, slip rings, lifting eyes

## D-25.05 Installs DC motors

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 2,3,4                            |
| Essential Skills     | Numeracy, Thinking, Document Use |

### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| D-25.05.01L | demonstrate knowledge of <b>DC motors</b> , their applications and procedures for use | identify types of <b>DC motors</b> and describe their characteristics and applications |
|             |   | identify terminology pertaining to <b>DC motors</b>                                    |

|             |  |   |
|-------------|--|---|
|             |  | identify <b>DC motor components</b> and describe their characteristics and applications                           |
|             |  | interpret codes and regulations   |
|             |  | interpret information found on drawings and specifications  |
|             |  | explain operating principles of <b>DC motors</b>  |
|             |  | interpret information contained on DC motor nameplates  |
| D-25.05.02L | demonstrate knowledge of procedures used to install and connect <b>DC motors</b> | identify considerations and requirements for selecting <b>DC motors</b> and controls, and their <b>components</b> |
|             |  | describe the procedures used to install <b>DC motors</b> and controls, and their <b>components</b>                |
|             |  | describe the procedures used to connect <b>DC motors</b> and controls and their <b>components</b>                 |

## RANGE OF VARIABLES

**DC motors** include: self-excited, separately excited, series, shunt, compound, dual field/combination

**DC motor components** include: frame, armature, rotor, stator, commutator, end bells, fans, brushes, brush holders, bearings, bushings

## D-25.06 Maintains DC motors

|                      |  |
|----------------------|--|
| Apprenticeship Level | 2,3,4                                      |
| Essential Skills     | Oral Communication, Thinking, Document Use |

### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives   |
|-------------|---|---|
| D-25.06.01L | demonstrate knowledge of <b>DC motors</b> , their applications and procedures for use | identify types of <b>DC motors</b> and describe their characteristics and applications  |
|             |   | identify terminology pertaining to <b>DC motors</b>                                     |
|             |   | identify <b>DC motor components</b> and describe their characteristics and applications |
|             |   | interpret codes and regulations   |
|             |   | interpret information found on drawings and specifications                              |
|             |   | explain operating principles of <b>DC motors</b>  |

|             |   |   |
|-------------|---|---|
|             |   | interpret information contained on DC motor nameplates                                |
| D-25.06.02L | demonstrate knowledge of procedures used to maintain <b>DC motors</b> | describe the procedures used to maintain <b>DC motors</b> and their <b>components</b> |

## RANGE OF VARIABLES

**DC motors** include: self-excited, separately excited, series, shunt, compound, dual field/combination

**DC motor components** include: frame, armature, rotor, stator, commutator, end bells, fans, brushes, brush holders, bearings, bushings

# MAJOR WORK ACTIVITY E

## Installs and maintains signalling and communication systems

### TASK E-26 Installs and maintains signalling systems

#### TASK DESCRIPTOR

Industrial electricians install, upgrade, and maintain signalling systems such as fire alarm systems, and security and surveillance systems which allow for the protection and management of people and property. These types of systems may be low voltage circuits, extra-low voltage circuits, and Class 1 or Class 2 circuits.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by adding, removing and replacing components.

For the purpose of this standard, “maintain” includes inspections, preventive/predictive maintenance, troubleshooting, replacing and repairing activities.

#### E-26.01 Installs fire alarm systems

Apprenticeship Level 4

Essential Skills Document Use, Reading, Thinking

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives  |
|-------------|--|--|
| E-26.01.01L | demonstrate knowledge of types of <b>fire alarm systems</b> , their applications and operation | interpret <b>codes, standards and regulations</b> pertaining to <b>fire alarm systems</b>                          |
|             |  | interpret information found on drawings and manufacturers’ specifications  |
|             |  | identify types of <b>fire alarm systems</b> and describe their characteristics and applications                    |
|             |  | describe types of <b>associated systems</b> that are interconnected with <b>fire alarm systems</b>                 |
|             |  | identify <b>fire alarm system components</b> and describe their characteristics and applications                   |
|             |  | identify the considerations and requirements for selecting <b>fire alarm systems</b> , and their <b>components</b> |

|             |  |  |
|-------------|--|--|
| E-26.01.02L | demonstrate knowledge of the procedures used to install, upgrade and connect <b>fire alarm systems</b> , their <b>components and connections to associated systems</b> | describe the procedures used to install, upgrade and connect <b>fire alarm systems</b> and their <b>components</b> |
|             |  | describe procedures used to interconnect <b>associated/ancillary systems</b> with <b>fire alarm systems</b>        |
|             |  | describe procedures for testing <b>fire alarm systems</b> and their <b>components</b>                              |
|             |  | describe the procedures for the start-up, commissioning and verification of <b>fire alarm systems</b>              |

## RANGE OF VARIABLES

**fire alarm systems** include: addressable (DCLA-DCLB-DCLC) and non-addressable (Class A – Class B) systems such as single stage, two stage, single zone, multi-zone

**codes, standards and regulations** include: CAN/ULC-S524, CAN/ULC-S536, CAN/ULC-S537, NBC, National Fire Code (NFC) and regulations specific to AHJ

**associated/ancillary systems** include: fire suppression systems, emergency power supplies fan shutdown/startup, PA systems, remote monitoring, magnetic door holders, elevator homing contactors, egress door securing and releasing devices, building automation systems, ancillary devices (suppression system contactors and fans), fire pump

**fire alarm system components** include: end of line devices (resistors, diodes), initiating devices (heat sensors, pull stations, fire/flame detectors, flow switches, gate valve switch, monitoring modules, smoke detectors, tamper switches) and signalling devices (horns, strobes, bells), panels (fire alarm panels [stand-by batteries], annunciator panels), relays

## E-26.02 Maintains fire alarm systems

|                      |                                 |
|----------------------|---------------------------------|
| Apprenticeship Level | 4                               |
| Essential Skills     | Thinking, Document Use, Reading |

### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives   |
|-------------|---|---|
| E-26.02.01L | demonstrate knowledge of <b>fire alarm systems</b> , their applications and operation | interpret <b>codes, standards and regulations</b> pertaining to <b>fire alarm systems</b>                         |
|             |   | interpret information pertaining to <b>fire alarm systems</b> found on drawings and manufacturers' specifications |
|             |   | identify types of <b>fire alarm systems</b> and describe their characteristics and applications                   |

|             |  |  |
|-------------|--|--|
|             |  | identify <b>fire alarm system components</b> and describe their characteristics and applications           |
|             |  | identify the considerations and requirements for selecting <b>fire alarm systems</b> and <b>components</b> |
|             |  | describe types of <b>associated/ancillary systems</b> that interconnect with <b>fire alarm systems</b>     |
| E-26.02.02L | demonstrate knowledge of the procedures used to maintain <b>fire alarm systems</b> | describe possible effects of <b>fire alarm system</b> maintenance on <b>associated systems</b>             |
|             |  | describe the procedures used to service and maintain <b>fire alarm systems</b> and <b>components</b>       |
|             |  | describe procedures for testing <b>fire alarm systems</b> and their <b>components</b>                      |

