PROGRAM PROGRAMME
EXCELLENCE
RED SEAL · SCEAU ROUGE

Red Seal Occupational Standard

Construction Electrician

2015

INTERPROVINCIAL STANDARD
CANADA
NORME INTERPROVINCIALE

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Canada

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CONSTRUCTION ELECTRICIAN

RED SEAL OCCUPATIONAL STANDARD

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FOREWORD

The Canadian Council of Directors of Apprenticeship (CCDA) recognizes this Red Seal Occupational Standard (RSOS) as the Red Seal standard for the Construction Electrician trade.

Background

The first National Conference on Apprenticeship in Trades and Industries, held in Ottawa in 1952, recommended that the federal government be requested to cooperate with provincial and territorial apprenticeship committees and officials in preparing analyses of a number of skilled occupations. Employment and Social Development Canada (ESDC) sponsors the Red Seal Program, which, under the guidance of the CCDA, develops a national occupational standard for each of the Red Seal trades.

Standards have the following objectives:

- to describe and group the tasks performed by skilled workers;
- to identify which tasks are performed in every province and territory;
- to develop instruments for use in the preparation of Interprovincial Red Seal Examinations and assessment tools for apprenticeship and certification authorities;
- to develop common tools for apprenticeship on-the-job and technical training in Canada;
- to facilitate the mobility of apprentices and skilled workers in Canada;
- to supply employers, employees, associations, industries, training institutions and governments with analyses of occupations.

Any questions, comments, or suggestions for changes, corrections, or revisions to this standard or any of its related products may be forwarded to:

Trades and Apprenticeship Division
Labour Market Integration Directorate
Employment and Social Development Canada
140 Promenade du Portage, Phase IV, 5th Floor
Gatineau, Quebec K1A 0J9
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STRUCTURE OF THE OCCUPATIONAL STANDARD

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

Description of the Construction 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 Construction Electrician trade: Some of the trends identified by industry as being the most important for workers in this trade

Pie Chart: a graph which depicts the national percentages of exam questions assigned to the major work activities

Task Matrix and Examination Weightings: a chart which outlines graphically the major work activities, tasks and sub tasks of this standard and their respective exam weightings

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

Industry Expected Performance: a description of the expectations regarding the level of performance of the task, including information related to specific codes, regulations and standards that must be observed

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

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

Skills:

Performance Criteria: description of the activities that are done as the sub-task is performed

Evidence of Attainment: proof that the activities of the sub-task meet the expected performance of a tradesperson who has reached journeyperson level

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 performance criteria, evidence of attainment, 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

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This standard was prepared by the Labour Market Integration Directorate of ESDC. The coordinating, facilitating and processing of this analysis were undertaken by employees of the standards development team of the Trades and Apprenticeship Division and of Apprenticeship New Brunswick. The host jurisdiction of Nova Scotia also participated in the development of this standard.

DESCRIPTION OF THE CONSTRUCTION ELECTRICIAN TRADE

"Construction Electrician" is this trade's official Red Seal occupational title approved by the CCDA. This standard covers tasks performed by a construction 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
Construction Electrician	■	■	■	■			■	■				■	
Electrician									■				
Electrician (Construction)					■					■	■		■
Electrician Construction and Maintenance						■							

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

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

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

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

This standard recognizes similarities or overlaps with the work of industrial electricians, powerline technicians, instrumentation and control technicians, and refrigeration and air conditioning mechanics. Construction electricians work with a wide variety of construction tradespeople, engineers and inspectors.

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

ESSENTIAL SKILLS SUMMARY

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

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

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

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

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

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.

READING

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

DOCUMENT USE

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

WRITING

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

ORAL COMMUNICATION

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

NUMERACY

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

THINKING SKILLS

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

WORKING WITH OTHERS

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

DIGITAL TECHNOLOGY

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

CONTINUOUS LEARNING

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

TRENDS IN THE CONSTRUCTION ELECTRICIAN TRADE

TECHNOLOGY

There is an ongoing growth of new technologies that influence a number of areas of the industry. Some emerging technologies include solar power systems, wind power systems, smart buildings and smart grid.

There is a growth of renewable and alternative energy technologies such as solar photovoltaic, wind, hydrokinetic, geothermal, and tidal power systems in Canada which opens additional employment opportunities for qualified construction electricians. The emergence of electric vehicles (EV) in the Canadian market means there is an accompanying need for electric vehicle charging stations. Construction electricians would be responsible for installing and maintaining these electric vehicle charging stations. In some jurisdictions, construction electricians are responsible for the installation and maintenance of communication systems such as voice, data, audio, video and signalling. These systems are constantly evolving.

Construction electricians are starting to use three dimensional (3D) modelling and building information modelling (BIM) to facilitate construction methods such as interpreting and updating drawings. They are using mobile devices to receive specifications and other information and assist in diagnostic procedures.

TRAINING AND UPGRADING

The combination of new opportunities for construction electricians, new technologies and specialized skills has significantly impacted the electrical industry and triggered the development and delivery of related training. For example, upgrading and training could include areas such as fiber optics, structured cabling, satellite integration, wireless and local area networks (LAN), wireless Internet Protocol (IP) based lighting and building automation, and renewable energies. More than ever, construction electricians need to constantly upgrade and acquire new skills either through formal training, manufacturers' training or on-the-job training to stay current.

In some parts of the industry, more and more variable frequency drives (VFD) are being installed. The VFDs along with other electronic components have the potential to create power quality problems. This requires electricians to become trained in the procedures for measuring electric power quality and the methods needed to monitor and improve the power quality.

Even though it is sometimes more cost effective to replace rather than repair electronic parts, a greater knowledge of electronic systems is still required to work with more complex electrical systems such as solid-state or computer-controlled.

SAFETY AND ENVIRONMENTAL CONSIDERATIONS

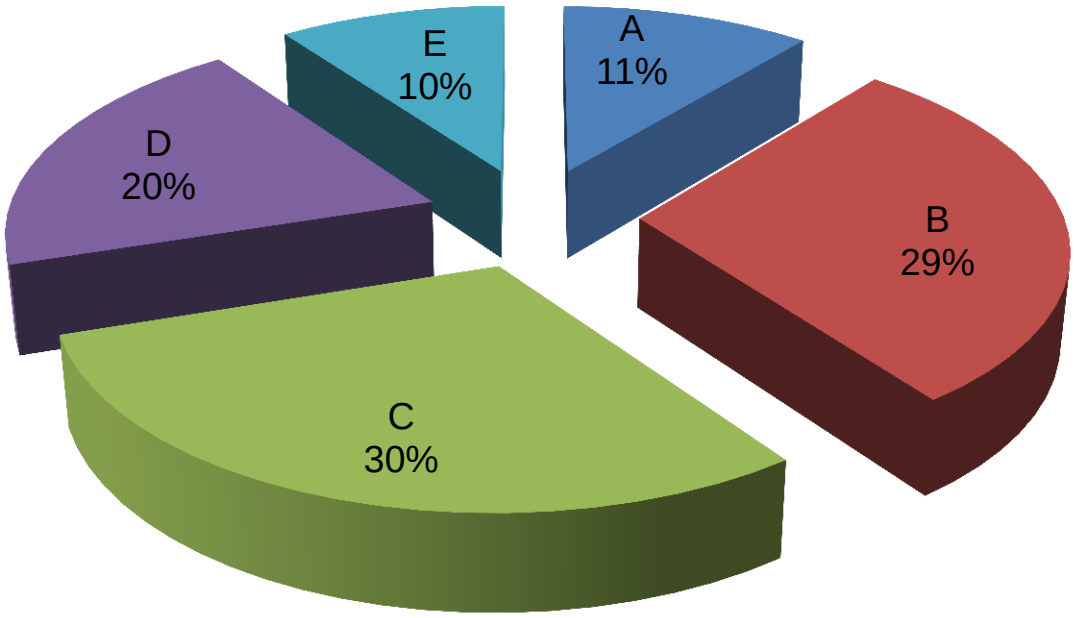
Safety standards continue to be emphasized and recognized in all aspects of the trade. Safety training is branching out to include areas such as arc flash, high voltage, working at heights and supervision. Incidents of serious injury and death of electrical workers underlines the dangerous nature of the work that electricians may be engaged in and that electricians have a shared responsibility to implement safety training and follow safe work procedures. Electricians have to use their expertise on the worksite to assess risks, manage hazards and report issues as they arise. The electrical industry in Canada is moving towards efficient and environmentally friendly construction techniques and energy saving devices such as light emitting diode (LED) lighting, automated lighting control and variable speed drives. Additionally, Leadership in Energy and Environmental Design (LEED) is a growing trend for building construction.

LANGUAGE REQUIREMENTS

It is expected that journeypersons are able to understand and communicate in either English or French, which are Canada's official languages. English or French are the common language of business as well as language of instruction in apprenticeship programs.

PIE CHART

OF RED SEAL EXAMINATION WEIGHTINGS



MWA A	PERFORMS COMMON OCCUPATIONAL SKILLS	11%
MWA B	INSTALLS, SERVICES AND MAINTAINS GENERATING, DISTRIBUTION AND SERVICE SYSTEMS	29%
MWA C	INSTALLS, SERVICES AND MAINTAINS WIRING SYSTEMS	30%
MWA D	INSTALLS, SERVICES AND MAINTAINS MOTORS AND CONTROL SYSTEMS	20%
MWA E	INSTALLS, SERVICES AND MAINTAINS SIGNALLING AND COMMUNICATION SYSTEMS	10%

This pie chart represents a breakdown of the interprovincial Red Seal examination. Percentages are based on the collective input from workers from the trade from across Canada. The Task Matrix on the next pages indicates the breakdown of tasks and sub-tasks within each Major Work Activity and the breakdown of questions assigned to the Tasks. Interprovincial examinations typically have between 100 and 150 questions.

CONSTRUCTION ELECTRICIAN
TASK MATRIX AND WEIGHTINGS

A - PERFORMS COMMON OCCUPATIONAL SKILLS — 11%

Task A-1 **Performs safety-related functions.** **25%**	**A-1.01 Uses personal protective equipment (PPE) and safety equipment.**	**A-1.02 Maintains safe work environment.**	**A-1.03 Performs lock-out and tag-out procedures.**
Task A-2 **Uses tools and equipment.** **17%**	**A-2.01 Uses common and specialty tools and equipment.**	**A-2.02 Uses access equipment.**	**A-2.03 Uses rigging, hoisting and lifting equipment.**
Task A-3 **Organizes work.** **17%**	**A-3.01 Interprets plans, drawings and specifications.**	**A-3.02 Organizes materials and supplies.**	**A-3.03 Plans project tasks and procedures.**
	A-3.04 Prepares worksite.	**A-3.05 Finalizes required documentation.**	
Task A-4 **Fabricates and installs support components.** **18%**	**A-4.01 Fabricates support structures.**	**A-4.02 Installs brackets, hangers and fasteners.**	**A-4.03 Installs seismic restraint systems.**
Task A-5 **Commissions and decommissions electrical systems.** **23%**	**A-5.01. Performs startup and shutdown procedures.**	**A-5.02 Performs commissioning and decommissioning of systems.**	
Task A-6 **Uses communication and mentoring techniques.** **0%**	**A-6.01 Uses communication techniques.**	**A-6.02 Uses mentoring techniques.**	

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

29%

Task B-7 **Installs, services and maintains consumer/supply services and metering equipment.** **18%**	**B-7.01 Installs single-phase consumer/supply services and metering equipment.**	**B-7.02 Installs three-phase consumer/supply services and metering equipment.**	**B-7.03 Performs servicing and maintenance of single-phase services and metering equipment.**
	B-7.04 Performs servicing and maintenance of three-phase services and metering equipment.		
Task B-8 **Installs, services and maintains protection devices.** **17%**	**B-8.01 Installs overcurrent protection devices.**	**B-8.02 Installs ground fault, arc fault and surge protection devices.**	**B-8.03 Performs servicing and maintenance of protection devices.**
Task B-9 **Installs, services and maintains distribution equipment.** **14%**	**B-9.01 Installs power distribution equipment.**	**B-9.02 Performs servicing and maintenance of power distribution equipment.**	
Task B-10 **Installs, services and maintains power conditioning, uninterruptible power supply (UPS) and surge suppression systems.** **15%**	**B-10.01 Installs power conditioning, UPS and surge suppression systems.**	**B-10.02 Performs servicing and maintenance of power conditioning, UPS and surge suppression systems.**	
Task B-11 **Installs, services and maintains bonding and grounding protection systems.** **16%**	**B-11.01 Installs grounding and bonding systems.**	**B-11.02 Installs ground fault systems.**	**B-11.03 Installs lightning protection systems.**
	B-11.04 Performs servicing and maintenance of bonding and grounding systems.		
Task B-12 **Installs, services and maintains power generation systems.** **7%**	**B-12.01 Installs AC (alternating current) generating systems.**	**B-12.02 Performs servicing and maintenance of AC generating systems.**	**B-12.03 Installs DC (direct current) generating systems.** **(NOT COMMON CORE)**
	B-12.04 Performs servicing and maintenance of DC generating systems. **(NOT COMMON CORE)**		

Task B-13 **Installs, services and maintains renewable energy systems.** **6%**	**B-13.01 Installs renewable energy systems.**	**B-13.02 Performs servicing and maintenance of renewable energy systems.**	
Task B-14 **Installs, services and maintains high voltage systems.** **5%**	**B-14.01 Installs high voltage equipment.**	**B-14.02 Installs high voltage cables.**	**B-14.03 Performs servicing and maintenance of high voltage systems.**
Task B-15 **Installs, services and maintains transformers.** **12%**	**B-15.01 Installs extra-low voltage transformers.**	**B-15.02 Installs low-voltage single-phase transformers.**	**B-15.03 Installs low-voltage three-phase transformers.**
	B-15.04 Installs high voltage transformers.	**B-15.05 Performs servicing and maintenance of transformers.**	

C - INSTALLS, SERVICES AND MAINTAINS WIRING SYSTEMS 30%

Task C-16 **Installs, services and maintains raceways, cables and enclosures.** **30%**	**C-16.01 Installs conductors and cables.**	**C-16.02 Installs conduit, tubing and fittings.**	**C-16.03 Installs raceways.**
	C-16.04 Installs boxes and enclosures.	**C-16.05 Performs servicing and maintenance of raceways, cables and enclosures.**	
Task C-17 **Installs, services and maintains branch circuitry.** **8%**	**C-17.01 Installs luminaires.**	**C-17.02 Installs wiring devices.**	**C-17.03 Installs lighting controls.**
	C-17.04 Installs lighting standards.	**C-17.05 Performs servicing of branch circuitry.**	**C-17.06 Installs, services and maintains airport runway lighting systems.**
	C-17.07 Installs, services and maintains traffic signal lights and controls.		
Task C-18 **Installs, services and maintains heating, ventilating and air-conditioning (HVAC) systems.** **12%**	**C-18.01 Connects HVAC systems.**	**C-18.02 Installs HVAC controls.**	**C-18.03 Performs servicing and maintenance of HVAC systems and controls.**
Task C-19 **Installs, services and maintains electric heating systems.** **16%**	**C-19.01 Installs electric heating systems.**	**C-19.02 Installs electric heating system controls.**	**C-19.03 Performs servicing and maintenance of electric heating systems and controls.**
Task C-20 **Installs, services and maintains exit and emergency lighting systems.** **11%**	**C-20.01 Installs exit and emergency lighting.**	**C-20.02 Performs servicing and maintenance of exit and emergency lighting systems.**	
Task C-21 **Installs, services and maintains cathodic protection systems.** **3%**	**C-21.01 Installs cathodic protection systems.**	**C-21.02 Performs servicing and maintenance of cathodic protection systems.**	

D - INSTALLS, SERVICES AND MAINTAINS MOTORS AND CONTROL SYSTEMS

20%

Task D-22 **Installs, services and maintains motor starters and controls.** **41%**	**D-22.01 Installs motor starters.**	**D-22.02 Performs servicing and maintenance of motor starters.**	**D-22.03 Installs motor controls.**
	D-22.04 Performs servicing and maintenance of motor controls.		
Task D-23 **Installs, services and maintains drives.** **17%**	**D-23.01 Installs AC drives.**	**D-23.02 Performs servicing and maintenance of AC drives.**	**D-23.03 Installs DC drives.**
	D-23.04 Performs servicing and maintenance of DC drives.		
Task D-24 **Installs, services and maintains motors.** **28%**	**D-24.01 Installs single-phase motors.**	**D-24.02 Performs servicing and maintenance of single-phase motors.**	**D-24.03 Installs three-phase motors.**
	D-24.04 Performs servicing and maintenance of three-phase motors.	**D-24.05 Installs DC motors.**	**D-24.06 Performs servicing and maintenance of DC motors.**
Task D-25 **Installs, programs, services and maintains automated control systems.** **14%**	**D-25.01 Installs automated control systems.**	**D-25.02 Performs servicing and maintenance of automated control systems.**	**D-25.03 Programs and configures automated control systems.**

E - INSTALLS, SERVICES AND MAINTAINS SIGNALLING AND COMMUNICATION SYSTEMS

10%

Task E-26 **Installs, services and maintains signaling systems.** **47%**	**E-26.01 Installs fire alarm systems.**	**E-26.02 Performs servicing and maintenance of fire alarm systems.**	**E-26.03 Installs security and surveillance systems.**
	E-26.04 Performs servicing and maintenance of security and surveillance systems.		
Task E-27 **Installs, services and maintains communication systems.** **26%**	**E-27.01 Installs voice/data/video (VDV) and community antenna television (CATV) systems.**	**E-27.02 Installs public address (PA) and intercom systems.**	**E-27.03 Installs nurse call systems.**
	E-27.04 Performs servicing and maintenance of communication systems.		
Task E-28 **Installs, services and maintains integrated control systems.** **27%**	**E-28.01 Installs building automation systems.**	**E-28.02 Installs building control systems.**	**E-28.03 Performs servicing and maintenance of integrated control systems.**

MAJOR WORK ACTIVITY A
PERFORMS COMMON OCCUPATIONAL SKILLS

Task A-1 Performs safety-related functions.