## RANGE OF VARIABLES

**fire alarm systems** include: addressable (DCLA-DCLB-DCLC) and non-addressable (Class A – Class B) systems such as single stage, two stage, single zone, multi-zone

**codes, standards and regulations** include: CAN/ULC-S524, CAN/ULC-S536, CAN/ULC-S537, NBC, NFC and regulations specific to AHJ

**fire alarm system components** include: end of line devices (resistors, diodes), initiating devices (heat sensors, pull stations, fire/flame detectors, flow switches, gate valve switch, monitoring modules, smoke detectors, tamper switches) and signalling devices (horns, strobes, bells), panels (fire alarm panels [stand-by batteries], annunciator panels), relays

**associated/ancillary systems** include: fire suppression systems, emergency power supplies fan shutdown/startup, PA systems, remote monitoring, magnetic door holders, elevator homing contactors, egress door securing and releasing devices, building automation systems, ancillary devices (suppression system contactors and fans), fire pump

## E-26.03 Installs security and surveillance systems

|                      |                                 |
|----------------------|---------------------------------|
| Apprenticeship Level | 4                               |
| Essential Skills     | Document Use, Reading, Thinking |

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| E-26.03.01L | demonstrate knowledge of <b>security and surveillance systems</b> , their applications and operation | interpret codes and regulations pertaining to <b>security and surveillance systems</b>                            |
|             |  | interpret information pertaining to <b>security and surveillance systems</b> found on drawings and specifications |

|             |   |   |
|-------------|---|---|
|             |   | identify types of <b>security and surveillance systems</b> and describe their characteristics and applications                    |
|             |   | describe types of <b>associated systems</b> that are interconnected with <b>security and surveillance systems</b>                 |
|             |   | identify <b>security and surveillance system components</b> and describe their characteristics and applications                   |
| E-26.03.02L | demonstrate knowledge of the procedures used to install, upgrade and connect <b>security and surveillance systems</b> and their <b>components</b> | identify the considerations and requirements for selecting <b>security and surveillance systems</b> and their <b>components</b>   |
|             |   | describe the procedures used to install, upgrade and connect <b>security and surveillance systems</b> and their <b>components</b> |
|             |   | describe procedures for testing <b>security and surveillance systems</b> and their <b>components</b>                              |
|             |   | describe the procedures for the start-up, commissioning and verification of <b>security and surveillance systems</b>              |

## RANGE OF VARIABLES

**security and surveillance systems** include: perimeter, space, spot

**security and surveillance system components** include: cameras, monitors, DVRs, motion sensors, card readers, bio-scanners, voice recognitions, magnetic locks, electronic locks, horns, panels, proximity sensors, glass break sensors, pressure sensors, RFID tags, key pads, power supplies, servers, GUIs

**associated systems** include: central alarm monitoring, automatic doors, LAN, building automation systems, lighting

## E-26.04 Maintains security and surveillance systems

|                      |                                 |
|----------------------|---------------------------------|
| Apprenticeship Level | 4                               |
| Essential Skills     | Thinking, Reading, Document Use |

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives  |
|-------------|--|--|
| E-26.04.01L | demonstrate knowledge of <b>security and surveillance systems</b> , their applications and operation | interpret codes and regulations pertaining to <b>security and surveillance systems</b> |
|             |  | interpret information found on drawings and specifications                             |



|             |   |   |
|-------------|---|---|
|             |   | identify types of <b>security and surveillance systems</b> and describe their characteristics and applications                  |
|             |   | identify <b>security and surveillance system components</b> and describe their characteristics and applications                 |
|             |   | identify the considerations and requirements for selecting <b>security and surveillance systems</b> and their <b>components</b> |
|             |   | describe types of <b>associated systems</b> that interconnect with <b>security and surveillance systems</b>                     |
| E-26.04.02L | demonstrate knowledge of the procedures used to maintain <b>security and surveillance systems</b> | describe possible effects of <b>security and surveillance system</b> maintenance on <b>associated systems</b>                   |
|             |   | describe the procedures used to maintain <b>security and surveillance systems</b> and their <b>components</b>                   |
|             |   | describe procedures for testing <b>security and surveillance systems</b> , their <b>components</b> and <b>cables</b>            |
|             |   | describe the procedures for the commissioning and verification of <b>security and surveillance systems</b>                      |

## RANGE OF VARIABLES

**security and surveillance systems** include: perimeter, space, spot

**security and surveillance system components** include: cameras, monitors, DVRs, motion sensors, card readers, bio-scanners, voice recognitions, magnetic locks, electronic locks, horns, panels, proximity sensors, glass break sensors, pressure sensors, RFID tags, key pads, power supplies, servers, GUIs

**associated systems** include: central alarm monitoring, automatic doors, LAN, building automation systems, lighting

**cables** include: fibre optic, data (Cat 5e, 6, 6A, 8), coaxial, twisted pairs, ELC, shielded pairs, triads, quads

## TASK E-27 Installs and maintains communication systems

### TASK DESCRIPTOR

Communication systems allow information to be transmitted by voice, sound, lighting and data from one point to another, using wireless and structured cabling, which includes fiber optic, copper and coaxial cables. These types of systems may include Class 1 and Class 2 circuits, low-voltage power circuit, extra-low voltage power circuit or low energy power circuit. They include voice/data/video (VDV), voice over Internet protocol (VoIP), community antenna television (CATV), public address (PA), intercom, nurse call systems, and various other industrial data communication systems.

Industrial data communication systems such as DeviceNet, Ethernet, Modbus are becoming more prevalent in the control environment for industrial electricians.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard, “maintain” includes inspection, preventive/predictive maintenance, troubleshooting, replacing and repairing activities.

#### E-27.01 Installs communication systems

|                      |     |
|----------------------|-----|
| Apprenticeship Level | 1,4 |
|----------------------|-----|

|                  |                                 |
|------------------|---------------------------------|
| Essential Skills | Reading, Thinking, Document Use |
|------------------|---------------------------------|

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| E-27.01.01L | demonstrate knowledge of <b>communication systems</b> , their applications and operation   | interpret codes, standards and regulations  |
|             |  | interpret information found on drawings and specifications  |
|             |  | identify types of <b>communication systems</b> and describe their characteristics and applications                  |
|             |  | describe types of <b>associated systems</b> that interconnect with <b>communication systems</b>                     |
| E-27.01.02L | demonstrate knowledge of the procedures used to install, address, upgrade and connect <b>communication systems</b> and their <b>components</b> | identify the considerations and requirements for selecting <b>communication systems</b> and their <b>components</b> |
|             |  | describe possible effects of communication system maintenance on associated systems                                 |

---

describe the procedures used to install, address, upgrade and connect **communication systems** and their **components**

---

describe procedures for testing **communication systems** and their **components**

---

describe the procedures for the commissioning and verification of **communication systems**

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## RANGE OF VARIABLES

**communication systems** include: VDV and CATV systems (UTP, ScTP, data cables, fiber optic, multi-mode and single-mode, coaxial and distributed antenna system [wireless]), PA systems (perimeter and space), intercom systems (one to one), nurse call systems (one-way, two-way, audible and visual, direct wire, IP based/structured cabling)

**associated systems** include: building control systems, elevator systems, fire alarm and suppression systems, security and surveillance systems, HVAC, lighting, energy management system, SCADA

**communication system components** include: cabling, termination blocks, outlet jacks, patch panels, face plates, patch cables, cable supports, cable management devices, surge protection for communication cabling systems, connectors, splice trays, cabinets, racks, power supplies, broadcast transmitters, receiving equipment, noise suppressors, satellite dishes, amplifiers, splitters, attenuators, terminators, bonding hardware, microphones, speakers, bells, tone generators, panels, handsets, door release strikes, GUIs, cameras, monitors, RFID tags, annunciator, key pads

**diagnostic and test equipment** includes: TDRs, OTDRs, cable analyzers, light source power meters, wire map testers, multimeters, ohmmeters

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## E-27.02 Maintains communication systems

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|                      |  |
|----------------------|--|
| Apprenticeship Level | 4  |
| Essential Skills     | Digital Technology, Thinking, Document Use |

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### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| E-27.02.01L | demonstrate knowledge of <b>communication systems</b> , their applications and operation | interpret codes, standards and regulations pertaining to <b>communication systems</b>               |
|             |  | interpret information found on drawings and specifications  |
|             |  | identify types of <b>communication systems</b> and describe their characteristics and applications  |
|             |  | identify <b>communication system components</b> and describe their characteristics and applications |

---

|             |   |  |
|-------------|---|--|
|             |   | describe types of <b>associated systems</b> that interconnect with <b>communication systems</b>        |
| E-27.02.02L | demonstrate knowledge of the procedures used to maintain <b>communication systems</b> | describe possible effects of <b>communication systems</b> and maintenance on <b>associated systems</b> |
|             |   | describe the procedures used to maintain <b>communication systems</b> and their <b>components</b>      |
|             |   | describe procedures for testing <b>communication systems</b> , their <b>components</b> and cables      |
|             |   | describe the procedures for verification of <b>communication systems</b>                               |

## RANGE OF VARIABLES

**communication systems** include: VDV and CATV systems (UTP, ScTP, data cables, fiber optic, multi-mode and single-mode, coaxial and distributed antenna system [wireless]), PA systems (perimeter and space), intercom systems (one to one), nurse call systems (one-way, two-way, audible and visual, direct wire, IP based/structured cabling), industrial data communication systems

**associated systems** include: building control systems, elevator systems, fire alarm and suppression systems, security and surveillance systems, HVAC, lighting, energy management system, SCADA

**communication system components** include: cabling, termination blocks, outlet jacks, patch panels, face plates, patch cables, cable supports, cable management devices, surge protection for communication cabling systems, connectors, splice trays, cabinets, racks, power supplies, broadcast transmitters, receiving equipment, noise suppressors, satellite dishes, amplifiers, splitters, attenuators, terminators, bonding hardware, microphones, speakers, bells, tone generators, panels, handsets, door release strikes, GUIs, cameras, monitors, RFID tags, annunciator, key pads

**diagnostic and test equipment** includes: TDRs, OTDRs, cable analyzers, light source power meters, wire map testers, multimeters, ohmmeters, network analyzer

## TASK E-28 Installs and maintains building automation systems

### TASK DESCRIPTOR

Building automation systems include integrated and environmental control systems.

Systems such as HVAC, fire alarm, lighting and security and other associated systems are interconnected through a building automation system that may signal or control the different building systems.

Building automation systems may also be integrated with automated control systems or may be stand alone.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard, “maintain” includes inspections, preventive/predictive maintenance, troubleshooting, replacing and repairing activities.

### E-28.01 Installs building automation systems

|                      |                                 |
|----------------------|---------------------------------|
| Apprenticeship Level | 4                               |
| Essential Skills     | Reading, Thinking, Document Use |

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| E-28.01.01L | demonstrate knowledge of <b>building automation systems</b> , their applications and operation                         | interpret standards pertaining to <b>building automation systems</b>  |
|             |  | interpret information pertaining to <b>building automation systems</b> found on drawings and specifications               |
|             |  | identify types of <b>building automation systems</b> and describe their characteristics and applications                  |
|             |  | identify <b>building automation system components</b> and describe their characteristics and applications                 |
|             |  | describe types of <b>associated systems</b> that interconnect with <b>building automation systems</b>                     |
|             |  | identify the considerations and requirements for selecting <b>building automation systems</b> and their <b>components</b> |
| E-28.01.02L | demonstrate knowledge of the procedures used to install <b>building automation systems</b> and their <b>components</b> | describe the procedures used to install <b>building automation systems</b> and their <b>components</b>                    |

describe procedures for testing **building automation systems** and their **components**

describe the procedures for the commissioning and verification of **building automation systems** and their **components**

## RANGE OF VARIABLES

**building automation systems** include: wireless, environmental control, integrated control, energy management, security and surveillance systems, pneumatic, analog electrical and DDC, computer control

**building automation system components** include: network cabling, sensors such as occupancy and light levels, servers, Power over Ethernet (PoE) switches, GUIs, damper motors, valves, contactors, contacts, annunciators, thermostats, solenoids, flow and sail switches, humidity sensors, digital, analog, pressure differential, temperature, light level, occupancy and level/float sensors

**associated systems** include: building control systems, LAN, elevator systems, fire alarm and suppression systems, security and surveillance systems, HVAC, lighting, communication systems, internet, energy management system, SCADA, PLC

## E-28.02 Maintains building automation systems

|                      |  |
|----------------------|--|
| Apprenticeship Level | 4  |
| Essential Skills     | Thinking, Digital Technology, Document Use |