TASK DESCRIPTOR

Construction electricians are responsible for ensuring the safety of themselves and others in the work environment. They must follow company, client and jurisdictional regulations.

It is critical that construction electricians be constantly aware of their surroundings and the hazards they may encounter.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Specific regulations and standards for this task include WHMIS, OH&S, Canadian Standards Association (CSA) Z460, Z462 and Z463, and client and company safety policy. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the authority having jurisdiction (AHJ) must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

A-1.01 Uses personal protective equipment (PPE) and safety equipment.

Essential Skills	Thinking Skills, Document Use, Reading

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-1.01.01P	identify ***site hazards*** and regulations requiring the use of ***PPE*** and ***safety equipment***	***site hazards*** are determined by site visits and by doing a pre-job analysis
A-1.01.02P	select ***PPE*** and ***safety equipment***	***PPE*** and ***safety equipment*** are selected to match tasks and hazardous situations
A-1.01.03P	ensure fit of ***PPE*** for the application	***PPE*** are adjusted to provide maximum protection for the individual

A-1.01.04P	recognize worn, damaged or defective ***PPE*** and ***safety equipment*** and tag and replace damaged or faulty ***PPE*** and ***safety equipment***	***PPE*** and ***safety equipment*** are inspected prior to use and not used when damaged or faulty, and tagged as such
A-1.01.05P	apply ***safety regulations and standards***	***safety regulations and standards*** are followed according to company, client, site and AHJ requirements
A-1.01.06P	organize, clean and store ***PPE*** and ***safety equipment***	organizing, cleaning and storage procedures are done according to company procedures and manufacturers' specifications
A-1.01.07P	recognize limitation of use of ***PPE*** and ***safety equipment***	***PPE*** and ***safety equipment*** are not used for other than their intended purposes according to manufacturers' limitation specifications

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

safety regulations and standards include: WHMIS, OH&S, CSA Z460, Z462 and Z463, client and company safety policy, general/prime contractor policies

site hazards include: working at heights, confined space, open excavation, live equipment, extreme weather conditions, hazardous locations

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-1.01.01L	demonstrate knowledge of ***PPE*** and ***safety equipment***, their ***applications***, maintenance, storage and procedures for use	identify types of ***PPE*** and ***safety equipment***
		describe ***applications*** and limitations of ***PPE*** and ***safety equipment***
		describe the procedures used to care for, maintain and store ***PPE*** and ***safety equipment***
A-1.01.02L	demonstrate knowledge of regulatory requirements pertaining to ***PPE*** and ***safety equipment***	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

A-1.02 Maintains safe work environment.

Essential Skills	Thinking Skills, Document Use, Reading

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
A-1.02.01P	perform housekeeping practices	work area is clean and clutter-free
A-1.02.02P	identify, report and eliminate potential and existing ***hazards***	***hazards*** are identified and mitigated
A-1.02.03P	set up ***barriers*** and ***signage*** to explain ***hazards***	***hazards*** are well marked by ***barriers*** and ***signage***
A-1.02.04P	store materials and equipment	materials and equipment are stored in designated areas, according to WHMIS, client and company policies and practices, site-specific practices and AHJ
A-1.02.05P	identify and respect physical limitations of self and others	identify physical limitations and work within them
A-1.02.06P	set up and identify locations containing ***safety components***	locations are identified with signage and on jobsite map
A-1.02.07P	enforce safe work practices	safe work practices are followed

RANGE OF VARIABLES

hazards include: arc flashes, liquid spills (flammable, corrosive, toxic), electric shocks, designated substance (asbestos, mercury, lead, silica), open holes, confined space, fire, tripping hazards, overhead work, hazardous locations

barriers and ***signage*** include: caution and danger tapes, fences, tags, signs

safety components include: first aid kits, fire extinguishers, material safety data sheets (MSDS) , eye wash stations

items include: inspections, potential hazards, safety meetings, injuries, training

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-1.02.01L	demonstrate knowledge of safe work practices	identify ***hazards*** and describe safe work practices to maintain safe work environment
		describe the procedures used in ***emergency situations***
A-1.02.02L	demonstrate knowledge of regulatory requirements pertaining to ***hazards*** and ***emergency situations***	identify and interpret the regulatory requirements pertaining to ***hazards*** and ***emergency situations***

RANGE OF VARIABLES

hazards include: arc flashes, liquid spills (flammable, corrosive, toxic), electric shocks, designated substance (asbestos, mercury, lead, silica), open holes, confined space, fire, tripping hazards, overhead work, hazardous locations

emergency situations include: evacuation, fire, hazardous chemical alarms

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

Essential Skills	Thinking Skills, Document Use, Reading

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-1.03.01P	coordinate lock-out and tag-out requirements with appropriate authorities and other trades	authorities and other trades are informed of isolation of system or equipment
A-1.03.02P	identify circuit for lock-out and tag-out, and recognize other equipment that may present a hazard	circuit isolation point(s) and voltage is identified by referring to panel schedules, drawings, single-line diagrams, cable and equipment tags; other energy sources and hazards are identified and secured
A-1.03.03P	select ***approved device*** to ensure lock-out and tag-out	***approved device*** is selected to match the equipment
A-1.03.04P	identify power source, and de-energize and lock-out equipment	identified circuit is isolated
A-1.03.05P	test system for zero potential using ***voltage-rated equipment***	system is tested for absence of voltage
A-1.03.06P	verify lock-out and tag-out	lock-out and tag-out is completed

RANGE OF VARIABLES

approved devices include: breaker lock, scissors, tag and arc flash protection equipment
voltage-rated equipment include: voltmeters, ground straps, high voltage testers

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
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 the testing equipment to be used is matched to the voltage and energy rating

Task A-2 Uses tools and equipment.

TASK DESCRIPTOR

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

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

A-2.01 Uses common and specialty tools and equipment.

Essential Skills Thinking Skills, Document Use, Reading

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-2.01.01P	organize and store ***tools, equipment*** and ***components***	***tools, equipment*** and ***components*** are organized and stored in designated cases and areas according to company and job site requirements
A-2.01.02P	clean, lubricate and adjust ***tools and equipment***	***tools and equipment*** are maintained according to manufacturers' specifications
A-2.01.03P	ensure calibration of measuring equipment	measuring equipment is calibrated according to manufacturers' specifications
A-2.01.04P	identify worn, damaged and defective ***tools and equipment***	damaged and defective ***tools and equipment*** are tagged and replaced or repaired according to manufacturers' specifications
A-2.01.05P	change tool ***components***	***components*** are changed according to job requirements
A-2.01.06P	identify hazards associated with ***tools and equipment***	***tools and equipment*** are used with PPE and safety equipment according to location, environment and application

RANGE OF VARIABLES

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

components include: chucks, bits, blades, cords, attachment plugs

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-2.01.01L	demonstrate knowledge of ***tools and equipment***, their applications and procedures for use	identify types of ***tools and equipment*** and describe their applications and procedures for use
A-2.01.02L	demonstrate knowledge of manufacturers' specifications, and operating and maintenance instructions	describe operating and maintenance procedures of ***tools and equipment***
A-2.01.03L	demonstrate knowledge of inspection procedures	describe the procedures used to inspect ***tools and equipment***
A-2.01.04L	demonstrate knowledge of limitations and ratings of electrical measuring equipment	describe limitations of measuring equipment and identify measuring equipment for task at hand
A-2.01.05L	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 tools, power tools and equipment, specialty tools and equipment, measuring equipment

A-2.02 Uses access equipment.

Essential Skills	Thinking Skills, Document Use, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-2.02.01P	identify traffic areas and ***potential hazards***	traffic areas and ***potential hazards*** are identified according to job site
A-2.02.02P	install barricades and signage to contain work zone	barricades and signage are installed according to regulations and ***potential hazards***
A-2.02.03P	select ***access equipment***	***access equipment*** is selected according to their limitation and task at hand
A-2.02.04P	set up and secure step ladders and extension ladders	ladders are set up and used according to manufacturers' recommendations and AHJ requirements
A-2.02.05P	visually and mechanically inspect for worn, damaged and defective ***access equipment***	***access equipment*** is inspected for ***damages***

A-2.02.06P	report, tag and decommission unsafe, worn, damaged and defective ***access equipment***	worn, damaged and defective ***access equipment*** is tagged and removed from service
A-2.02.07P	organize and store ***access equipment***	***access equipment*** is stored according to manufacturers' specifications and job site requirements
A-2.02.08P	work from approved and certified ***access equipment***	***access equipment*** is certified and approved for job task

RANGE OF VARIABLES

potential hazards include: overhead hazards, ladder footing and stability, confined spaces, trenches

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

damages include: broken ladder, leaking oil, out-of-line safety chains and gates

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

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.

Essential Skills	Thinking Skills, Document Use, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
A-2.03.01P	identify traffic areas and ***potential hazards***	traffic areas and ***potential hazards*** are identified according to job site
A-2.03.02P	install barricades and signage to contain work zone	barricades and signage are installed according to regulations and ***potential hazards***
A-2.03.03P	select rigging, hoisting and lifting equipment	rigging, hoisting and lifting equipment is selected according to their limitation and task at hand
A-2.03.04P	secure rigging, hoisting and lifting equipment	rigging, hoisting and lifting equipment is secured according to manufacturers and AHJ requirements
A-2.03.05P	use and interpret hand and audible signals	hand and audible signals are used to direct load to intended position
A-2.03.06P	ensure capacity of rigging, hoisting and lifting equipment	rigging, hoisting and lifting equipment loading capacity meets engineering and AHJ requirements
A-2.03.07P	visually and mechanically inspect for worn, damaged and defective rigging, hoisting and lifting equipment	rigging, hoisting and lifting equipment is inspected for ***damages***
A-2.03.08P	report, tag and decommission unsafe, damaged and defective rigging, hoisting and lifting equipment	damaged and defective rigging, hoisting and lifting equipment is tagged and removed from service
A-2.03.09P	secure load for application	load is secured according to engineer and manufacturers' specifications, AHJ requirements and company policy
A-2.03.10P	clean, lubricate and store rigging, hoisting and lifting equipment	rigging, hoisting and lifting equipment is cleaned, lubricated and stored according to company procedures and manufacturers' specifications
A-2.03.11P	perform minor field maintenance on rigging, hoisting and lifting equipment	rigging, hoisting and lifting equipment is maintained according to manufacturers' specifications
A-2.03.12P	move load to final position	load is moved to final position according to drawings and specifications

RANGE OF VARIABLES

potential hazards include: overhead hazards, dropped loads, damaged rigging hardware, congested worksites, confined spaces, trenches

damages include: worn slings, worn shackles, missing or distorted safety catches, frayed ropes and slings, oil leaks

	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 ***potential hazards*** 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 ***regulatory requirements*** 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 ***considerations*** when rigging material/equipment for lifting
		identify and describe ***procedures used to communicate*** during hoisting, lifting and rigging operations

RANGE OF VARIABLES

potential hazards include: overhead hazards, dropped loads, damaged rigging hardware, congested worksites, confined spaces, trenches

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

Construction 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, prepare the worksite and organize the materials and supplies needed. Construction electricians must document their work and prepare as-built drawings and operations and maintenance (O&M) manuals.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

A-3.01 Interprets plans, drawings and specifications.

Essential Skills Document Use, Reading, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-3.01.01P	identify symbols found on drawings and specifications	symbols are identified from legends, notes and specifications
A-3.01.02P	scale dimensions to determine location of devices	location of devices is determined by making a measurement using scaling from drawings
A-3.01.03P	locate and cross-reference information on plans, drawings, specifications and contract documents	installation information is obtained by interpreting plans, drawings, specifications and contract documents
A-3.01.04P	visualize finished product based on information in plans, drawings and specifications	visualization is described to supervisor and confirmed as matching the job requirements
A-3.01.05P	determine if plans, drawings, schematics and specifications are current	plans, drawings, schematics and specifications are compared with the existing installation

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-3.01.01L	demonstrate knowledge of ***drawings***, schematics and specifications and their applications	identify types of ***drawings, schematics and specifications,*** and describe their applications
		identify documentation requirements for modifying drawings and specifications
		describe the procedures used to document changes made to equipment and wiring
A-3.01.02L	demonstrate knowledge of imperial and SI (système internationale) units in trade documentation	interpret imperial and SI units of measure used
A-3.01.02L	demonstrate knowledge of interpreting and extracting ***information*** from drawings, schematics and specifications	interpret and extract ***information*** from drawings, schematics and specifications
		explain how scaling is performed to position devices

RANGE OF VARIABLES

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

information includes: elevations, scales, legends, symbols and abbreviations, notes and specifications, addendums, Construction Specifications Canada (CSC) Specification Divisions 25, 26, 27 and 28

A-3.02 Organizes materials and supplies.

Essential Skills Document Use, Thinking Skills, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-3.02.01P	identify and select ***materials*** and ***supplies***	***materials*** and ***supplies*** are selected according to drawings, specifications and CEC requirements
A-3.02.02P	locate, order and schedule delivery of ***materials and supplies***	***materials*** and ***supplies*** are ordered and delivered according to ***criteria***
A-3.02.03P	load, unload and store ***materials*** and ***supplies***	***materials*** and ***supplies*** are loaded, unloaded and stored according to ***factors***
A-3.02.04P	perform material take-off to identify required ***materials and supplies***	***materials*** and ***supplies*** are identified according to drawings and specifications

A-3.02.05P	coordinate receiving of ***materials*** and ***supplies*** to ensure delivery of shipment	***materials*** and ***supplies*** are received according to established schedule
A-3.02.06P	verify shipments of ***materials*** and ***supplies*** to ensure that quality and quantity match order	***materials*** and ***supplies*** are counted and compared to order, and are inspected for shipping damage
A-3.02.07P	perform inventory control	inventory is counted and stored in secured area

RANGE OF VARIABLES

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

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

criteria include: storage availability, shelf life, product availability, delivery and site schedules

factors include: installation sequence, job specifications, site conditions

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-3.02.01L	demonstrate knowledge of the procedures used to plan and organize ***materials*** and ***supplies***	identify ***sources of information*** relevant to organize ***materials*** and ***supplies***
		describe the ***considerations*** to organize ***materials*** and ***supplies***

RANGE OF VARIABLES

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

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

sources of information include: drawings, specifications, client requirements

considerations include: available space, schedule, storage location

A-3.03 Plans project tasks and procedures.

Essential Skills	Thinking Skills, Document Use, Working with Others

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
A-3.03.01P	visually inspect work environment to determine job requirements from approved documentation	job requirements are determined by site visit, and approved documentation
A-3.03.02P	determine labour and equipment requirements	labour and equipment requirements are determined according to ***job specifications***
A-3.03.03P	establish and maintain schedules	schedules are maintained according to ***criteria***
A-3.03.04P	coordinate work with other trades	work is coordinated with other trades according to ***requirements***
A-3.03.05P	draw and sketch layouts	layouts are drawn according to the installation task at hand

RANGE OF VARIABLES

job specifications include: CEC, conductor sizes, load requirements locations
criteria include: weather, product availability project progression
requirements include: shutdown and installation sequencing

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-3.03.01L	demonstrate knowledge of the procedures used to plan and organize job tasks and procedures	identify ***sources of information*** relevant to planning job tasks and procedures
		describe the ***considerations*** to plan and organize job tasks and procedures
		describe the function of project schedule charts

RANGE OF VARIABLES

sources of information include: drawings, specifications, client requirements
considerations include: available space, schedule/sequence, permits, hazards assessment, personnel, tools and equipment, materials and supplies, storage location

A-3.04 Prepares worksite.

Essential Skills Thinking Skills, Document Use, Reading

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
A-3.04.01P	perform pre-job assessment	pre-job assessment is performed by site visit
A-3.04.02P	visually inspect to identify traffic areas and ***potential hazards***	traffic areas and ***potential hazards*** are identified by site visit
A-3.04.03P	install barricades and signage to contain work zone	work zone is contained according to job requirements and safety codes
A-3.04.04P	create openings and penetrations in structures and equipment	openings and penetrations are created according to job requirements and building codes
A-3.04.05P	ensure sufficient lighting and ventilation of work area	work area is ventilated and level of lighting is according to safety and building codes
A-3.04.06P	ensure required materials and equipment are on site	materials and equipment are readily accessible for installation
A-3.04.07P	control workplace and storage access	workplace and storage access is controlled by gates, fences and barriers to limit access
A-3.04.08P	ensure surveys and ***locates*** are completed and marked-out	***locates*** are identified on the ground with paint and on site plan

RANGE OF VARIABLES

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

locates include: underground services and utilities, concealed building elements

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-3.04.01L	demonstrate knowledge of the procedures used to prepare worksite	identify ***sources of information*** relevant to prepare worksite
		identify ***potential hazards*** relevant to prepare worksite
		describe the ***considerations*** to prepare worksite

A-3.04.02L	demonstrate knowledge of the procedures used to locate ***elements*** encased in concrete and soil	identify types of surveying equipment used to locate ***elements*** in concrete walls and floors, concrete slab on grade and in soil
		describe the safety requirements taken when x-ray surveying equipment is used in occupied buildings

RANGE OF VARIABLES

sources of information include: drawings, specifications, AHJ and client 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

A-3.05 Finalizes required documentation.

Essential Skills Document Use, Writing, Thinking Skills

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
A-3.05.01P	document alterations by modifying plans, schematics and drawings to reflect changes and additions made to original application	plans, schematics and drawings are modified to reflect changes
A-3.05.02P	log data from various ***sources*** to assist with maintenance and replacement	paper and digital copies of setting files are saved to assist with maintenance
A-3.05.03P	compile maintenance manuals from installed equipment manufacturers' specifications	product data sheets for various equipment are included in the maintenance manuals
A-3.05.04P	submit required final documentation, including as-built drawings, to client	as-built drawings and O&M manuals are submitted to client according to job specifications

RANGE OF VARIABLES

sources include: equipment parameters such as VFD, HMI, PLC, prints, schematics, programs

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-3.05.01L	demonstrate knowledge of documentation, its purpose, application and use	describe and identify types of documentation developed from different tasks
		describe procedures for finalizing documentation

Task A-4 Fabricates and installs support components.

TASK DESCRIPTOR

Construction electricians fabricate support structures to protect and support 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.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

A-4.01 Fabricates support structures.

Essential Skills	Numeracy, Document Use, Thinking Skills

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-4.01.01P	measure equipment to determine support structure size, strength and weight	dimensions of support structure is determined according to equipment size
A-4.01.02P	draw sketch	sketch is drawn with dimensions and measurements of support structure and equipment
A-4.01.03P	determine ***material*** for support structure	***materials*** are selected according to job specifications and ***factors***
A-4.01.04P	select and use ***fasteners***	***fasteners*** are selected to meet job specifications and site conditions

A-4.01.05P	prepare ***material*** by cutting to size and drilling holes	***materials*** are cut and drilled to size according to sketch
A-4.01.06P	assemble material to create structure	structure is assembled according to sketch, and is straight and free of sharp protrusions

RANGE OF VARIABLES

materials include: wood, steel, aluminum
factors include: environment, strength and durability ratings, cost
service fasteners include: anchors, nuts, bolts, screws
fasteners include: screws, straps, inserts, anchors, wedge clamps, seismic restraints, insulators

	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 ***materials***, their characteristics and application
		identify ***fasteners***, 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: anchors, nuts, bolts, screws

A-4.02 Installs brackets, hangers and fasteners.

Essential Skills	Document Use, Thinking Skills, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
A-4.02.01P	select ***brackets***, ***hangers*** and ***fasteners***	***brackets***, ***hangers*** and ***fasteners*** are selected according to job specifications and intended purposes
A-4.02.02P	determine installation location to avoid ***obstructions***	***obstructions*** are avoided
A-4.02.03P	secure ***brackets***, ***hangers*** and ***fasteners*** to structure	***brackets***, ***hangers*** and ***fasteners*** are secured level, square, following building lines to structure according to job specifications and intended purposes

RANGE OF VARIABLES

obstructions include: duct work, plumbing pipes, structural members, equipment
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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-4.02.01L	demonstrate knowledge of ***brackets***, ***hangers*** and ***fasteners***, their applications, and their use	identify types of ***brackets***, ***hangers*** and ***fasteners***, their characteristics and application
		describe procedures for securing ***brackets***, ***hangers*** and ***fasteners*** to structure
		identify ***building materials***, their characteristics and application
A-4.02.02L	demonstrate knowledge of measurement and layout techniques	identify measurement and layout techniques to ensure ***brackets***, ***hangers*** and ***fasteners*** are positioned and mounted according to job specifications

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.

Essential Skills	Document Use, Reading, Thinking Skills

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
no	yes	yes	yes	NV	yes	no	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
A-4.03.01P	select and fabricate ***seismic restraint systems***	***seismic restraint systems*** are selected and fabricated according to job specifications and jurisdictional regulations
A-4.03.02P	determine installation location to avoid ***obstructions***	***obstructions*** are avoided
A-4.03.03P	position, mount and secure ***seismic restraint systems*** to structure	***seismic restraint systems*** are positioned, mounted and secured according to structure location, job specifications and jurisdictional regulations

RANGE OF VARIABLES

seismic restraint systems include: chains, cables, rods, aircraft wires
obstructions include: duct work, plumbing pipes

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-4.03.01L	demonstrate knowledge of ***seismic restraint systems,*** their applications and their use	identify types of ***seismic restraint systems***, their characteristics and requirements
		describe procedures for mounting and securing ***seismic restraint systems*** to structure
		identify materials to be installed

RANGE OF VARIABLES

seismic restraint systems include: chains, cables, rods, aircraft wires

Task A-5 Commissions and decommissions electrical systems.

TASK DESCRIPTOR

Construction electricians start up and commission electrical systems to ensure safe and intended operation. Commissioning of electrical systems may require liaison with equipment manufacturers. Construction electricians also shut down systems to perform preventative maintenance or to replace defective equipment. They decommission systems to prepare them for removal.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

A-5.01 Performs startup and shutdown procedures.

Essential Skills	Document Use, Thinking Skills, Oral Communication

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-5.01.01P	identify equipment that needs to be energized	equipment is identified and its source of supply is verified by documentation
A-5.01.02P	identify equipment that needs to be de-energized	equipment is identified and its source of supply is locked out and tagged out
A-5.01.03P	test cables and conductors for ground faults and phase identification	cables and conductors are tested with an insulation resistance tester and continuity tester
A-5.01.04P	follow specifications sequence for startup	system is energized according to job specifications, type of system and manufacturers' specifications
A-5.01.05P	follow specifications sequence for shutdown	system is de-energized according to job specifications, type of system and manufacturers' specifications
A-5.01.06P	check ***system peripherals*** for specified operation	***system peripherals*** operate according to job and manufacturers' specifications
A-5.01.07P	apply temporary safety ground on shutdown, and remove on startup	temporary safety grounds are used and removed according to safety codes, CEC and job requirements
A-5.01.08P	verify busbar connections and torquing of bolts	busbars are torqued according to manufacturers' specifications

A-5.01.09P	verify that safety and shipping material has been removed from equipment and check for tools and loose hardware prior to startup	shipping material, construction debris and tools are removed from equipment and loose equipment hardware is secured prior to startup
A-5.01.10P	notify required personnel of startup and shutdown procedures	personnel is cleared from area prior to startup and shutdown procedures

RANGE OF VARIABLES

system peripherals include: detection, status and alarm systems

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-5.01.01L	demonstrate knowledge of startup and shutdown procedures and their purpose	identify ***hazards*** and describe safe work practices pertaining to starting up and shutting down systems or equipment
		identify the purpose of starting up and shutting down and the types of systems and equipment requiring it
		identify and interpret ***information sources*** and documentation pertaining to the starting up and shutting down of systems or equipment

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, Z462 and Z463

A-5.02 Performs commissioning and decommissioning of systems.

Essential Skills	Document Use, Numeracy, Working with Others

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-5.02.01P	check documentation and nameplate data for operational parameters	operational parameters are set or adjusted according to manufacturers' and job specifications
A-5.02.02P	confirm ***system peripherals*** are functional	***system peripherals*** are operating to their intended purpose
A-5.02.03P	perform ***operational checks***	results of ***operational checks*** are recorded and documented

A-5.02.04P	visually inspect system for ***problems***	***problems*** are identified
A-5.02.05P	adjust components to achieve desired operation	adjustments are completed so that equipment operates as an integrated system
A-5.02.06P	isolate power from equipment	equipment is de-energized using lockout and tagging procedures
A-5.02.07P	identify and remove ***equipment feed*** from distribution source	***equipment feed*** is disconnected and removed
A-5.02.08P	collaborate with other trades to ensure all services are disconnected	other trades are informed of disconnected services and all hazards are removed
A-5.02.09P	confirm system is de-energized	system is checked to confirm absence of potential energy

RANGE OF VARIABLES

system peripherals include: detection, status and alarm systems

operational checks include: current, winding temperature, phase rotation, voltage, protection settings

problems include: wrong direction of rotation, out of specification rotation speed, alarm tripping, equipment malfunction

equipment feed include: cable, conduit, conductors

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-5.02.01L	demonstrate knowledge of commissioning and decommissioning and their purpose	identify ***hazards*** and describe safe work practices pertaining to commissioning and decommissioning systems or equipment
		identify the purpose of commissioning and decommissioning and the types of systems and equipment requiring them
		identify and interpret ***information sources*** and documentation pertaining to the commissioning and decommissioning of systems or equipment
		identify ***diagnostic and test equipment*** for the purpose of commissioning and 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, Z462 and Z463

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

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.

INDUSTRY EXPECTED PERFORMANCE

Communication and mentoring on the job must be done with mutual respect and must take into account personal responsibilities, attitude, oral communication and career outcomes. Construction electricians must communicate with appropriate trade terminology as defined in occupational health and safety requirements and the trades' codes, such as the Canadian Electrical Code (CEC) and the National Building Code (NBC).

All communication must be done in accordance with the Canadian Human Rights Act and be free from harassment and discrimination.

Mentoring styles can vary by workplace and individual. Different things work for different people. A focus on workplace mentoring is about helping ensure that the skills, tips, techniques and best practices are passed on. This benefits industry as a whole by raising productivity and creating safer and healthier workplaces.

A-6.01 Uses communication techniques.

Essential Skills	Oral Communication, Working with Others, Continuous Learning, Digital Technology

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-6.01.01P	demonstrates two-way communication practices	instructions and messages are understood by both parties involved in communication
A-6.01.02P	listens using ***active listening*** practices	steps of ***active listening*** are utilized
A-6.01.03P	receives and responds to feedback on work	response to feedback indicates understanding and corrective measures are taken
A-6.01.04P	uses questioning to improve communication	questions enhance understanding, on-the-job training and goal setting
A-6.01.05P	participates in safety and information meetings	meetings are attended and information is understood and applied

RANGE OF VARIABLES

active listening includes: hearing, interpreting, reflecting, responding, paraphrasing

	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 ***people in the workplace***
		identify ***sources of information*** to effectively communicate
		identify communication and ***learning styles***
		identify ***personal responsibilities and attitudes*** that contribute to on-the-job success
		identify communication that constitutes ***harassment*** and ***discrimination***

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, but are not limited to: 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.

Essential Skills	Oral Communication, Working with Others, Continuous Learning

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
A-6.02.01P	identify and communicate learning objective and point of lesson	apprentice or learner can explain the objective and point of the lesson
A-6.02.02P	link lesson to other lessons and the job	lesson order and unplanned learning opportunities are defined
A-6.02.03P	demonstrates performance of a skill to an apprentice or learner	***steps required to demonstrate a skill*** are performed
A-6.02.04P	set up conditions required for an apprentice or learner to practice a skill	***practice conditions*** are set up so that the skill can be practiced safely by the apprentice or learner
A-6.02.05P	assess apprentice or learner's ability to perform tasks with increasing independence	performance of apprentice or learner improves with practice to a point where skill can be done with little supervision
A-6.02.06P	give supportive and corrective feedback	apprentice or learner adopts best practice after having been given supportive or corrective feedback
A-6.02.07P	support apprentices in pursuing technical training opportunities	technical training is completed within timeframe prescribed by apprenticeship authority
A-6.02.08P	support equity group learners and apprentices	workplace is harassment and discrimination-free
A-6.02.09P	implement probationary period for learners to assess their suitability to the trade	commitment is demonstrated by the learner and more suitable career options are provided to others

RANGE OF VARIABLES

steps required to demonstrate a skill include: 5 Ws, explaining, showing, giving encouragement, following up to ensure skill is performed correctly

practice conditions means: guided, limited independence, full independence

	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 ***essential skills*** in the workplace
		identify different ways of learning
		identify different ***learning needs*** and strategies to meet ***learning needs***
		identify ***strategies to assist in learning a skill***
A-6.02.02L	identify, explain and demonstrate ***strategies for teaching*** workplace skills	identify different roles played by a workplace mentor
		describe the ***steps*** 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 skills, 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, SERVICES AND MAINTAINS GENERATING, DISTRIBUTION AND SERVICE SYSTEMS

Task B-7 Installs, services 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, installation includes both new installations and upgrading of systems by removing and replacing components.