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| E-28.02.01L | demonstrate knowledge of <b>building automation systems</b> , their applications and operation | interpret <b>standards</b> pertaining to <b>building automation systems</b>   |
|             |  | interpret information pertaining to <b>building automation systems</b> found on drawings and specifications               |
|             |  | identify types of <b>building automation systems</b> and describe their characteristics and applications                  |
|             |  | identify <b>building automation system components</b> and describe their characteristics and applications                 |
|             |  | describe types of <b>associated systems</b> that interconnect with <b>building automation systems</b>                     |
|             |  | identify the considerations and requirements for selecting <b>building automation systems</b> and their <b>components</b> |

|             |   |  |
|-------------|---|--|
| E-28.02.02L | demonstrate knowledge of the procedures used to maintain <b>building automation systems</b> | describe the procedures used to maintain <b>building automation systems</b> and their <b>components</b>            |
|             |   | describe the procedures for testing <b>building automation systems</b> , their <b>components</b> and <b>cables</b> |
|             |   | describe the procedures for the commissioning and verification of <b>building automation systems</b>               |

## RANGE OF VARIABLES

**building automation systems** include: wireless, environmental control, integrated control, energy management, security and surveillance systems, pneumatic, analog electrical and direct digital control (DDC), computer control

**standards** include: ANSI/ASHRAE 135 (BACnet), UL 916, ANSI/TIA 862

**building automation system components** include: network cabling, sensors such as occupancy and light levels, servers, Power over Ethernet (PoE) switches, GUIs, damper motors, valves, contactors, contacts, annunciators, thermostats, solenoids, flow and sail switches, humidity sensors, digital, analog, pressure differential, temperature, light level, occupancy and level/float sensors

**associated systems** include: building control systems, LAN, elevator systems, fire alarm and suppression systems, security and surveillance systems, HVAC, lighting, communication systems, Internet, energy management system, SCADA, PLC

**cables** include: fibre optic, data, coaxial, twisted pairs, ELC, shielded pairs, tri-ads, quads

# MAJOR WORK ACTIVITY F

## Installs and maintains process control systems

### TASK F-29 Installs and maintains input/output (I/O) devices

#### TASK DESCRIPTOR

I/O devices are used in control systems. There may be discrete or analog devices. Industrial electricians must be able to install and maintain these devices.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard, “maintain” includes inspection, preventative/predictive maintenance, troubleshooting, replacing and repairing activities.

#### F-29.01 Installs discrete input/output (I/O) devices

Apprenticeship Level 4

Essential Skills Document Use, Digital Technology, Reading

#### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| F-29.01.01L | demonstrate knowledge of <b>discrete control devices</b> , their applications and operation | identify hazards and describe safe work practices pertaining to install <b>discrete control devices</b>                    |
|             |   | interpret information pertaining to <b>discrete control devices</b> found on drawings and specifications                   |
|             |   | explain the use of discrete versus analog devices  |
|             |   | identify types of <b>discrete control devices</b> and describe their characteristics and applications                      |
|             |   | identify discrete control device components and accessories and describe their characteristics and applications            |
|             |   | identify types of <b>voltage used with discrete devices</b> and describe their characteristics, applications and operation |



|             |  |   |
|-------------|--|---|
|             |  | explain the use of <b>discrete control devices</b> for <b>measurement</b>   |
|             |  | identify the considerations and requirements for selecting <b>discrete control devices</b> , their components and accessories |
| F-29.01.02L | demonstrate knowledge of the procedures used to install, connect and calibrate <b>discrete control devices</b> | describe the procedures used to install, connect and set <b>discrete control devices</b> , their components and accessories   |
|             |  | describe the procedures used to calibrate <b>discrete control devices</b>   |

## RANGE OF VARIABLES

**discrete control devices** include: on-off control, counters and totalizers, timers, relays, pressure, temperature, level, flow

**voltage used with discrete device** includes: DC or AC voltage

**measurement** includes: pressure, temperature, flow, level, mass, density

## F-29.02 Maintains discrete input/output (I/O) devices

Apprenticeship Level

4

Essential Skills

Digital Technology, Thinking, Document Use

### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| F-29.02.01L | demonstrate knowledge of <b>discrete control devices</b> , their applications and operation | identify hazards and describe safe work practices pertaining to <b>discrete control devices</b>                            |
|             |   | interpret information pertaining to <b>discrete control devices</b> found on drawings and specifications                   |
|             |   | explain the use of discrete versus analog devices  |
|             |   | identify <b>types of discrete control devices</b> and describe their characteristics and applications                      |
|             |   | identify <b>discrete control device</b> components and accessories and describe their characteristics and applications     |
|             |   | identify types of <b>voltage used with discrete devices</b> and describe their characteristics, applications and operation |

|             |   |   |
|-------------|---|---|
|             |   | explain the use of <b>discrete control devices</b> for <b>measurement</b>   |
|             |   | identify the considerations and requirements for selecting <b>discrete control devices</b> , their components and accessories |
| F-29.02.02L | demonstrate knowledge of the procedures used to maintain and test <b>discrete control devices</b> | describe the procedures used to maintain <b>discrete control devices</b> , their components and accessories                   |
|             |   | describe the procedures used to repair and test <b>discrete control devices</b> , their components and accessories            |

## RANGE OF VARIABLES

**discrete control devices** include: on-off control, counters and totalizers, timers, relays, pressure, temperature, level, flow

**voltage used with discrete device** includes: DC or AC voltage

**measurement** includes: pressure, temperature, flow, level, mass, density

## F-29.03 Installs analog input/output (I/O) devices

|                      |  |
|----------------------|--|
| Apprenticeship Level | 4  |
| Essential Skills     | Numeracy, Digital Technology, Document Use |

### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| F-29.03.01L | demonstrate knowledge of <b>analog control devices</b> , their applications and operation | identify hazards and describe safe work practices  |
|             |   | interpret information found on drawings and specifications   |
|             |   | explain the use of analog versus discrete devices  |
|             |   | identify types of <b>analog control devices</b> and describe their characteristics, applications and operation           |
|             |   | identify <b>analog control device</b> components and accessories and describe their characteristics and applications     |
|             |   | identify types of <b>signals used with analog devices</b> and describe their characteristics, applications and operation |

|             |  |   |
|-------------|--|---|
|             |  | explain the use of <b>analog control devices</b> for <b>measurement</b>   |
|             |  | identify the considerations and requirements for selecting <b>analog control devices</b> , their components and accessories |
| F-29.03.02L | demonstrate knowledge of the procedures used to install, connect and calibrate <b>analog control devices</b> | describe the procedures used to install, and connect <b>analog control devices</b> , their components and accessories       |
|             |  | describe the procedures used to calibrate <b>analog control devices</b>   |

## RANGE OF VARIABLES

**types of analog control devices** include: pressure, proximity, level, motion, flow, temperature and vibration transmitters, proportional valves, linear actuators, solenoid valves, transducers