Construction electricians service single- 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.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

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

Essential Skills	Numeracy, Thinking Skills, Reading

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-7.01.01P	determine size and type of ***service, service components*** and ***service conductors***	size and type of ***service components*** and ***service conductors*** are selected based on calculated load, client and CEC requirements and site-specific conditions
B-7.01.02P	determine layout and location of ***service components***	layout allows for ***service components*** to be mounted according to AHJ and CEC clearance and height requirements to provide access for branch circuit installation and components
B-7.01.03P	determine trench size and minimum cover requirements	trench size and cover allow for the installation of direct burial cables and underground raceways and are constructed according to the AHJ and CEC requirements
B-7.01.04P	determine overhead clearance	overhead clearance conforms to AHJ and CEC requirements for the usage of the area and proximity to structures
B-7.01.05P	protect ***service components*** for temporary single-phase service	***service components*** are protected from environmental and mechanical damage, and from public access
B-7.01.06P	mount and secure ***service components***	***service components*** are securely mounted using ***fasteners*** designed for attachment to the material of the support structure
B-7.01.07P	install ***service conductors***	***service conductors*** are installed without damage to insulation, without stress and the neutral conductor is identified
B-7.01.08P	terminate ***service conductor***	insulation is removed and conductors are tightened and secured according to manufacturers' specifications, and antioxidant is applied where required
B-7.01.09P	conduct tests of ***service components, service conductor*** and ***metering equipment***	***service components, service conductor*** and ***metering equipment*** are functional and connected to match the application requirements
B-7.01.10P	identify service information on panels and ***metering equipment***	branch circuits and main breaker are labelled on panel directory and meters are labelled for multi-units

B-7.01.11P	bond non-current carrying metallic ***service components***	metallic ***service components*** are bonded using CEC-approved bonding methods
B-7.01.12P	ground neutral conductor	neutral conductor is grounded at point of service entrance using CEC-approved grounding methods and ***grounding electrodes***
B-7.01.13P	bond metallic piping and structures	gas lines, water lines and metallic building structures are bonded according to CEC requirements
B-7.01.14P	remove and dispose of ***existing service components*** and ***service conductors*** when replacing, and update documentation	used ***service components*** and ***service conductors*** are disposed of according to local codes and waste disposal requirements

RANGE OF VARIABLES

services include: overhead, underground, temporary

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

service conductors include: wire, cables, conductors

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

metering equipment includes: meter sockets, current transformers (CT), potential transformers (PT), enclosures

grounding electrodes include: manufacturers (rods, plates, clamps), field assembled (buried copper conductors), in-situ (metallic water pipes, metallic pilings).

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-7.01.01L	demonstrate knowledge of ***single-phase services*** and their applications	interpret codes and regulations pertaining to ***single-phase services***
		interpret information pertaining to ***single-phase services*** found on drawings and specifications
		identify types of ***single-phase services*** and describe their characteristics and applications
		identify ***service components, service conductors*** and ***fasteners,*** describe their purpose and applications
		identify the considerations and requirements for selecting the type of ***single-phase services, service components*** and ***service conductors***
B-7.01.02L	demonstrate knowledge of ***single-phase service*** installation methods	identify sources of information and documentation required for the installation of ***single-phase services***
		identify and describe the methods used to install ***single-phase services***, ***service components*** and ***service conductors***

		identify and describe the methods used to connect ***service conductors***
		identify the methods of grounding and bonding ***single-phase services***
B-7.01.03L	demonstrate knowledge of load calculations for a ***single-phase service***	identify the method used to calculate load
		calculate load for a ***single-phase service***

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

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

B-7.02 Installs three-phase consumer/supply services and metering equipment.

Essential Skills	Numeracy, Thinking Skills, Reading

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-7.02.01P	determine size and type of ***service, service components*** and ***service conductors***	size and type of ***service components*** and ***service conductors*** are selected according to calculated load, client and CEC requirements and site-specific conditions
B-7.02.02P	determine layout and location of ***service components***	layout allows for ***service components*** to be mounted according to the AHJ and CEC clearance and height requirements to provide access for branch circuit installation
B-7.02.03P	determine trench size and minimum cover requirements	trench size and cover allows for the installation of direct burial cables and underground raceways, and are constructed according to the AHJ and CEC requirements
B-7.02.04P	determine overhead clearance	overhead clearance conforms to the AHJ and the CEC requirements for the usage of the area and proximity to structures
B-7.02.05P	protect ***service components*** for temporary three-phase service	***service components*** are protected from environmental and mechanical damage, and from public access

B-7.02.06P	mount and secure ***service components***	***service components*** are securely mounted using ***fasteners*** designed for attachment to the material of the support structure
B-7.02.07P	install ***service conductors***	***service conductors*** are installed without damage to insulation, without stress and the neutral and three-phase conductors are colour-coded
B-7.02.08P	terminate service conductor	conductors are tightened and secured, and insulation is removed according to manufacturers' specifications and antioxidant is applied where required
B-7.02.09P	conduct tests of ***service components, service conductor*** and ***metering equipment***	***service components, service conductor*** and ***metering equipment*** are functional and connected to match the application requirements
B-7.02.10P	identify service information on ***metering equipment*** and main disconnect	main disconnect is labelled and meters are labelled for multi-units
B-7.02.11P	bond non-current carrying metallic ***service components***	non-current carrying metallic ***service components*** are bonded using CEC-approved bonding methods
B-7.02.12P	ground neutral conductor	neutral conductor is grounded at point of service using CEC-approved grounding methods and using AHJ-approved ***grounding electrodes***
B-7.02.13P	bond metallic piping and structures	gas lines, water lines and metallic building structures are bonded according to CEC requirements
B-7.02.14P	remove and dispose of ***existing service components*** and ***service conductors*** when replacing, and update documentation	used ***service components*** and ***service conductors*** are disposed of according to local codes and waste disposal requirements

RANGE OF VARIABLES

services include: overhead, underground, temporary

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

service conductors include: wire, cables, conductors

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

grounding electrodes include: rods, plates, clamps, copper conductor

metering equipment includes: meter sockets, CTs, PTs, enclosures

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-7.02.01L	demonstrate knowledge of ***three-phase services*** and their applications	interpret codes and regulations pertaining to ***three-phase services***
		interpret information pertaining to ***three-phase services*** found on drawings and specifications

		identify types of ***three-phase services*** and describe their characteristics and applications
		identify ***service components, service conductors*** and ***fasteners,*** describe their purpose and applications
		identify the considerations and requirements for selecting the type of ***three-phase services, service components*** and ***service conductors***
B-7.02.02L	demonstrate knowledge of ***three-phase service*** installation methods	identify sources of information and documentation required for the installation of ***three-phase services***
		identify and describe the methods used to install ***three-phase services***, ***service components*** and ***service conductors***
		identify and describe the methods used to connect ***service conductors***
		identify the methods of grounding and bonding ***three-phase services***
		identify ground fault and ground detection type protection systems
B-7.02.03L	demonstrate knowledge of load calculations for a ***three-phase service***	identify the method used to calculate load
		calculate load for a three-phase service

RANGE OF VARIABLES

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

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

service conductors include: wire, cables, conductors

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

B-7.03 Performs servicing and maintenance of single-phase services and metering equipment.

Essential Skills	Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-7.03.01P	obtain detailed description of malfunction from client	malfunction issues and information are identified and recorded
B-7.03.02P	conduct ***field assessment*** using ***diagnostic and test equipment***	***field assessments*** are conducted using the ***diagnostic and test equipment*** that provides the most definitive diagnostics
B-7.03.03P	determine source of malfunction based on ***field assessment***	source of malfunction is identified
B-7.03.04P	determine course of action	course of action for the type of malfunction is identified
B-7.03.05P	repair malfunctioning components	repaired components are operational
B-7.03.06P	select replacement components	equivalent replacement components (original equipment manufacturer [OEM] replacement when mandated) are selected
B-7.03.07P	install replacement components	replacement components are installed with minimal disruptions
B-7.03.08P	determine maintenance requirements	maintenance requirements are identified by consequence of failure
B-7.03.09P	create maintenance schedule	maintenance schedule is created by considering maintenance requirements
B-7.03.10P	follow maintenance schedule	maintenance tasks are done according to established schedule
B-7.03.11P	conduct tests using ***diagnostic and test equipment***	tests are conducted according to established maintenance schedule and test results are recorded
B-7.03.12P	update maintenance log	maintenance log is updated to reflect servicing and maintenance tasks performed

RANGE OF VARIABLES

field assessments include: sensory inspections, technical inspections

diagnostic and test equipment includes: multimeters, voltage testers, ammeters, power quality analyzers, thermographic imaging devices, insulation resistance testers

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-7.03.01L	demonstrate knowledge of the methods used to service and maintain single-phase service	describe the methods used to service single-phase services and their components
		describe the methods used to maintain single-phase services and their components
B-7.03.01L	demonstrate knowledge of the theory of single-phase systems	describe theory of Edison three-wire system
		describe single-phase circuit fundamentals

B-7.04 Performs servicing and maintenance of three-phase services and metering equipment.

Essential Skills	Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-7.04.01P	obtain detailed description of malfunction from client	malfunction issues and information are identified and recorded
B-7.04.02P	conduct ***field assessment*** using ***diagnostic and test equipment***	***field assessments*** are conducted using the ***diagnostic and test equipment*** that provides the most definitive diagnostics
B-7.04.03P	determine source of malfunction based on ***field assessment***	source of malfunction is identified
B-7.04.04P	determine course of action	course of action for the type of malfunction is identified
B-7.04.05P	repair malfunctioning components	repaired components are operational
B-7.04.06P	select replacement components	equivalent replacement components (OEM replacement when mandated) are selected
B-7.04.07P	install replacement components	replacement components are installed with minimal disruptions
B-7.04.08P	determine maintenance requirements	maintenance requirements are identified by consequence of failure
B-7.04.09P	create maintenance schedule	maintenance schedule is created by considering maintenance requirements

B-7.04.10P	follow maintenance schedule	maintenance tasks are done according to established schedule
B-7.04.11P	conduct tests using ***diagnostic and test equipment***	tests are conducted according to established maintenance schedule and test results are recorded
B-7.04.12P	update maintenance log	maintenance log is updated to reflect servicing and maintenance tasks performed

RANGE OF VARIABLES

field assessments include: sensory inspections, technical inspections

diagnostic and test equipment includes: multimeters, voltage testers, ammeters, power quality analyzers, thermographic imaging devices, phase rotation meters, insulation resistance testers

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-7.04.01L	demonstrate knowledge of the methods used to service and maintain three-phase service	describe the methods to service three-phase services and their components
		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, services and maintains protection devices.

TASK DESCRIPTOR

Overcurrent protection devices provide protection against overcurrent 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 overload protection for the circuit. Surge protection devices prevent transient voltages that originate outside from entering into the whole system.

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

Construction electricians service overcurrent, ground fault, arc fault and surge protection 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.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

B-8.01 Installs overcurrent protection devices.

Essential Skills	Document Use, Numeracy, Thinking Skills

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-8.01.01P	determine type and size of ***enclosures***	***enclosure*** type and size is based on load requirements, environment and type of equipment
B-8.01.02P	determine type and rating of ***overcurrent device***	type and rating of ***overcurrent device*** is determined
B-8.01.03P	secure ***overcurrent devices***	devices are mounted and secured to enclosures and/or busbars using ***hardware*** designed for the equipment
B-8.01.04P	terminate ***overcurrent devices***	***overcurrent devices*** are connected to line and load according to manufacturers' specifications
B-8.01.05P	set trip settings and ensure protection is coordinated	trip settings are based on load requirements, coordination studies and CEC requirements

B-8.01.06P	update ***required documentation*** and labels	branch circuits and distribution circuits are labelled on directories and other ***required documentation***
B-8.01.07P	remove and dispose of existing ***enclosures***, ***overcurrent devices*** and ***hardware*** when replacing, and update documentation	all used ***enclosures***, ***overcurrent devices*** and ***hardware*** are disposed of according to local codes and waste disposal requirements

RANGE OF VARIABLES

enclosures include: CSA / National Electrical Manufacturers' Association (NEMA) classification, hazardous locations (as defined by the Markings of Section 18 of the CEC)

overcurrent devices include: fuses, breakers, relay protection

hardware includes: bolts, screws, brackets, stand-offs, cabling, transition pieces

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

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-8.01.01L	demonstrate knowledge of ***overcurrent devices***, their applications and operation	interpret codes and regulations pertaining to ***overcurrent devices***
		interpret information pertaining to ***overcurrent devices*** found on drawings and specifications
		explain the purpose and operation of ***overcurrent devices***
		explain the effects of short-circuit current and describe the associated damage to the circuit
		identify types of ***overcurrent devices*** and describe their characteristics and applications
		identify the considerations and requirements for selecting ***overcurrent devices***
		explain the purpose of coordination studies
B-8.01.02L	demonstrate knowledge of the procedures used to install ***overcurrent devices***	describe the procedures used to install ***overcurrent devices***
		explain the value of updating ***required documentation***
		explain the procedures used to adjust trip settings

RANGE OF VARIABLES

overcurrent devices include: fuses, breakers, relay protection

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

B-8.02 Installs ground fault, arc fault and surge protection devices.

Essential Skills Document Use, Thinking Skills, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-8.02.01P	determine branch circuit and distribution circuits protection requirements	branch circuit and distribution circuits protection is determined according to location, environment, application and CEC requirements
B-8.02.02P	determine type of ***ground fault protection device*** to use	***ground fault protection devices*** are determined according to load, location, use and CEC requirements
B-8.02.03P	determine type of ***arc fault protection device*** to use	***arc fault protection devices*** are determined according to location and CEC requirements
B-8.02.04P	determine type of ***surge protection device*** to use	***surge protection devices*** are determined according to client requirements
B-8.02.05P	mount protection devices	devices are mounted and secured using ***hardware*** designed for the equipment
B-8.02.06P	terminate protection devices	conductors are tightened and secured, and insulation is removed according to manufacturers' specifications
B-8.02.07P	update ***required documentation*** and labels	branch circuits and distribution circuits are labelled on directories and other ***required documentation***
B-8.02.08P	remove and dispose of existing protection devices when replacing and update documentation	all used ***ground fault protection devices, arc fault protection devices*** and ***surge protection devices*** are disposed of according to local codes and waste disposal requirements

RANGE OF VARIABLES

ground fault protection devices include: ground fault circuit interrupter (GFCI) receptacle, breaker

arc fault protection devices include: arc fault circuit interrupter (AFCI) receptacle, breaker

surge protection devices include: metal oxide varistor (MOV), zener diodes, thyristors, surge suppressors

hardware includes: bolts, screws, brackets, stand-offs, cabling, transition pieces, boxes

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

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-8.02.01L	demonstrate knowledge of ***ground fault, arc fault*** and ***surge protection devices***, their applications and operation	interpret codes and regulations pertaining to ***ground fault, arc fault*** and ***surge protection devices***
		interpret information pertaining to ***ground fault, arc fault*** and ***surge protection devices*** found on drawings and specifications
		explain the purpose and operation of ***ground fault, arc fault*** and ***surge protection devices***
		identify types of ***ground fault, arc fault*** and ***surge protection devices*** and describe their characteristics and applications
		identify the considerations and requirements for selecting ***ground fault, arc fault*** and ***surge protection devices***
B-8.02.02L	demonstrate knowledge of the procedures used to install ***ground fault, arc fault*** and ***surge protection devices***	describe the procedures used to install ***ground fault, arc fault*** and ***surge protection devices***
		explain the value of updating ***required documentation***

RANGE OF VARIABLES

ground fault protection devices include: GFCI receptacle, breaker

arc fault protection devices include: AFCI receptacle, breaker

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

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

B-8.03 Performs servicing and maintenance of ground fault, arc fault and surge protection devices.

Essential Skills	Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-8.03.01P	obtain detailed description of malfunction from client	malfunction issues and information are identified and recorded
B-8.03.02P	conduct ***field assessment*** using ***diagnostic and test equipment***	***field assessments*** are conducted using the ***diagnostic and test equipment*** that provides the most definitive diagnostics
B-8.03.03P	determine source of malfunction based on ***field assessment***	source of malfunction is identified
B-8.03.04P	determine course of action	course of action for the type of malfunction is identified
B-8.03.05P	select replacement components	equivalent replacement components (OEM replacement when mandated) are selected
B-8.03.06P	install replacement components	replacement components are installed with minimal disruptions
B-8.03.07P	determine maintenance requirements	maintenance requirements are identified by consequence of failure
B-8.03.08P	create maintenance schedule	maintenance schedule is created by considering maintenance requirements
B-8.03.09P	follow maintenance schedule	maintenance tasks are done according to established schedule
B-8.03.10P	conduct tests using ***diagnostic and test equipment***	tests are conducted according to established maintenance schedule, and test results are recorded
B-8.03.11P	update maintenance log	maintenance log is updated to reflect servicing and maintenance tasks performed

RANGE OF VARIABLES

field assessments include: sensory inspections, technical inspections

diagnostic and test equipment includes: multimeters, voltage testers, ammeters, power quality analyzers, thermographic imaging devices, insulation resistance testers

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-8.03.01L	demonstrate knowledge of the methods and theory used to service and maintain protection devices	describe the methods and theory used to service protection devices
		describe the methods and theory used to maintain protection devices

Task B-9 Installs, services and maintains distribution equipment.

TASK DESCRIPTOR

Distribution equipment provides power for all electrical systems and equipment. This equipment allows for safe utilization of electricity.

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

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

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

B-9.01 Installs power distribution equipment.

Essential Skills Document Use, Thinking Skills, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-9.01.01P	determine size and type of ***power distribution equipment*** and type of ***enclosure***	size and type of ***power distribution equipment*** are selected based on CEC calculated load, client requirements and site-specific conditions
B-9.01.02P	determine layout and location of ***power distribution equipment***	layout allows for ***power distribution equipment*** to be installed according to CEC required working clearance, and at a location where components to be installed can be mounted square, level and plumb matching building lines
B-9.01.03P	install and secure ***power distribution equipment***	***power distribution equipment*** is securely mounted to the structure using ***fasteners*** designed for attachment to the material of the support structure
B-9.01.04P	install feeder and supply conductors	feeder and supply conductors are installed without damage to insulation, without stress and the neutral and three-phase conductors are colour-coded

B-9.01.05P	terminate feeder and supply conductor connections	conductors are tightened and secured, and insulation is removed according to manufacturers' specifications, and antioxidant is applied where required
B-9.01.06P	conduct tests of ***power distribution equipment*** and feeders	***power distribution equipment*** and feeders are functional and connected to match the application requirements
B-9.01.07P	identify information on ***power distribution equipment***	***power distribution equipment*** is labelled according to job and client requirements
B-9.01.08P	remove and dispose of existing ***power distribution equipment*** when replacing and update documentation	all used ***power distribution equipment***, ***enclosures***, feeder and supply conductors are disposed of according to local codes and waste disposal requirements

RANGE OF VARIABLES

power distribution equipment includes: panels, sub-panels, power distribution centres (PDC), switchboards, breakers, fuses, disconnects, racking equipment, CTs, PTs, busbars, splitters, MCCs

enclosures include: CSA / NEMA type designation, hazardous locations (as defined by the Markings of Section 18 of the CEC)

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

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

RANGE OF VARIABLES

power distribution equipment includes: panels, sub-panels, PDCs, switchboards, breakers, fuses, disconnects, racking equipment, CTs, PTs, busbars, splitters, MCCs

enclosures include: CSA / NEMA type designation, hazardous locations (as defined by the Markings of Section 18 of the CEC)

considerations include: load, voltage ratings, required circuit capacity

B-9.02 Performs servicing and maintenance of power distribution equipment.

Essential Skills	Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-9.02.01P	obtain detailed description of malfunction from client	malfunction issues and information are identified and recorded
B-9.02.02P	conduct ***field assessment*** using ***diagnostic and test equipment***	***field assessments*** are conducted using the ***diagnostic and test equipment*** that provides the most definitive diagnostics
B-9.02.03P	determine source of malfunction based on ***field assessment***	source of malfunction is identified based on ***diagnostic and test equipment*** results
B-9.02.04P	determine course of action	course of action for the type of malfunction is identified
B-9.02.05P	repair malfunctioning components	repaired components are operational
B-9.02.06P	select replacement components	equivalent replacement components (OEM replacement when mandated) are selected
B-9.02.07P	install replacement components	replacement components are installed with minimal disruptions
B-9.02.08P	determine maintenance requirements	maintenance requirements are identified and revised by consequence of failure
B-9.02.09P	create maintenance schedule	maintenance schedule is created by considering maintenance requirements
B-9.02.10P	follow maintenance schedule	maintenance tasks are done according to established schedule
B-9.02.11P	conduct tests using ***diagnostic and test equipment***	tests are conducted according to established maintenance schedule and test results are recorded
B-9.02.12P	update maintenance log	maintenance log is updated to reflect servicing and maintenance tasks performed

RANGE OF VARIABLES

field assessments include: sensory inspections, technical inspections

diagnostic and test equipment includes: multimeters, voltage testers, ammeters, power quality analyzers, thermographic imaging devices, phase/motor rotation meters, insulation resistance testers

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-9.02.01L	demonstrate knowledge of the methods and theory used to service and maintain ***power distribution equipment***	describe the methods and theory to service ***power distribution equipment*** and their components
		describe the methods and theory used to maintain ***power distribution equipment*** and their components

RANGE OF VARIABLES

power distribution equipment includes: panels, sub-panels, PDCs, switchboards, breakers, fuses, disconnects, racking equipment, CTs, PTs, busbars, splitters, MCCs

Task B-10 Installs, services and maintains power conditioning, uninterruptible power supply (UPS) and surge suppression systems.

TASK DESCRIPTOR

Power conditioning systems include capacitors and saturation transformers, 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, installation includes both new installations and upgrading of systems by removing and replacing components.

Construction electricians service power conditioning, UPS and surge suppression systems by troubleshooting, diagnosing faults, and repairing them. They also perform maintenance to ensure these systems are in good operating condition.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

B-10.01 Installs power conditioning, UPS and surge suppression systems.

Essential Skills	Thinking Skills, Numeracy, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-10.01.01P	analyze existing system to assess ***conditions*** that require power conditioning	voltage and power factor characteristics that are outside of standards are identified
B-10.01.02P	identify type of power conditioning required	type of power conditioning is identified according to system requirements
B-10.01.03P	perform calculations to size power conditioning, UPS and surge suppression ***components***	***components*** are sized for the requirements of the application
B-10.01.04P	install ***components***	***components*** are securely installed and mounted matching building lines using ***fasteners*** designed for the attachment to the material of the support structure

B-10.01.05P	terminate and interconnect ***components***	***components*** are terminated and interconnected according to electrical drawings and specifications, job and CEC requirements (for example, conductors secure with no insulation compromised and not pinched)
B-10.01.06P	analyze system output to ensure effectiveness of power conditioning installation	test results reflect improved power quality
B-10.01.07P	conduct tests of power conditioning, UPS and surge suppression after installation and record results	power conditioning, UPS and surge suppression is functional and connected to match the application requirements
B-10.01.08P	remove existing power conditioning and UPS components when replacing and update documentation	equipment is removed with minimal impact to the environment and drawings reflect operational changes

RANGE OF VARIABLES

conditions include: harmonics, power factor correction, transient voltages and current, induced frequencies

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

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

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-10.01.01L	demonstrate knowledge of types of power conditioning, UPS and surge suppression systems and their applications	interpret codes and regulations pertaining to power conditioning, UPS and surge suppression 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 ***power factor correction equipment*** and describe their characteristics, applications and operation
		identify ***equipment used to reduce harmonics*** in power distribution systems and describe their characteristics, applications and operation
		identify ***surge suppression equipment*** used in power distribution system conditioning and describe their characteristics, applications and operation

		identify types of ***UPS equipment*** 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, UPS and surge suppression systems	describe the procedures used to install power conditioning, UPS and surge suppression 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), capacitors
equipment used to reduce harmonics includes: passive and active filters, transformers and capacitors
surge suppression equipment includes: capacitors, shunt coils and diodes
UPS equipment includes: online, offline, maintenance bypass and static bypass, battery systems

B-10.02 Performs servicing and maintenance of power conditioning, UPS and surge suppression systems.

Essential Skills	Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-10.02.01P	obtain detailed description of operation and malfunction of power conditioning, UPS and surge suppression systems	required ***information*** about equipment operation is gathered from end user
B-10.02.02P	conduct ***field assessments*** using ***diagnostic and test equipment*** to determine source of malfunction	source of malfunction is identified based on ***diagnostic and test equipment*** results
B-10.02.03P	identify and remove defective ***components*** of power conditioning, UPS and surge suppression systems	defective ***component*** is removed without damage to system or other components
B-10.02.04P	repair malfunctioning ***components***	repaired ***components*** are operational
B-10.02.05P	select replacement ***components***	replacement ***components*** (OEM replacement when mandated) are selected according to application requirements
B-10.02.06P	install replacement ***components***	***components*** are installed with minimal disruptions and interruptions

B-10.02.07P	conduct tests of power conditioning, UPS and surge suppression systems after repair	power conditioning, UPS and surge suppression systems are functional and connected to match the application requirements
B-10.02.08P	***clean, lubricate and adjust*** components	power conditioning, UPS and surge suppression system components are restored to optimal conditions
B-10.02.09P	record tests in maintenance schedule	operational problems are identified in maintenance schedule data with detailed notations
B-10.02.10P	compare and analyze maintenance test results	maintenance is performed when required based on analysis of test results and comparison with specifications

RANGE OF VARIABLES

end user information includes: log books, manufacturers' manuals, standard operating procedures, anecdotal details from maintenance personnel

field assessments include: sensory inspections, technical inspections

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

diagnostic and test equipment include: battery load testers, multimeters, voltmeters, ammeters, power quality analyzers, oscilloscopes, thermographic imaging devices

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

cleaning lubricating and adjusting procedures include: cleaning fans and filters, lubricating bearings and bushings, load testing batteries, adjusting cabinets and door seals

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-10.02.01L	demonstrate knowledge of types of power conditioning, UPS and surge suppression systems and their applications	interpret codes and regulations pertaining to power conditioning, UPS and surge suppression 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 ***power factor correction equipment*** and describe their characteristics, applications and operation
		identify ***equipment used to reduce harmonics*** in power distribution systems and describe their characteristics, applications and operation
		identify ***surge suppression equipment*** used in power distribution system conditioning and describe their characteristics, applications and operation

		identify types of ***UPS equipment*** used in power distribution system conditioning and describe their characteristics, applications and operation
B-10.02.02L	demonstrate knowledge of procedures used to service and maintain power conditioning, UPS and surge suppression systems	describe the procedures used to service and maintain power conditioning, UPS and surge suppression systems
		identify hazards with UPS systems when working with batteries, multiple sources and capacitors

RANGE OF VARIABLES

power factor correction equipment includes: synchronous condensers (motors), capacitors, inverters (renewable energy)

equipment used to reduce harmonics includes: passive and active filters, transformers and capacitors

surge suppression equipment includes: capacitors, shunt coils and diodes

UPS equipment includes: online, offline, maintenance bypass and static bypass, battery systems

Task B-11 Installs, services and maintains bonding and grounding protection systems.

TASK DESCRIPTOR

Bonding and grounding systems are used to protect life and equipment from transient and fault current. Ground fault protection systems are used to protect against electrical current leakage, which could result in electrical shock or equipment malfunctions.

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

Construction electricians service bonding and grounding protection systems by troubleshooting, diagnosing faults, and repairing them. They also perform maintenance to ensure these systems are in good operating condition.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

B-11.01 Installs grounding and bonding systems.

Essential Skills	Digital Technology, Document Use, Reading

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-11.01.01P	determine type of ***grounding electrodes***	***grounding electrodes*** are determined based on site-specific conditions and engineering specifications
B-11.01.02P	determine ground conductor size	conductor size is determined based on supply voltage and CEC requirements
B-11.01.03P	determine layout and location of ***grounding system components***	layout allows for the most efficient installation of grounding electrodes, routing of the grounding conductor, and point of termination at the source of supply and/or service equipment
B-11.01.04P	install ***grounding system components***	***grounding system components*** are installed according to layout and site conditions

B-11.01.05P	terminate and interconnect ***grounding system components***	***grounding system components*** are terminated and interconnected according to electrical drawings and specifications, job and CEC requirements (for example, conductors secure with no insulation compromised and not pinched)
B-11.01.06P	terminate grounding conductor	grounding conductor is securely terminated at the source of supply and ***grounding electrode*** according to CEC requirements
B-11.01.07P	perform ground resistance test	ground resistance test is performed using ***ground testing equipment*** and recorded
B-11.01.08P	determine bonding method	bonding method is determined based on environment, amperage, voltage, mechanical protection, and conductor material and size
B-11.01.09P	install ***bonding components***	***bonding components*** are installed in a manner to ensure continuity between non-current carrying components or apparatus of electrical systems and other metallic components

RANGE OF VARIABLES

grounding electrodes include: manufacturers' (rods, plates, clamps), field assembled (buried copper conductors), in-situ (metallic water pipes, metallic pilings)

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

ground testing equipment includes: ground loop impedance tester, ground megohmmeter

bonding components include: metallic raceways, cables, grounding bushings, copper or aluminum conductors, connectors, locknuts, terminations

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-11.01.01L	demonstrate knowledge of ***grounding*** and ***bonding methods*** and equipment	interpret codes and regulations pertaining to grounding and bonding
		interpret information pertaining to grounding and bonding found on drawings and specifications
		identify ***grounding methods***
		identify ***bonding methods***
		identify grounding conductors, equipment and components, and describe their characteristics and applications
		identify bonding conductors, equipment and components, and describe their characteristics and applications

		identify the considerations and requirements for selecting grounding conductors, methods, equipment and components
		identify the considerations and requirements for selecting bonding conductors, methods, equipment and components
		explain the purpose and differences between grounding and bonding, and identify situations where interconnection of bonding is required
B-11.01.02L	demonstrate knowledge of the procedures used to install grounding systems	describe the procedures used to install grounding systems
		describe the method used to calculate grounding conductor size
B-11.01.03L	demonstrate knowledge of the procedures used to install bonding systems	describe the procedures used to install bonding systems
		describe the method used to calculate bonding conductor size

RANGE OF VARIABLES

grounding methods are determined by the level of voltage
bonding methods are based on the ampacity of the conductor, metallic conduits and tubing

B-11.02 Installs ground fault systems.

Essential Skills Digital Technology, Reading, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-11.02.01P	determine the need for, and the type of ***ground fault system***	the need and type of ***ground fault system*** required are determined according to client and CEC requirements
B-11.02.02P	position and mount ***ground fault system components***	***ground fault system components*** are securely mounted using ***fasteners*** designed for the attachment to the material of the support structure
B-11.02.03P	terminate and interconnect ***ground fault system components***	***ground fault system components*** are terminated and interconnected according to electrical drawings and specifications, and job and CEC requirements (for example, conductors secure with no insulation compromised and not pinched)

B-11.02.04P	set parameters for ***ground fault systems***	parameters are set to trip or alarm as required according to type of ***ground fault system*** installed and coordination studies
B-11.02.05P	test operation of ***ground fault system***	***ground fault system*** trips or alarms as required

RANGE OF VARIABLES

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

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

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

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-11.02.01L	demonstrate knowledge of ground fault systems and their operation	identify types of ***ground fault systems*** and describe their characteristics and applications
		explain the purpose of ***ground fault systems***
		interpret codes and regulations pertaining to ***ground fault systems***
		interpret information pertaining to ***ground fault systems*** found on drawings and specifications
		identify the considerations and requirements for selecting the type of ***ground fault systems components***
B-11.02.02L	demonstrate knowledge of ***ground fault system*** installation methods	identify and describe the methods used to install ***ground fault systems*** and ***ground fault system components***

RANGE OF VARIABLES

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

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

B-11.03 Installs lightning protection systems.

Essential Skills	Thinking Skills, Reading, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-11.03.01P	determine the need for, and the type of ***lightning protection system*** required	the need and type of ***lightning protection system*** required is determined subject to type and use of structure, and AHJ and client requirements
B-11.03.02P	select and lay out ***lightning protection components***	layout allows for ***lightning protection components*** to be installed in a manner to direct lightning energy to ground
B-11.03.03P	position and mount ***lightning protection components***	***lightning protection components*** are securely mounted using ***fasteners*** designed for attachment to the material of the support structure
B-11.03.04P	terminate and interconnect ***lightning protection components***	***lightning protection components*** are terminated and interconnected according to electrical drawings and specifications, and job and CEC requirements (for example, conductors are installed in smooth sweeping curves)
B-11.03.05P	remove and dispose of existing ***lightning protection components*** when replacing and update documentation	all used ***lightning protection components*** are disposed of according to local codes and waste disposal requirements
B-11.03.06P	verify installation	visual inspection of component installation is performed to ensure interconnection requirements are met

RANGE OF VARIABLES

lightning protection systems include: lightning arrester protection, structure protection

lightning protection components include: lightning rod (air terminal), intercepting conductors, down conductors, ground electrodes (ground rods), supports, lightning arresters

fasteners include: screws, straps, inserts, anchors, wedge clamps, insulators

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-11.03.01L	demonstrate knowledge of ***lightning protection systems*** and their operation	explain the purpose of ***lightning protection systems***
		interpret codes and regulations pertaining to ***lightning protection systems***
		interpret information pertaining to ***lightning protection systems*** found on drawings and specifications
		identify the considerations and requirements for selecting the type of ***lightning protection systems***
B-11.03.02L	demonstrate knowledge of ***lightning protection system*** installation methods	identify and describe the methods used to install ***lightning protection systems*** and ***lightning protection components***

RANGE OF VARIABLES

lightning protection systems include: lightning arrester protection, structure protection

lightning protection components include: lightning rod (air terminal), intercepting conductors, down conductors, ground electrodes (ground rods), supports, lightning arresters

B-11.04 Performs servicing and maintenance of bonding and grounding systems.