**signals used with analog devices** include: resistance, current, voltage (sinking or sourcing)

**measurement** includes: pressure, temperature, flow, level, mass, density

## F-29.04 Maintains analog input/output (I/O) devices

|                      |  |
|----------------------|--|
| Apprenticeship Level | 4  |
| Essential Skills     | Numeracy, Digital Technology, Document Use |

### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives  |
|-------------|---|--|
| F-29.04.01L | demonstrate knowledge of <b>analog control devices</b> , their applications and operation | identify hazards and describe safe work practices  |
|             |   | interpret information found on drawings and specifications   |
|             |   | explain the use of analog versus discrete devices  |
|             |   | identify types of <b>analog control devices</b> and describe their characteristics, applications and operation           |
|             |   | identify <b>analog control device</b> components and accessories and describe their characteristics and applications     |
|             |   | identify types of <b>signals used with analog devices</b> and describe their characteristics, applications and operation |
|             |   | explain the use of <b>analog control devices</b> for <b>measurement</b>  |

|             |   |   |
|-------------|---|---|
|             |   | identify the considerations and requirements for selecting <b>analog control devices</b> , their components and accessories |
| F-29.04.02L | demonstrate knowledge of the procedures used to maintain and test <b>analog control devices</b> | describe the procedures used to maintain <b>analog control devices</b> , their components and accessories                   |
|             |   | describe the procedures used to test <b>analog control devices</b> , their components and accessories                       |

## RANGE OF VARIABLES

**analog control devices** include: pressure, proximity, level, motion, flow, temperature and vibration transmitters, proportional valves, linear actuators, solenoid valves, transducers

**signals used with analog devices** include: resistance, current, voltage (sinking or sourcing)

**measurement** includes: pressure, temperature, flow, level, mass, density

# TASK F-30 Installs, programs and maintains automated control systems

## TASK DESCRIPTOR

In industrial environments, the process requires control and the ability to interface with other systems. These controls can be complex automated systems. Automated control systems are often programmable systems such as PLC and DCS.

The operator interfaces for many of these systems have migrated from physical hardware to graphical user interfaces (GUI) such as HMIs. As a result, the electrical work pertaining to the input/output devices has become software based.

Automated control systems may also be integrated with Building Automation Systems.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard, “maintain” includes inspection, preventative/predictive maintenance, troubleshooting, replacing and repairing activities.

### F-30.01 Installs automated control systems

Apprenticeship Level 4

Essential Skills Document Use, Digital Technology, Thinking

#### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives  |
|-------------|--|--|
| F-30.01.01L | demonstrate knowledge of <b>automated control systems</b> , their applications and operation | identify types of <b>automated control systems</b> and describe their characteristics                              |
|             |  | identify <b>automated control system components</b> and describe their purpose and operation                       |
|             |  | interpret information found on drawings and specifications   |
|             |  | interpret codes and regulations pertaining to <b>automated control systems</b>                                     |
|             |  | identify sources of information pertaining to automated control system installation, configuration and programming |
|             |  | identify <b>number</b> and <b>code systems</b> and describe their applications                                     |
|             |  | perform conversions between <b>number systems</b>  |
|             |  | explain and interpret <b>control circuit logic</b>   |

|             |  |  |
|-------------|--|--|
| F-30.01.02L | demonstrate knowledge of <b>automated control system data communication systems</b>  | identify types of <b>automated control system data communication systems</b> and describe their characteristics, applications and operation  |
|             |  | identify <b>automated control system data communication system</b> components and describe their characteristics, applications and operation |
|             |  | identify <b>methods used to communicate</b> with automated control systems   |
| F-30.01.03L | demonstrate knowledge of procedures used to install and connect <b>automated control systems</b> and their <b>components</b> | describe the procedures used to install <b>automated control systems</b> and their <b>components</b>   |
|             |  | describe the procedures used to connect <b>automated control systems</b> and their <b>components</b>   |

## RANGE OF VARIABLES

**automated control systems** include: PLC, SCADA system, DCS

**automated control system components** include: hardware (power supply, central processing unit [CPU], input/output [I/O] system, programming terminals), software

**number systems** include: binary, decimal, hexadecimal, octal

**code systems** include: binary coded decimal (BCD), American Standard Code for Information Interchange (ASCII)

**control circuit logic** includes: relay logic, ladder logic, function block, text based

**automated control system data communication systems** include: Ethernet, Modbus, Profibus, BACnet, Fieldbus, DeviceNet, ControlNet

**methods used to communicate with automated control systems** include: handheld, computer, HMI

## F-30.02 Maintains automated control systems

|                      |  |
|----------------------|--|
| Apprenticeship Level | 4  |
| Essential Skills     | Oral Communication, Digital Technology, Thinking |

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives   |
|-------------|--|---|
| F-30.02.01L | demonstrate knowledge of <b>automated control systems</b> , their applications and operation | identify types of <b>automated control systems</b> and describe their characteristics, applications and operation |
|             |  | identify <b>automated control system components</b> and describe their purpose and operation                      |
|             |  | interpret information found on drawings and specifications  |

|             |   |   |
|-------------|---|---|
|             |   | interpret codes and regulations pertaining to <b>automated control systems</b>  |
|             |   | identify sources of information pertaining to <b>automated control system</b> service, maintenance, troubleshoot and configuration    |
|             |   | identify <b>number</b> and <b>code systems</b> and describe their applications  |
|             |   | perform conversions between <b>number systems</b>   |
|             |   | explain and interpret <b>control circuit logic</b>  |
| F-30.02.02L | demonstrate knowledge of <b>data communication systems</b>                              | identify types of <b>data communication systems</b> and describe their characteristics, applications and operation                    |
|             |   | identify automated control system data communication system components and describe their characteristics, applications and operation |
|             |   | identify <b>methods used to communicate</b> with automated control systems  |
|             |   | identify <b>basic instruction sets for ladder logic</b> and <b>basic function block</b> , and describe their applications             |
| F-30.02.03L | demonstrate knowledge of procedures for maintenance of <b>automated control systems</b> | describe the procedures used to maintain <b>automated control systems</b> and their <b>components</b>                                 |
|             |   | describe basic PID control theory   |
|             |   | describe <b>basic process control theory</b>  |

## RANGE OF VARIABLES

**automated control systems** include: PLC, SCADA system, DCS

**automated control system components** include: hardware (power supply, central processing unit [CPU], input/output [I/O] system, programming terminals), software

**number systems** include: binary, decimal, hexadecimal, octal

**code systems** include: BCD, ASCII, gray code

**control circuit logic** includes: relay logic, ladder logic, function block

**data communication systems** include: Ethernet, Modbus, Profibus, BACnet, Fieldbus, DeviceNet

**methods used to communicate with automated control systems** include: handheld, computer, HMI  
**basic instruction sets for ladder logic** include: examine-on (normally open contact) and examine-off (normally closed contact), output, timers, counters, sequencers, shift registers, block transfers, data registers

**basic function block** include: input block, control block and output block

**basic process control theory** includes: control loops, control modes, loop tuning

## F-30.03 Programs automated control systems

Apprenticeship Level

4

Essential Skills

Digital Technology, Document Use, Thinking, Numeracy

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives  |
|-------------|--|--|
| F-30.03.01L | demonstrate knowledge of <b>automated control systems</b> , their applications and operation         | <p>identify automated control system <b>programming languages</b> and describe their applications</p> <p>explain the difference between PLC and DCS systems</p>  |
| F-30.03.02L | demonstrate knowledge of <b>data communication systems</b> for automated control systems             | <p>identify types of <b>data communication systems</b> and describe their characteristics, applications and operation</p> <p>compare and contrast types of <b>data communication systems</b></p>   |
| F-30.03.03L | demonstrate knowledge of procedures for programming and configuring <b>automated control systems</b> | <p>describe the <b>procedures</b> used to perform programming, editing and configuration of <b>automated control systems</b> online and offline</p> <p>interpret codes and regulations pertaining to <b>automated control systems</b></p> <p>identify <b>basic instruction sets for ladder logic</b> and <b>basic function block</b> and describe their applications</p> <p>identify <b>number</b> and <b>code systems</b> and describe their applications</p> <p>perform conversions between <b>number systems</b></p> <p>explain and interpret <b>control circuit logic</b></p> <p>describe basic PID control theory</p> |



## RANGE OF VARIABLES

**automated control systems** include: PLC, SCADA system, DCS

**automated control system components** include: hardware (power supply, central processing unit [CPU], input/output [I/O] system, programming terminals), software

**number systems** include: binary, decimal, hexadecimal, octal

**code systems** include: BCD, ASCII, gray code

**control circuit logic** includes: relay logic, ladder logic, function block, text based

**data communication systems** include: Ethernet, Modbus, Profibus, BACnet, Fieldbus, DeviceNet

**methods used to communicate with automated control systems** include: handheld, computer, HMI

**basic instruction sets for ladder logic** include: examine-on (normally open contact) and examine-off (normally closed contact), output, timers, counters, sequencers, shift registers, block transfers, data registers

**basic function block** includes: input block, control block and output block

### F-30.04 Optimizes system performance

Apprenticeship Level

4

Essential Skills

Digital Technology, Document Use, Thinking, Numeracy

#### KNOWLEDGE

##### Learning Outcomes

##### Learning Objectives

|             |  |   |
|-------------|--|---|
| F-30.04.01L | demonstrate knowledge of <b>automated control systems</b> , their applications and operation                     | identify <b>automated control system programming languages</b> and describe their applications  |
| F-30.04.02L | demonstrate knowledge of <b>data communication systems</b> for <b>automated control systems</b>                  | identify types of <b>data communication systems</b> and describe their characteristics, applications and operation  |
| F-30.04.03L | demonstrate knowledge of procedures for programming, configuring and optimizing <b>automated control systems</b> | describe the procedures used to perform programming, editing, configuration, optimization and firmware updates of <b>automated control systems</b> online and offline |
|             |  | interpret codes and regulations pertaining to <b>automated control systems</b>  |
|             |  | identify <b>basic instruction sets for ladder logic</b> and <b>basic function block</b> and describe their applications   |
|             |  | identify <b>number</b> and <b>code systems</b> and describe their applications  |
|             |  | perform conversions between <b>number systems</b>   |
|             |  | explain and interpret <b>control circuit logic</b>  |

---

describe basic *PID control theory*

describe *basic process control theory*

---

## RANGE OF VARIABLES

**automated control systems** include: PLC, SCADA system, DCS

**automated control system components** include: hardware (power supply, central processing unit [CPU], input/output [I/O] system, programming terminals), software,

**number systems** include: binary, decimal, hexadecimal, octal

**code systems** include: BCD, ASCII, gray

**control circuit logic** includes: relay logic, ladder logic, function block, text based

**data communication systems** include: Ethernet, Modbus, Profibus, BACnet, Fieldbus, DeviceNet

**methods used to communicate with automated control systems** include: handheld, computer, HMI

**basic instruction sets for ladder logic** include: Normally Open (NO), Normally Closed (NC), output

**basic function block** include: input block, control block and output block

**basic process control theory** includes: control loops, control modes, loop tuning

## TASK F-31 Installs and maintains pneumatic and hydraulic control systems

### TASK DESCRIPTOR

Pneumatic and hydraulic equipment is used to supply energy and to control equipment and processes through the use of air, nitrogen, process gases and fluids. Industrial electricians install and maintain pneumatic and hydraulic control systems.

For the purpose of this standard, “install” includes both new installations and upgrading of systems by removing and replacing components.

For the purpose of this standard, “maintain” includes inspection, preventative/predictive maintenance, troubleshooting, replacing and repairing activities.

---

### F-31.01 Installs pneumatic control systems

---

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 4                                |
| Essential Skills     | Numeracy, Thinking, Document Use |

---

#### KNOWLEDGE

|             | Learning Outcomes   | Learning Objectives   |
|-------------|---|---|
| F-31.01.01L | demonstrate knowledge of <b>pneumatic control systems</b> , their <b>components</b> and operation | interpret information pertaining to <b>pneumatic control systems</b> devices found on drawings and specifications |
|             |   | identify types of <b>pneumatic control systems</b> and describe their applications                                |

---

|             |  |   |
|-------------|--|---|
|             |  | interpret <b>documentation</b> to determine the operation of pneumatic control systems        |
| F-31.01.02L | demonstrate knowledge of pneumatic related calculations  | perform pneumatic related <b>calculations</b>   |
| F-31.01.03L | demonstrate knowledge of the procedures used to install <b>pneumatic control system equipment</b> and components | describe the procedures used to install <b>pneumatic control systems</b> and their components |

## RANGE OF VARIABLES

**pneumatic control systems** include: instrument air, instrument gas

**components** include: regulators, separators, tubing, actuators, solenoids, pumps, positioners, accumulators, compressors, tanks, coolers, filters, dryers, automated oilers

**documentation** includes: schematics, manufacturers' manuals

**calculations** include: signal conversion, unit conversion

## F-31.02 Maintains pneumatic control systems

|                      |                                  |
|----------------------|----------------------------------|
| Apprenticeship Level | 4                                |
| Essential Skills     | Numeracy, Thinking, Document Use |