Essential Skills	Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-11.04.01P	obtain detailed description of malfunction from client	malfunction issues and ***information*** are identified and recorded
B-11.04.02P	conduct ***field assessment*** using ***diagnostic and test equipment***	***field assessments*** are conducted using the ***diagnostic and test equipment*** that provides the most definitive diagnostics
B-11.04.03P	determine source of malfunction based on ***field assessment***	source of malfunction is identified
B-11.04.04P	determine course of action	course of action for the type of malfunction is identified
B-11.04.05P	repair malfunctioning components	repaired components are operational
B-11.04.06P	select replacement components	equivalent replacement components (OEM replacement when mandated) are selected

B-11.04.07P	install replacement components	replacement components are installed with minimal disruptions
B-11.04.08P	determine maintenance requirements	maintenance requirements are identified by consequence of failure
B-11.04.09P	create maintenance schedule	maintenance schedule is created by considering maintenance requirements
B-11.04.10P	follow maintenance schedule	maintenance tasks are done according to established schedule
B-11.04.11P	conduct tests using ***diagnostic and test equipment***	tests are conducted according to established maintenance schedule, and test results are recorded
B-11.04.12P	update maintenance log	maintenance log is updated to reflect servicing and maintenance tasks performed

RANGE OF VARIABLES

information includes: log books, manufacturers' manuals, standard operating procedures, anecdotal details from maintenance personnel

field assessments include: sensory inspections, technical inspections

diagnostic and test equipment includes: multimeters, voltage testers, ammeters, insulation resistance testers

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-11.04.01L	demonstrate knowledge of the methods used to service and maintain bonding and grounding and associated protection systems	describe the methods used to service bonding and grounding and associated protection systems, and their components
		describe the methods used to maintain bonding and grounding and associated protection systems, and their components

Task B-12 Installs, services and maintains power generation 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 building is isolated from the power grid.

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

Construction electricians service power generating systems by troubleshooting, diagnosing faults, and repairing them. They also perform maintenance to ensure these systems are in good operating condition.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

B-12.01 Installs alternating current (AC) generating systems.

Essential Skills Numeracy, Document Use, Thinking Skills

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-12.01.01P	determine power requirements for the application by performing load calculations and tests	power requirements are determined using connected load
B-12.01.02P	determine the type and capacity of ***AC generating system*** and ***components*** to be installed for the application	type and capacity of ***AC generating systems*** and ***components*** meet the established requirements
B-12.01.03P	position and mount ***AC generating systems*** and ***components***	***AC generating system*** is positioned to account for ventilation according to manufacturers' and job specifications and AHJ requirements
B-12.01.04P	terminate and interconnect ***AC generating systems*** and ***components***	***AC generating systems*** and ***components*** are terminated and interconnected according to electrical drawings and specifications, job and CEC requirements (for example, conductors secure with no insulation compromised and not pinched)

B-12.01.05P	ground or bond ***AC generating systems*** and components	***AC generating system*** and components are grounded and bonded using a conductor sized according to CEC requirements
B-12.01.06P	program ***AC generating systems*** and controls for startup and shutdown sequences	programming of ***AC generating system*** meets functionality and established parameters and test results are documented
B-12.01.07P	conduct tests of ***AC generating systems*** and ***AC generating system components*** after installation, make required adjustments to ensure required voltage and frequency, and record results	***AC generating systems*** and ***AC generating system components*** are functional and connected according to the job specification, AHJ and CEC requirements, and test results are recorded
B-12.01.08P	disconnect existing ***AC generating systems*** and ***AC generating system components***, ensure safety of remaining installation and update documentation	***AC generating systems*** and ***AC generating system components*** are disconnected, remaining installations are terminated according to CEC requirements and documentation is updated

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, Automatic Voltage Regulator (AVR)

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-12.01.01L	demonstrate knowledge of **AC generating systems** and ***AC generating system components***, their applications and operation	describe the components of ***AC generating systems*** and explain their operating principles
		identify types of ***AC generating systems*** and describe their characteristics and applications
		identify ***AC generating system components*** and describe their characteristics and applications
		identify the considerations and requirements for selecting ***AC generating systems*** and ***AC generating system components***
		interpret information pertaining to ***AC generating systems*** found on drawings and specifications
		interpret codes, standards and regulations pertaining to ***AC generating systems***

B-12.01.02L	demonstrate knowledge of the procedures used to install and connect ***AC generating systems***	describe the procedures used to install ***AC generating systems*** and ***AC generating system components***
		describe the procedures used to connect ***AC generating systems*** and ***AC generating system components***
		describe the procedures used to control the output voltage, phase sequencing and frequency of AC generators

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

B-12.02 Performs servicing and maintenance of AC generating systems.

Essential Skills	Oral Communication, Digital Technology, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-12.02.01P	obtain detailed description of operation and malfunction of ***AC generating system***	required information about equipment operation is gathered from end user
B-12.02.02P	conduct ***field assessments*** using ***diagnostic and test equipment*** to determine source of malfunction	source of malfunction is identified based on inspection and ***diagnostic equipment and test equipment*** results
B-12.02.03P	identify and remove defective ***AC generating system components***	defective component is removed without damage to system or other components
B-12.02.04P	repair malfunctioning components	repaired components are operational
B-12.02.05P	select replacement components	replacement components (OEM replacement when mandated) are selected according to the application
B-12.02.06P	install replacement components	components are installed with minimal disruptions and interruptions
B-12.02.07P	conduct tests of ***AC generating systems*** after repair	***AC generating system*** is connected according to manufacturers' specifications, CEC requirements and the direction of rotation according to specifications

B-12.02.08P	perform ***service procedures*** to ***AC generating system components***	***AC generating system components*** are restored to optimal conditions
B-12.02.09P	record tests in maintenance schedule	maintenance log is updated to reflect servicing and maintenance tasks performed
B-12.02.10P	compare and analyze maintenance test results	maintenance is performed when required based on analysis of test results and comparison with specifications

RANGE OF VARIABLES

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

field assessments include: sensory inspections, technical inspections

diagnostic and test equipment includes: multimeters, voltage testers, ammeters, oscilloscope, power quality analyzers, high pot tester, thermographic imaging devices, phase rotation meters, insulation resistance testers, ground loop tester

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, Automatic Voltage Regulator (AVR)

service procedures include: cleaning cooling fans, adjusting belt tensioners, lubricating bearings and bushings, cleaning switches

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

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

AC generators include: single-phase, three-phase, portable, stationary

B-12.03 Installs direct current (DC) generating systems. (NOT COMMON CORE)

Essential Skills	Thinking Skills, Numeracy, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
no	yes	no	no	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-12.03.01P	determine power requirements for the application by performing load calculations and tests	power requirements are determined using connected load
B-12.03.02P	determine the type and capacity of ***DC generating system*** and ***DC generating system components*** to be installed for the application	type and capacity of ***DC generating systems*** and ***DC generating system components*** meet the established requirements
B-12.03.03P	position and mount ***DC generating systems*** and ***components***	***DC generating system*** is positioned to account for ventilation according to manufacturers' and job specifications, and AHJ requirements
B-12.03.04P	terminate and interconnect ***DC generating systems*** and ***components***	***DC generating systems*** and ***components*** are terminated and interconnected according to electrical drawings and specifications, job and CEC requirements (for example, conductors secure with no insulation compromised and not pinched)
B-12.03.05P	ground or bond ***DC generating systems*** and ***components***	***DC generating system*** and ***DC generating system components*** are grounded and bonded using a conductor type and size according to CEC requirements
B-12.03.06P	program ***DC generating systems*** and controls for startup and shutdown sequences	***DC generating system*** is programmed and meets functionality and established parameters and test results are documented

B-12.03.07P	conduct tests of ***DC generating systems*** and ***DC generating system components*** after installation, make required adjustments to ensure voltage and record results	***DC generating systems*** and ***DC generating system components*** are connected according to job, AHJ and CEC requirements, and test results are recorded
B-12.03.08P	disconnect existing ***DC generating systems*** and ***DC generating system components*** and ensure safety of remaining installation, and update documentation	***DC generating systems*** and ***DC generating system components*** are disconnected, remaining installations are terminated according to CEC requirements and documentation is updated
B-12.03.01P	determine power requirements for the application by performing load calculations and tests	power requirements are determined using connected load
B-12.03.02P	determine the type and capacity of ***DC generating system*** and ***DC generating system components*** to be installed for the application	type and capacity of ***DC generating systems*** and ***DC generating system components*** meet the established requirements

RANGE OF VARIABLES

DC generating systems include: portable, stationary, manually operated, automatically operated

DC generating system components include: transfer switch, prime mover, cables, conductors, overcurrent devices, overload devices, fuel storage

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

	describe the procedures used to connect ***DC generating systems*** and ***DC generating system components***
	describe the procedures used to control the output voltage of ***DC generators***

RANGE OF VARIABLES

DC generating systems include: portable, stationary, manually operated, automatically operated

DC generating system components include: transfer switch, prime mover, cables, conductors, overcurrent devices, overload devices, fuel storage

DC generators include: series, shunt, compound, portable, stationary

B-12.04 Performs servicing and maintenance of DC generating systems. (NOT COMMON CORE)

Essential Skills	Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
no	yes	no	no	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-12.04.01P	obtain detailed description of operation and malfunction of DC generating system	required information about equipment operation is gathered from end user
B-12.04.02P	conduct ***field assessments*** using ***diagnostic and test equipment*** to determine source of malfunction	source of malfunction is identified based on inspection and ***diagnostic and test equipment*** results
B-12.04.03P	identify and remove defective ***DC generating system components***	defective ***DC generating system components*** are removed without damage to system or other components
B-12.04.04P	repair malfunctioning components	repaired components are operational
B-12.04.05P	select replacement components	replacement components (OEM replacement when mandated) match the application
B-12.04.06P	install replacement components	components are installed with minimal disruptions and interruptions
B-12.04.07P	conduct tests of ***DC generating system*** after repair	***DC generating system*** is functional and connected for the application and the direction of rotation is according to specifications
B-12.04.08P	perform ***service procedures*** to ***DC generating system components***	***DC generating system components*** are restored to optimal conditions

B-12.04.09P	record tests in maintenance schedule	maintenance log is updated to reflect servicing and tasks performed
B-12.04.10P	compare and analyze maintenance test results	maintenance is performed when required based on analysis of test results and comparison with specifications

RANGE OF VARIABLES

field assessments include: sensory inspections, technical inspections

diagnostic and test equipment includes: multimeters, voltage testers, ammeters, oscilloscopes, high pot testers, thermographic imaging devices, phase rotation meters, insulation resistance testers, ground loop testers

DC generating systems include: portable, stationary, manually operated, automatically operated

DC generating system components include: transfer switch, brushes, prime mover, cables, conductors, overcurrent devices, overload devices, fuel storage

service procedures include: cleaning cooling fans, adjusting belt tensioners, lubricating bearings and bushings, adjusting and setting brushes, cleaning switches

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

RANGE OF VARIABLES

DC generating systems include: portable, stationary, manually operated, automatically operated

DC generating system components include: transfer switch, prime mover, cables, conductors, overcurrent devices, overload devices, fuel storage

DC generators include: series, shunt, compound, portable, stationary

Task B-13 Installs, services and maintains renewable energy systems.

TASK DESCRIPTOR

Alternative and renewable energy generation 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, wind or tidal powered that use renewable sources of energy.

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

Construction electricians service alternative and renewable energy systems by troubleshooting, diagnosing faults, and repairing them. They also perform maintenance to ensure alternative and renewable energy systems are in good operating condition.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

B-13.01 Installs renewable energy systems.

Essential Skills Thinking Skills, Numeracy, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-13.01.01P	determine energy requirements for the application by performing load calculations and tests	calculations are performed according to applicable energy requirements or production requirements
B-13.01.02P	determine capacity of ***renewable energy system*** to be installed for the application	size and capacity of ***renewable energy system*** are determined
B-13.01.03P	determine the type of ***renewable energy connection*** to be installed for the application	***renewable energy connection*** type is determined
B-13.01.04P	position and mount ***renewable energy systems and control*** and ***storage system*** components	***renewable energy systems and control*** and ***storage system components*** are securely mounted using ***fasteners*** designed for attachment to the material of the support structure

B-13.01.05P	terminate and interconnect ***renewable energy system*** and ***control system components***	***renewable energy system*** and ***control system components*** are terminated and interconnected according to electrical drawings and specifications, and job and CEC requirements (for example, conductors secure with no insulation compromised and not pinched)
B-13.01.06P	conduct tests of ***renewable energy system*** after installation and record results	***renewable energy system*** is functional and connected according to the application requirements
B-13-01.07P	remove existing equipment when replacing and update documentation	equipment is removed with minimal impact to the environment and drawings reflect operational changes
B-13-01.08P	determine ground and bonding requirements for renewable energy systems	method and materials for system grounding are selected

RANGE OF VARIABLES

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

renewable energy connections include: grid dependent and grid independent (stand-alone)

control system components include: transfer switches, sun-tracking systems, batteries, charge controller, load bank, inverters with anti-islanding capability

used components: pumped hydro, compressed air energy storage, batteries (various technologies), flow batteries, flywheel energy storage

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

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-13.01.01L	demonstrate knowledge of ***renewable energy systems***, their applications and operation	identify types of ***renewable energy systems*** and describe their characteristics, applications and operation
		identify renewable energy system components and describe their characteristics, applications and operation
		identify type of ***renewable energy connections***
		interpret codes and regulations pertaining to ***renewable energy systems***
		define terminology associated with ***renewable energy systems***

B-13.01.02L	demonstrate knowledge of procedures to install and connect ***renewable energy systems*** and ***control system components***	describe the procedures used to install ***renewable energy systems*** and ***control system components***
		describe the procedures used to connect ***renewable energy systems*** and ***control system components***

RANGE OF VARIABLES

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

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

control system components include: transfer switches, sun-tracking systems, batteries, charge controller, load bank, inverters with anti-islanding capability

B-13.02 Performs servicing and maintenance of renewable energy systems.

Essential Skills	Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-13.02.01P	obtain detailed description of operation and malfunction of renewable energy systems	required information about equipment operation is gathered from end user
B-13.02.02P	conduct ***field assessments*** using ***diagnostic and test equipment*** to determine source of malfunction	source of malfunction is identified based on inspection and ***diagnostic and test equipment*** results
B-13.02.03P	identify and remove defective renewable energy systems components	defective components are removed without damage to system or other components
B-13.02.04P	repair malfunctioning components	repaired components are operational
B-13.02.05P	select replacement components	replacement components (OEM replacement when mandated) match the application
B-13.02.06P	install replacement components	components are installed with minimal disruptions and interruptions
B-13.02.07P	conduct tests of ***renewable energy systems*** after repair	***renewable energy system*** is connected according to job, AHJ and CEC requirements
B-13.02.08P	***lubricate, clean and adjust*** components	***renewable energy systems*** are restored to optimal conditions

B-13.02.09P	record tests in maintenance schedule	maintenance log is updated to reflect servicing and maintenance tasks performed
B-13.02.10P	compare and analyze maintenance test results	maintenance is performed when required based on analysis of test results and comparison with specifications

RANGE OF VARIABLES

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

field assessments include: sensory inspections, technical inspections

diagnostic and test equipment includes: multimeters, voltmeters, ammeters, thermographic imaging devices, irradiation meters, tachometers, oscilloscopes, insulation resistance testers

lubrication, cleaning and adjusting procedures include: cleaning fans and filters, adjusting cabinets and door seals, lubricating bearings and bushings, cleaning photovoltaic modules, recalibrating tracking system

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-13.02.01L	demonstrate knowledge of ***renewable energy systems***, their applications and operation	identify types of ***renewable energy systems*** and describe their characteristics, applications and operation
		identify renewable energy system components and describe their characteristics, applications and operation
		interpret codes and regulations pertaining to ***renewable energy systems***
		define terminology associated with ***renewable energy systems***
B-13.02.02L	demonstrate knowledge of procedures to service and maintain ***renewable energy systems***	describe the procedures used to service ***renewable energy systems*** and their components
		describe the procedures used to maintain ***renewable energy systems*** and their components

RANGE OF VARIABLES

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

Task B-14 Installs, services and maintains high voltage systems.