### KNOWLEDGE

|             | Learning Outcomes  | Learning Objectives  |
|-------------|--|--|
| F-31.02.01L | demonstrate knowledge of <b>pneumatic control systems</b> , their components and operation                 | interpret information found on drawings and specifications                                     |
|             |  | identify types of <b>pneumatic control systems</b> and describe their applications             |
|             |  | interpret <b>documentation</b> to determine the operation of pneumatic control systems         |
| F-31.02.02L | demonstrate knowledge of pneumatic related calculations  | perform pneumatic related <b>calculations</b>  |
| F-31.02.03L | demonstrate knowledge of the procedures used to maintain pneumatic control system equipment and components | describe the procedures used to maintain <b>pneumatic control systems</b> and their components |

## RANGE OF VARIABLES

**pneumatic control systems** include: instrument air, instrument gas

**documentation** includes: schematics, manufacturers' manuals

**calculations** include: signal conversion, unit conversion

## **F-31.03** Installs hydraulic control systems

|                      |                                 |
|----------------------|---------------------------------|
| Apprenticeship Level | 4                               |
| Essential Skills     | Thinking, Document Use, Reading |

### **KNOWLEDGE**

|             | <b>Learning Outcomes</b>   | <b>Learning Objectives</b>  |
|-------------|--|---|
| F-31.03.01L | demonstrate knowledge of hydraulic control systems, their components and operation                               | interpret information found on drawings and specifications<br><br>identify types of hydraulic control systems and describe their applications<br><br>interpret <b>documentation</b> to determine the operation of hydraulic control systems |
| F-31.03.02L | demonstrate knowledge of the procedures used to install hydraulic control system equipment and <b>components</b> | describe the procedures used to install hydraulic control systems and their <b>components</b>   |

### **RANGE OF VARIABLES**

**documentation** includes: schematics, manufacturers' manuals

**components** include: accumulators, pumps, tanks, coolers, filters, reservoirs, tubing, hoses, fittings, snubbers, thermometers, fluids

## **F-31.04** Maintains hydraulic control systems

|                      |                                 |
|----------------------|---------------------------------|
| Apprenticeship Level | 4                               |
| Essential Skills     | Reading, Thinking, Document Use |

### **KNOWLEDGE**

|             | <b>Learning Outcomes</b>  | <b>Learning Objectives</b>   |
|-------------|---|--|
| F-31.04.01L | demonstrate knowledge of hydraulic control systems, their <b>components</b> and operation                         | interpret information pertaining to hydraulic control systems devices found on drawings and specifications<br><br>interpret <b>documentation</b> to determine the operation of hydraulic control systems |
| F-31.04.02L | demonstrate knowledge of the procedures used to maintain hydraulic control system equipment and <b>components</b> | describe the procedures used to maintain hydraulic control systems and their <b>components</b>   |

## **RANGE OF VARIABLES**

**documentation** includes: schematics, manufacturers' manuals

**components** include: accumulators, pumps, tanks, coolers, filters, reservoirs, tubing, hoses, fittings, snubbers, thermometers

# APPENDIX A

## ACRONYMS

|       |   |
|-------|---|
| AC    | alternating current                                 |
| AED   | automated external defibrillator                    |
| AFCI  | arc fault circuit interrupter                       |
| AHJ   | authority having jurisdiction                       |
| ANSI  | American National Standards Institute               |
| AVR   | Automatic Voltage Regulator                         |
| ASCII | American Standard Code for Information Interchange  |
| BAC   | Building Automation and Control                     |
| BCD   | binary coded decimal                                |
| BICSI | Building Industry Consulting Services International |
| BIL   | Basic Insulation Level                              |
| CAD   | computer-aided design                               |
| CAM   | computer-aided manufacturing                        |
| CATV  | community antenna television                        |
| CEC   | Canadian Electrical Code                            |
| CFC   | chlorofluorocarbon                                  |
| CMMS  | computerized maintenance management systems         |
| CPR   | cardiopulmonary resuscitation                       |
| CPU   | central processing unit                             |
| CSA   | Canadian Standards Association                      |
| CSC   | Construction Specifications Canada                  |
| CT    | current transformer                                 |
| DAS   | distributed antenna system                          |
| DC    | direct current                                      |
| DCLA  | data communication link, Class A                    |
| DCLB  | data communication link, Class B                    |
| DCLC  | data communication link, Class C                    |
| DCS   | distributed control system                          |
| DDC   | direct digital control                              |
| DMM   | digital multimeter                                  |
| DVR   | digital video recorder                              |
| EMC   | electro-magnetic compatibility                      |
| EMT   | electrical metallic tubing                          |
| ENT   | electrical non-metallic tubing                      |
| FLC   | full load current                                   |
| GFCI  | ground fault circuit interrupter                    |
| GUI   | graphical user interface                            |
| HMI   | human machine interfacing                           |
| HID   | high intensity discharge                            |
| HVAC  | heating, ventilation and air-conditioning           |
| I/O   | input/output  |
| IEEE  | Institute of Electrical and Electronics Engineers   |

|       |   |
|-------|---|
| IP    | Ingress Protection  |
| kVA   | kilovolt-amps   |
| LAN   | local area network  |
| LED   | light emitting diode  |
| MCC   | motor control centre  |
| MOV   | metal oxide varistor  |
| NBC   | National Building Code  |
| NFC   | National Fire Code  |
| O&M   | operations and maintenance                                    |
| OEM   | original equipment manufacturer                               |
| OH&S  | Occupational Health and Safety                                |
| OTDR  | optical time-domain reflectometer                             |
| PA    | public address  |
| PCB   | polychlorinated biphenyl                                      |
| PDC   | power distribution centre                                     |
| PLC   | programmable logic controller                                 |
| PoE   | power over Ethernet   |
| PID   | proportional-integral-derivative                              |
| PPE   | personal protective equipment                                 |
| VT    | voltage transformer (previously called potential transformer) |
| PVC   | Poly Vinyl Chloride   |
| RFID  | radio frequency identification                                |
| SCADA | Supervisory Control and Data Acquisition                      |
| SDS   | Safety Data Sheets  |
| ScTP  | screened twisted pair   |
| SIS   | safety instrumented systems                                   |
| SPL   | sound pressure level  |
| SI    | système internationale  |
| TDG   | Transportation of Dangerous Goods                             |
| TDR   | time-domain reflectometer                                     |
| TIA   | Telecommunications Industry Association                       |
| ULC   | Underwriters Laboratories of Canada                           |
| UPS   | uninterruptible power supply                                  |
| UTP   | unshielded twisted pair                                       |
| VA    | volt-ampere   |
| VDV   | voice / data / video  |
| VFD   | variable frequency drive                                      |
| VoIP  | voice over Internet protocol                                  |
| WHMIS | Workplace Hazardous Materials Information System              |
| WLL   | working load limit  |

# APPENDIX B

## TOOLS AND EQUIPMENT

### Hand Tools

adjustable wrenches  
cable tie gun  
cable splice/stripper tool  
calculator  
chisels  
coaxial stripper and crimper  
crimping pliers  
drill bits  
files  
fish tape  
flashlight  
fuse puller  
grounding tools/temporary protective grounds  
hack saw  
hammers  
hex keys (metric/imperial or SAE)  
hole saws  
jumpers  
knives  
knock-out cutters  
linesman pliers  
needle nose pliers  
nut drivers (metric/imperial or SAE)  
picks  
pipe benders  
pipe threaders  
pullers  
punches  
scraper  
screwdrivers  
screw starter  
scribe  
semi-conductor extactor  
side cutters  
slide lock pliers  
socket sets (metric/imperial or SAE)  
spline keys  
static discharge wristbands and anti-static mats  
step drill  
taps (metric/imperial or SAE) and dies  
tape measures  
telescopic magnet  
telescopic mirror  
torch (butane, propane, oxy-acetylene)  
trouble light  
voice data crimp tools  
voice data punch down tools  
wire strippers  
wrenches (metric/imperial or SAE)



## Portable Power Tools

circular saw  
cut-off saw  
drill  
grinder  
hammer drill  
heat gun  
hydraulic crimper  
hydraulic knock-out punch  
impact gun

jig saw  
magnetic base drill press  
power pipe bender  
pipe threading machine  
PVC bender  
reciprocating saw  
soldering equipment  
wire puller

## Powder-Actuated Tools

exothermic welding equipment

powder-actuated fastening tool

## Stationary Power Tools

band saw  
bearing heater  
belt sander  
bench grinder  
buffer  
chop saw  
drill press

grinder  
hydraulic power unit  
hydraulic press  
parts washer  
sand blaster  
threading machine  
under cutting machine

## Fibre Optic Tools

cleaver  
inspection scope  
optical time-domain reflectometer (OTDR)

polishing pucks  
power meter and light source  
swivel/fuse

## Electrical Test and Diagnostic Equipment

chart recorder  
circuit tracer  
clamp ammeter  
conductivity tester  
contact resistance meter  
frequency meter  
Geiger counter  
ground fault finder  
hi-pot tester  
instrumentation loop calibrator  
insulation resistance tester  
(megohmmeter/megger)

optical power meter and light source  
optical time domain reflectometer (OTDR)  
oscilloscope  
phase sequence tester  
potential tester  
pressure calibration pump  
signal generator  
sound meter  
temperature gun  
thermal graphic camera  
thermal graphic equipment

## **Electrical Test and Diagnostic Equipment (continued)**

|                              |                                 |
|------------------------------|---------------------------------|
| laptop computer and software | time domain reflectometer (TDR) |
| lumen meter (testing light)  | timer                           |
| multimeter                   | voltage tester                  |
| network analysers            | Wheatstone bridge               |
| non-contact voltage tester   |                                 |

## **Mechanical Measuring Equipment**

|                          |   |
|--------------------------|---|
| alignment tools          | pressure gauges                                       |
| dial indicators          | protractor  |
| distance measuring wheel | tachometer  |
| feeler gauges            | torque wrenches                                       |
| hydrometer               | vernier calipers                                      |
| micrometers              | vibration sensor (accelerometer, velocity, proximity) |

## **Rigging, Tugging, Hoisting, Lifting Material**

|   |                     |
|---|---------------------|
| articulated boom lift                   | platform lift       |
| beam clamps                             | pulley              |
| block and tackle                        | ropes               |
| cable puller (hand or electric powered) | scissor lift        |
| cable pulling grips (wire mesh grips)   | shackles            |
| chain fall/come-along                   | slings              |
| hoists                                  | strain relief       |
| lifting eyes                            | tow motor/fork lift |

## **Scaffolding and Access Equipment**

|                  |                 |
|------------------|-----------------|
| aerial man lift  | portable stairs |
| extension ladder | scaffolds       |
| man baskets      | scissor lift    |
| platform lift    | step ladder     |

## **Personal Protective Equipment and Safety Equipment**

|                          |                                |
|--------------------------|--------------------------------|
| air pack                 | high voltage test equipment    |
| arc flash PPE            | hot gloves                     |
| dust mask                | hot pad                        |
| ear protectors           | hot stick                      |
| face shield              | knee pads                      |
| fall arrest equipment    | low voltage gloves (insulated) |
| fall restraint equipment | protective apron               |
| fire retardant clothing  | protective gloves/gauntlets    |

**Personal Protective Equipment and Safety Equipment (continued)**

- gas detectors
- grounding stick
- hard hat
- harness
- high visibility vests
- high voltage gloves (insulated)
- respirator
- S.C.B.A. (Self-Contained Breathing Apparatus)
- safety footwear
- safety glasses/goggles
- welding gloves

# APPENDIX C

## GLOSSARY

|                            |  |
|----------------------------|--|
| <b>arc flash</b>           | extremely high temperature electrical discharge produced by an electrical fault in the air that occurs on live equipment resulting from a low impedance connection to ground or another voltage phase in an electrical system. The intensity of the discharge is dependent on the size of the energy source and the size of the conductors                 |
| <b>bonding</b>             | low impedance path obtained by permanently joining all non-current- carrying metal parts to assure electrical continuity and having the capacity to conduct safely any current likely to be imposed on it  |
| <b>cable</b>               | a complete manufactured assembly of one or more insulated conductors which may also include optical fibres, fillers, strength members, insulating and protective material, having a continuous overall covering providing electrical, mechanical and environmental protection to the assembly  |
| <b>cathodic protection</b> | protection technique to control the corrosion of a metal surface by making that surface the cathode of an electrochemical cell   |
| <b>dip switches</b>        | a group of miniature switches  |
| <b>commissioning</b>       | initial startup of new equipment systematically to OEM specifications  |
| <b>extra low voltage</b>   | any voltage up to and including 30 volts, as per CEC   |
| <b>grounding</b>           | permanent and continuous conductive path to the earth with sufficient ampacity to carry any fault current liable to be imposed on it, and of a sufficiently low impedance to limit the voltage rise above ground and to facilitate the operation of the protective devices in the circuit  |
| <b>high voltage</b>        | any voltage exceeding 750 volts, as per CEC  |
| <b>low voltage</b>         | any voltage exceeding 30 volts but not exceeding 750 volts, as per CEC   |
| <b>raceway</b>             | any channel designed for holding wires, cables, or busbars, and, unless otherwise qualified by rules of the CEC, the term includes conduit (rigid, flexible, metal, non-metallic), electrical, metallic and nonmetallic tubing (EMT and ENT) underfloor raceways, cellular floors, surface raceways, wireways, cable trays, busways, and auxiliary gutters |
| <b>unit equipment</b>      | a piece of equipment with its own storage battery, charging means, transfer switch, lamps or output terminals, test switch and indicators  |