TASK DESCRIPTOR

Construction electricians assemble, install, erect and connect equipment and cables for high voltage applications (voltages above 750V) such as switchyards, sub-stations, electrical vaults, solar photovoltaic systems, chillers and MCC's. 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, installation includes both new installations and upgrading of systems by removing and replacing components.

Construction electricians service high voltage systems by troubleshooting, diagnosing faults, and repairing them. They also perform maintenance to ensure these systems are in good operating condition.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

B-14.01 Installs high voltage equipment.

Essential Skills Reading, Digital Technology, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-14.01.01P	determine installation requirements for ***high voltage equipment***	requirements for ***high voltage equipment*** is determined subject to location, AHJ and client requirements
B-14.01.02P	lay out ***high voltage equipment***	layout allows for ***high voltage equipment*** to be installed level, square and plumb, matching building lines with required access and egress
B-14.01.03P	assemble high voltage equipment	high voltage equipment is assembled according to job requirements and manufacturers' specifications
B-14.01.04P	interconnect high voltage equipment	high voltage equipment is interconnected using busbars or cabling systems depending on application
B-14.01.05P	bond ***non-current carrying metallic components***	***non-current carrying metallic components*** are bonded to ground

B-14.01.06P	install ground grid	ground grid is installed according to step and touch voltage requirements and CEC requirements
B-14.01.07P	perform ground resistance test	ground resistance test is performed using ***testing equipment*** and recorded
B-14.01.08P	perform ***acceptance tests***	***acceptance tests*** are conducted using required ***testing standards***
B-14.01.09P	install labelling and signage on high voltage equipment	high voltage equipment is labelled, and signage is evident according to client, site and CEC requirements
B-14.01.10P	update ***required documentation***	changes to the installation of ***high voltage equipment*** are recorded on ***documentation required by AHJ***
B-14.01.11P	remove and dispose of existing ***high voltage equipment*** and components when replacing and update documentation	used ***high voltage equipment*** and components are disposed of according to local codes and waste disposal requirements

RANGE OF VARIABLES

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

non-current carrying metallic components include: fences, towers, doors, enclosures

testing equipment includes: ground loop impedance tester, megohmmeter

acceptance tests include: polarization, ground grid resistance, high pot, phasing, functionality, timing, current injection

testing standards include: manufacturer, Institute of Electrical and Electronics Engineers (IEEE), North American Electrical Testing Association (NETA), AHJ

documentation required by AHJ include: as-builts, schematics (AC, DC), drive drawings, shop drawings, single-line drawings, three-line drawings

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-14.01.01L	demonstrate knowledge of ***high voltage equipment***	interpret codes and regulations pertaining to ***high voltage equipment***
		interpret information pertaining to ***high voltage equipment*** found on drawings and specifications
		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 ***high voltage equipment***

B-14.01.02L	demonstrate knowledge of the procedures used to install ***high voltage equipment***	describe the procedures used to install ***high voltage equipment***
		describe the procedures used to install ground grid
		identify sources of information and ***documentation required by AHJ*** for installation of ***high voltage equipment***
B-14.01.03L	demonstrate knowledge of testing procedures	identify testing procedures
		describe the procedures used to perform ground resistance testing and ***acceptance testing*** of ***high voltage equipment***

RANGE OF VARIABLES

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

documentation required by AHJ includes: as-builts, schematics (AC, DC), shop drawings, single-line drawings, three-line drawings)

acceptance tests include: polarization, ground grid resistance, high pot, phasing, functionality, timing, current injection

B-14.02 Installs high voltage cables.

Essential Skills	Thinking Skills, Numeracy, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-14.02.01P	determine size and type of ***high voltage cable***	size and type of ***high voltage cable*** are selected according to calculated load, client requirements, existing site conditions and CEC
B-14.02.02P	determine layout and location of ***high voltage cable*** installation	layout allows for ***high voltage cable*** to be installed with clearance and at a location where the components can be mounted level, square and plumb
B-14.02.03P	determine trench size and minimum cover requirements	trench size and cover allows for the installation of direct burial cables and underground raceways according to the area
B-14.02.04P	install flagging and warning tape	flagging and warning tape are installed according to job and AHJ requirements

B-14.02.05P	determine overhead clearance	overhead clearance conforms to AHJ and CEC requirements for the usage of the area and proximity to structures
B-14.02.06P	mount and secure ***high voltage cable components***	***high voltage cable components*** are securely mounted to the equipment using ***fasteners*** designed for attachment to the cable supports of the support structure
B-14.02.07P	install ***high voltage cables***	***high voltage cables*** are installed without damage to insulation, without stress and the neutral and three-phase conductors are colour-coded
B-14.02.08P	install terminations on ***high voltage cables***	potheads and stress relief terminations are installed according to manufacturers' instructions
B-14.02.09P	conduct high pot test of ***high voltage cables***	***high voltage cables*** are tested to manufacturers' recommendations
B-14.02.10P	identify cable information on each conductor	each conductor is labelled and colour-coded according to CEC and client requirements
B-14.02.11P	bond cable shield	cable shield is bonded as required
B-14.02.12P	remove and dispose of ***high voltage cables*** and ***high voltage cable components*** when replacing and update documentation	all used ***high voltage cables*** and ***high voltage cable components*** are disposed of according to local codes and waste disposal requirements

RANGE OF VARIABLES

high voltage cables include: armoured cables (with or without shielded conductor), trailing cables, shielded cables, unshielded cables, bus ducts, conduit

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

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

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-14.02.01L	demonstrate knowledge of ***high voltage cables***, their applications and operation	identify types of ***high voltage cables*** and describe their characteristics and applications
		identify ***high voltage cable components*** and describe their characteristics and applications
		identify the considerations and requirements for selecting ***high voltage cables*** and ***high voltage cable components***
B-14.02.02L	demonstrate knowledge of the procedures used to install and terminate ***high voltage cables***	describe the procedures used to install and terminate ***high voltage cables*** and ***high voltage cable components***

B-14.02.03L	demonstrate knowledge of testing procedures	identify testing procedures
		describe the procedures used to perform high pot tests

RANGE OF VARIABLES

high voltage cables include: armoured cables (with or without shielded conductor), trailing cables, shielded cables, unshielded cables, bus ducts, conduit

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

B-14.03 Performs servicing and maintenance of high voltage systems.

Essential Skills	Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-14.03.01P	obtain detailed description of malfunction from client	malfunction issues and information are identified and recorded
B-14.03.02P	conduct ***field assessment*** using ***diagnostic and test equipment***	***field assessments*** are conducted using the ***diagnostic and test equipment*** that provides the most definitive diagnostics
B-14.03.03P	determine source of malfunction based on ***field assessment***	source of malfunction is identified
B-14.03.04P	determine course of action	course of action for the type of malfunction is identified
B-14.03.05P	select replacement components	equivalent replacement components (OEM replacement when mandated) that match the application are selected
B-14.03.06P	install replacement components	components are installed with minimal disruptions and interruptions
B-14.03.07P	repair malfunctioning components	repaired components are operational
B-14.03.08P	determine maintenance requirements	maintenance requirements are identified by consequence of failure
B-14.03.09P	create maintenance schedule	maintenance schedule is created by considering maintenance requirements
B-14.03.10P	follow maintenance schedule	maintenance tasks are done according to established schedule
B-14.03.11P	isolate components	components are isolated in order to allow for safe testing procedures

B-14.03.12P	conduct tests using ***diagnostic and test equipment***	tests are conducted according to established maintenance schedule and test results are recorded
B-14.03.13P	update maintenance log and ***required documentation***	maintenance log and ***required documentation*** is updated to reflect servicing and maintenance tasks performed

RANGE OF VARIABLES

field assessments include: sensory inspections, technical inspections

diagnostic and test equipment includes: multimeters, voltage testers, ammeters, power quality analyzers, high pot testers, thermographic imaging devices, phase rotation meters, insulation resistance testers, ground loop tester, arc flash equipment, ground straps

required documentation includes: schematic diagrams and drawings, maintenance schedules, single line diagrams

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-14.03.01L	demonstrate knowledge of the procedures used to service and maintain ***high voltage equipment***	describe the procedures used to service ***high voltage equipment*** and their ***components***
		describe the procedures used to maintain ***high voltage equipment*** and their ***components***
B-14.03.02L	demonstrate knowledge of the methods used to service and maintain ***high voltage cables***	describe the procedures used to service, ***high voltage cables*** and their ***components***
		describe the procedures used to maintain ***high voltage cables*** and their ***components***

RANGE OF VARIABLES

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

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

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

Task B-15 Installs, services and maintains transformers.

TASK DESCRIPTOR

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

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

Construction electricians service transformers by troubleshooting, diagnosing faults, and repairing them. They also perform maintenance to ensure transformers are in good operating condition.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

B-15.01 Installs extra-low voltage transformers.

Essential Skills	Thinking Skills, Numeracy, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-15.01.01P	determine type of ***extra-low voltage transformer*** required and its VA rating	type of ***extra-low voltage transformer*** meets criteria for operation
B-15.01.02P	calculate conductor requirements	conductor type and size are selected according to CEC requirements
B-15.01.03P	determine overcurrent devices based on requirements	type and rating of overcurrent devices are determined
B-15.01.04P	install overcurrent devices based on requirements	overcurrent devices are installed such that transformer is protected
B-15.01.05P	position and mount ***extra-low voltage transformer***	***extra-low voltage transformer*** is mounted according to the application
B-15.01.06P	connect transformer leads	transformer leads are connected according to the application

B-15.01.07P	conduct tests of ***extra-low voltage transformer*** after installation and record results	***extra-low voltage transformer*** is functional and connected according to the application requirements
B-15.01.08P	remove existing ***extra-low voltage transformer*** when replacing and update documentation	***extra-low voltage transformers*** are removed with minimal impact to the environment and drawings reflect operational changes

RANGE OF VARIABLES

extra-low voltage transformers include: Class 1 and Class 2 circuits according to the CEC

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-15.01.01L	demonstrate knowledge of ***extra-low voltage transformers***, their applications and operation	explain the operating principles of ***extra-low voltage transformers***
		interpret information contained on ***extra-low voltage transformer*** nameplates
		identify types of ***extra-low voltage transformers*** and describe their characteristics and applications
		identify ***extra-low voltage transformer components*** and describe their characteristics and applications
		identify the considerations and requirements for selecting ***extra-low voltage transformers***
B-15.01.02L	demonstrate knowledge of procedures used to install ***extra-low voltage transformers***	describe the procedures used to install ***extra-low voltage transformers***

RANGE OF VARIABLES

extra-low voltage transformers include: Class 1 and Class 2 circuits according to the CEC

extra-low voltage transformer components include: casing, core, primary and secondary windings

B-15.02 Installs low-voltage single-phase transformers.

Essential Skills	Numeracy, Digital Technology, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-15.02.01P	determine type of ***low-voltage single-phase transformer*** required and its kilovolt-amp (kVA) rating	type of ***low-voltage single-phase transformer*** meets criteria for operation
B-15.02.02P	calculate conductor requirements	conductor type and size are selected according to CEC requirements
B-15.02.03P	determine overcurrent devices based on ***system requirements***	type and rating of overcurrent devices are determined according to CEC requirements
B-15.02.04P	install overcurrent devices based on ***system requirements***	overcurrent devices are installed such that transformer is protected
B-15.02.05P	position and mount ***low-voltage single-phase transformer***	***low-voltage single-phase transformer*** is mounted according to the application
B-15.02.06P	connect transformer leads	transformer leads are connected according to the application
B-15.02.07P	select and change tap settings of ***low-voltage single-phase transformers***	output voltage meets application requirements
B-15.02.08P	ground and bond transformer	transformer is grounded and bonded to meet CEC requirements
B-15.02.09P	conduct ***tests*** of ***low-voltage single-phase transformer*** after installation and record results	***low-voltage single-phase transformer*** is functional and connected according to the application
B-15.02.10P	remove existing ***low-voltage single-phase transformer*** when replacing and update documentation	***low-voltage single-phase transformer*** is removed with minimal impact to the environment and drawings reflect operational changes

RANGE OF VARIABLES

low-voltage single-phase transformers include: dry-type and liquid-filled

system requirements include: input/output voltage, polarities, kVA ratings, conductor size, overcurrent protection

tests include: insulation test, voltage test, polarity test, amperage test

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-15.02.01L	demonstrate knowledge of ***low-voltage single-phase transformers***, their applications and operation	explain the operating principles of ***low-voltage single-phase transformers***
		identify types of ***low-voltage single-phase transformers*** and describe their characteristics and applications
		identify ***low-voltage single-phase transformer components*** and describe their characteristics and applications
		interpret information contained on ***low-voltage single-phase transformer*** nameplates
		explain transformer polarity and terminal markings
		identify the considerations and requirements for selecting ***low-voltage single-phase transformers***
B-15.02.02L	demonstrate knowledge of procedures used to install ***low-voltage single-phase transformers***	describe the procedures used to install ***low-voltage single-phase transformers***
		interpret codes and regulations pertaining to ***low-voltage single-phase transformers***
		describe the procedures used to install ***low-voltage single-phase transformers*** in parallel

RANGE OF VARIABLES

low-voltage single-phase transformers include: dry-type and liquid-filled

low-voltage single-phase transformer components include: oil pumps, ventilation fans, casing, core, primary and secondary windings, bushings, on-line and off-line tap changers, oil

B-15.03 Installs low-voltage three-phase transformers.

Essential Skills	Numeracy, Digital Technology, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-15.03.01P	determine type of ***low-voltage three-phase transformer*** required and its kVA rating	type of ***low-voltage three-phase transformer*** meets criteria for operation
B-15.03.02P	calculate conductor requirements	conductor type and size are selected according to CEC requirements
B-15.03.03P	determine overcurrent devices based on ***system requirements***	type and rating of overcurrent devices are determined according to CEC requirements
B-15.03.04P	install overcurrent devices based on ***system requirements***	overcurrent devices are installed such that transformer is protected
B-15.03.05P	position and mount ***low-voltage three-phase transformer***	***low-voltage three-phase transformer*** is mounted according to the application
B-15.03.06P	select and change tap settings ***of low-voltage three-phase transformers***	output voltage meets application requirements
B-15.03.07P	connect transformer leads	transformer leads are connected according to the application
B-15.03.08P	ground and bond transformer	transformer is grounded and bonded to meet CEC requirements
B-15.03.09P	conduct ***tests*** of ***low-voltage three-phase transformer*** after installation and record results	***low-voltage three-phase transformer*** is functional and connected for the application
B-15.03.10P	remove existing ***low-voltage three-phase transformer*** when replacing and update documentation	***low-voltage three-phase transformer*** is removed with minimal impact to the environment and drawings reflect operational changes

RANGE OF VARIABLES

low-voltage single-phase transformers include: dry-type and liquid-filled

system requirements include: input/output voltage, polarities, kVA ratings, conductor size, overcurrent protection

tests include: insulation test, voltage test, polarity test, amperage test

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

RANGE OF VARIABLES

low-voltage three-phase transformers include: dry-type and liquid-filled

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

low-voltage three-phase transformer components include: oil pumps, ventilation fans, casing, core, primary and secondary windings, bushings, on-line and off-line tap changers, oil

B-15.04 Installs high voltage transformers.

Essential Skills	Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-15.04.01P	determine type of ***high voltage transformer*** required and its kVA rating	type of ***high voltage transformer*** meets criteria for operation
B-15.04.02P	calculate conductor requirements	conductor type and size are calculated according to CEC requirements
B-15.04.03P	determine overcurrent devices based on ***system requirements***	type and rating of overcurrent devices are determined
B-15.04.04P	install overcurrent devices based on ***system requirements***	overcurrent devices are installed such that transformer is protected
B-15.04.05P	position and mount ***high voltage transformer***	***high voltage transformer*** is mounted according to the application
B-15.04.06P	select and change tap settings of ***high voltage transformers***	output voltage meets application requirements
B-15.04.07P	connect transformer leads	transformer leads are connected according to the application
B-15.04.08P	ground and bond transformer	transformer is bonded and grounded to meet CEC requirements
B-15.04.09P	conduct ***tests*** of ***high voltage transformer*** after installation and record results	***high voltage transformer*** is functional and connected for the application
B-15.04.10P	remove existing ***high voltage transformer*** when replacing and update documentation	***high voltage transformer*** is removed with minimal impact to the environment and drawings reflect operational changes

RANGE OF VARIABLES

high voltage transformers include: dry-type and liquid-filled

system requirements include: input/output voltage, polarities, kVA ratings, conductor size, overcurrent protection

tests include: insulation test, voltage test, high-pot test, oil analysis test, amperage test

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-15.04.01L	demonstrate knowledge of ***high voltage transformers***, their applications and operation	explain the operating principles of ***high voltage transformers***
		identify types of ***high voltage transformers*** and describe their characteristics and applications
		identify ***winding configurations*** for ***high voltage transformers***
		identify ***high voltage transformer components*** and describe their characteristics and applications
		interpret information contained on ***high voltage transformer*** nameplates
		explain transformer polarity and terminal markings
		identify the considerations and requirements for selecting ***high voltage transformers***
B-15.04.02L	demonstrate knowledge of procedures used to install ***high voltage transformers***	describe the procedures used to install ***high voltage transformers***
		interpret codes and regulations pertaining to ***high voltage transformers***
		describe the procedures used to install ***high voltage transformers*** in parallel

RANGE OF VARIABLES

high voltage transformers include: dry-type and liquid-filled

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

high voltage transformer components include: oil pumps, ventilation fans, casing, core, primary and secondary windings, desiccant breather, buchholz relay, bushings, on-line and off-line tap changers, oil

B-15.05 Performs servicing and maintenance of transformers.

Essential Skills	Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
B-15.05.01P	obtain detailed description of operation and malfunction of transformers	required information about equipment operation is gathered from end user
B-15.05.02P	conduct ***field assessments*** using ***diagnostic and test equipment*** to determine source of malfunction	source of malfunction is identified based on inspection and ***diagnostic and test equipment*** results
B-15.05.03P	identify and remove defective components of transformers	defective components are removed without damage to system or other components
B-15.05.04P	select replacement components	replacement components (OEM replacement when mandated) match the application
B-15.05.05P	install replacement components	components are installed with minimal disruptions and interruptions
B-15.05.06P	conduct ***tests*** of transformers after repair	transformer assembly is connected according to job and CEC requirements, and manufacturers' specifications
B-15.05.07P	***clean, lubricate and adjust*** transformer components	transformer components are restored to optimal conditions
B-15.05.08P	record ***tests*** in maintenance log	maintenance log is updated to reflect servicing and maintenance tasks performed
B-15.05.09P	compare and analyze maintenance ***test*** results	maintenance is performed when required based on analysis of ***test*** results and comparison with specifications

RANGE OF VARIABLES

field assessments include: sensory and technical inspections

diagnostic and test equipment include: multimeters, megohmmeters, dielectric oil testing equipment, voltage testers, thermographic imaging devices, power quality analyzers, turn ratio meters, arc flash equipment, ground clusters

cleaning, lubrication and adjustment procedures include: lubricating fans, cleaning filters, cleaning and adjusting taps

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-15.05.01L	demonstrate knowledge of ***transformers***, their applications and procedures for use	identify types of ***transformers*** and describe their characteristics and applications
		identify ***transformer components*** and describe their characteristics
		interpret codes and regulations pertaining to ***transformers***
		interpret information pertaining to ***transformers*** found on drawings and specifications
		explain the construction and operating principles of ***transformers***
		interpret information contained on ***transformer*** nameplates
B-15.05.02L	demonstrate knowledge of procedures used to service and maintain ***transformers***	describe the procedures used to service ***transformers*** and their ***components***
		describe the procedures used to maintain ***transformers*** and their ***components***

RANGE OF VARIABLES

transformers include: extra-low voltage, dry-type and liquid-filled

transformer components include: oil pumps, ventilation fans, casing, core, primary and secondary windings, desiccant breather, buchholz relay, bushings, on-line and off-line tap changers, oil

MAJOR WORK ACTIVITY C
INSTALLS, SERVICES AND MAINTAINS WIRING SYSTEMS

Task C-16 Installs, services and maintains raceways, cables and enclosures.

TASK DESCRIPTOR

Raceways support and protect conductors. Enclosures may be used to access and terminate the content of the raceway, and to facilitate the pulling and the interconnection of components. Raceways and cables are installed in various environments. Construction electricians install, service and maintain raceways and conductors and restore openings in firewalls.

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

Construction electricians service raceways, cables and enclosures by performing visual inspections, troubleshooting, diagnosing faults, and repairing them. They also perform maintenance to ensure raceways, cables and enclosures are in good operating condition.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

C-16.01 Installs conductors and cables.

Essential Skills Thinking Skills, Numeracy, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
C-16.01.01P	determine ***installation requirements*** and select conductors and cables, and ***components***	size and type of conductors, cables and ***components*** are selected according to drawings and specifications and CEC requirements
C-16.01.02P	measure, cut and assemble conductors and cables, and components	conductors and cables are grouped, tagged and colour-coded according to drawings and specifications and client requirements
C-16.01.03P	mount, support and install conductors and cables, and ***components***	***conductor and cable components*** are mounted, supported and installed according to drawings and specifications, CEC, National Building Code (NBC), and client requirements
C-16.01.04P	prepare conductors and cables for termination	conductors and cables are cleaned and prepared for termination according to manufacturers' specifications
C-16.01.05P	terminate conductors and cables	conductors and cables are terminated leaving no excessive bare conductor or loose strands, and phased and torqued according to electrical, client and manufacturers' specifications
C-16.01.06P	complete required documentation to reflect changes to the new and/or updated installation	all changes are recorded in the documentation and made available to the necessary parties

C-16.01.07P	determine requirements for removal of existing conductors and cables, connectors and supports if applicable when performing an upgrade	removal requirements are determined according to client requirements and considering impact removal will have on the facility
C-16.01.08P	remove conductors and cables, connectors and supports when replacing and update documentation	conductors, cables, connectors and supports are removed according to electrical specifications and the National Fire Code (NFC) and remaining installations are supported and terminated according to CEC requirements

RANGE OF VARIABLES

installation requirements include: purpose of the cable or conductor, equipment required for installation, installation environment in locations such as hazardous, wet, underground, outdoor, category 1, category 2

conductor and cable components include: mechanical fittings, compression fittings, straps, connectors, hangers

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-16.01.01L	demonstrate knowledge of types of conductors and cables and their associated components	identify types of conductors and cables and describe their characteristics and applications
		identify ***conductor and cable components*** and describe their characteristics and applications
		interpret codes, regulations and standards 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/or install conductors and cables	identify the considerations and requirements for removal of conductors and cables and their associated components
		identify the considerations and requirements for selecting conductors and cables and their associated components
		describe the procedures used to remove conductors and cables and their associated components
		describe the procedures used to ***prepare*** and install conductors and cables and their associated components
		describe the procedures used to terminate conductors and cables

RANGE OF VARIABLES

conductor and cable components include: mechanical fittings, compression fittings, straps, connectors, hangers

preparation must include: preparation of aluminum conductors and cables

C-16.02 Installs conduit, tubing and fittings.

Essential Skills	Thinking Skills, Numeracy, Reading

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
C-16.02.01P	determine ***installation requirements*** and select conduit, tubing and fittings	size and type of conduit, tubing and fittings are selected according to drawings and specifications and CEC requirements
C-16.02.02P	determine routing of conduit and tubing	routing of the conduit and tubing is practical for the application and takes into consideration other trades
C-16.02.03P	measure, cut, thread and bend conduit and tubing	conduit and tubing are measured, cut, threaded and bent to meet the requirements of the routing
C-16.02.04P	assemble, position, mount and support conduit, tubing and fittings	conduit, tubing and fittings are assembled, positioned, mounted and supported to meet the requirements of the application and, without damage according to CEC and NBC requirements
C-16.02.05P	determine requirements for removal of existing conduit, tubing and fittings if applicable when performing an upgrade	removal requirements are determined according to client requirements and considering the impact removal will have on the facility
C-16.02.06P	remove conduit, tubing and fittings when replacing and update documentation	conduit, tubing and fittings are removed and remaining installations are supported and terminated according to CEC requirements

RANGE OF VARIABLES

installation requirements include: purpose of the conduit, tubing and fitting, equipment required for installation, installation environment in locations such as hazardous, wet, underground, outdoor, category 1, category 2

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-16.02.01L	demonstrate knowledge of types of conduit, tubing and fittings, their components and applications	identify types of conduit, tubing and fittings and describe their characteristics, applications and limitations
		identify conduit, tubing and fitting components and describe their characteristics and applications
		identify tools and equipment 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 and fittings
C-16.02.02L	demonstrate knowledge of procedures to remove and/or install conduit, tubing and fittings	identify the considerations and requirements for removal of conduit, tubing and fittings and their components
		identify the considerations and requirements for selecting conduit, tubing and fittings and their components
		describe the procedures used for the removal of conduit and tubing
		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 systems
		describe the procedures used to select and install conduit and tubing related components

C-16.03 Installs raceways.

Essential Skills	Thinking Skills, Numeracy, Reading

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
C-16.03.01P	determine ***installation requirements*** and select raceways	size and type of ***raceway*** are selected according to drawings and specifications and CEC requirements
C-16.03.02P	determine routing of ***raceway***	routing of the ***raceway*** is practical for the application and takes into consideration other trades
C-16.03.03P	measure, cut and form ***raceways***	***raceways*** are measured, cut and formed to meet the requirements of the routing
C-16.03.04P	assemble, position, mount and support ***raceways***	***raceways*** are assembled, positioned, mounted and supported to meet the requirements of the application and without damage according to CEC and NBC requirements
C-16.03.05P	determine requirements for removal of existing ***raceways*** if applicable when performing an upgrade	removal requirements are determined according to client requirements and considering the impact removal will have on the facility
C-16.03.06P	remove ***raceways*** and their ***components*** when replacing and update documentation	***raceways*** and their ***components*** are removed according to electrical specifications and remaining installations are supported and terminated according to CEC requirements

RANGE OF VARIABLES

installation requirements include: purpose of the raceway, equipment required for installation, installation environment in locations such as hazardous, wet, underground, outdoor, category 1, category 2

raceways, in this sub-task include: cable tray wireways, 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 16.02

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

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-16.03.01L	demonstrate knowledge of types of ***raceways*** and their components	identify types of ***raceways***, and describe their characteristics and applications
		identify ***raceway components*** and describe their characteristics and applications
		interpret codes, regulations and standards pertaining to ***raceways***
		interpret information pertaining to ***raceways*** found on drawings and specifications
C-16.03.02L	demonstrate knowledge of procedures used to remove and/or install and support ***raceways***	identify the considerations and requirements for removal of ***raceways*** and their ***components***
		identify the considerations and requirements for selecting ***raceways*** and their ***components***
		describe the procedures used to remove ***raceways*** and their ***components***
		describe the procedures used to install and support ***raceways*** and their ***components***

RANGE OF VARIABLES

raceways, in this sub-task include: cable tray wireways, 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 16.02

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

C-16.04 Installs boxes and enclosures.

Essential Skills	Thinking Skills, Numeracy, Reading

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
C-16.04.01P	determine ***installation requirements*** and select boxes and enclosures	size and type of boxes and enclosures are selected according to drawings, specifications and CEC requirements
C-16.04.02P	determine installation location for boxes and enclosures	location for the box and/or enclosure is practical for the application and takes into consideration other trades
C-16.04.03P	assemble, position, mount and support boxes and enclosures	boxes and enclosures are assembled positioned, mounted and supported to meet the requirements of the application and without damage according to CEC and NBC requirements
C-16.04.04P	determine requirements for removal of existing boxes and enclosures if applicable when performing an upgrade	removal requirements are determined according to client requirements and considering the impact removal will have on the facility
C-16.04.05P	remove boxes and enclosures when replacing and update documentation	boxes and enclosures are removed and remaining installations are supported and terminated according to industry expected performance requirements

RANGE OF VARIABLES

installation requirements include: purpose of the box or enclosure, equipment required for installation, installation environment in locations such as hazardous, wet, underground, outdoor, category 1, category 2

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-16.04.01L	demonstrate knowledge of boxes and enclosures	identify types of boxes and enclosures and describe their characteristics and applications
		interpret codes, regulations and standards pertaining to boxes and enclosures
		interpret information pertaining to boxes and enclosures found on drawings and specifications

C-16.04.02L	demonstrate knowledge of procedures used to remove and/or install and support boxes and enclosures	identify the ***considerations*** and requirements for removal of boxes and enclosures
		identify the ***considerations*** and requirements for selecting boxes and enclosures
		describe the procedures used to remove boxes and enclosures
		describe the procedures used to install and support boxes and enclosures

RANGE OF VARIABLES

considerations include: volume, environment, accessibility, size of raceway or cable entering the box or enclosure, CSA / NEMA classification

C-16.05 Performs servicing and maintenance of raceways, cables and enclosures.

Essential Skills	Digital Technology, Oral Communication, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
C-16.05.01P	conduct ***field assessments*** using ***diagnostic and test equipment*** and record results	***diagnostic and test equipment*** that match the testing requirements is used and test results are recorded
C-16.05.02P	determine source of malfunction based on ***field assessment***	source of malfunction is identified
C-16.05.03P	repair and/or replace malfunctioning component	malfunctioning component is repaired and/or replaced and system is returned to original state
C-16.05.04P	conducts tests of conductors and cables and record results	***diagnostic and test equipment*** that match the testing requirements is used and test results are recorded
C-16.05.05P	re-torque terminations and test conductors for excessive heating	terminations are re-torqued according to manufacturers' specifications and required documentation of torquing and test results is completed

RANGE OF VARIABLES

field assessments include: sensory and technical inspections

diagnostic and test equipment includes: megohmeters, multimeters, thermographic imaging devices, phase rotation meters, cable locators

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-16.05.01L	demonstrate knowledge of the procedures to service raceways, cables and enclosures	identify the ***considerations*** when servicing raceways, cables and enclosures
		describe the procedures to service raceways, cables and enclosures
C-16.05.02L	demonstrate knowledge of the procedures to maintain raceways, cables and enclosures	identify the ***considerations*** when maintaining raceways, cables and enclosures
		describe the procedures to maintain raceways, cables and enclosures

RANGE OF VARIABLES

considerations include: changes from the original installation, heat points, physical damage, information from the end user

Task C-17 Installs, services and maintains branch circuitry.

TASK DESCRIPTOR

Various devices and fixtures 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 and lighting controls control light functions, adjust lighting levels and save power. Construction electricians install and service branch circuitry.

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

Construction electricians service branch circuitry by performing visual inspections, troubleshooting, diagnosing faults, and repairing them.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

C-17.01 Installs luminaires.

Essential Skills Numeracy, Thinking Skills, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
C-17.01.01P	determine type of luminaire required and the associated ***installation requirements*** for the application	size and type of luminaire are selected for the application and according to electrical drawings and specifications, client and CEC requirements
C-17.01.02P	calculate demand load and determine branch circuit requirements	calculations are completed based on the voltage and amperage requirements
C-17.01.03P	determine installation location for luminaire	luminaire locations are determined according to electrical drawings and specifications, client requirements and the design criteria for the luminaire
C-17.01.04P	select branch circuit wiring	branch circuit wiring is selected according to electrical drawings and specifications, and CEC requirements

C-17.01.05P	install branch circuit wiring	branch circuit wiring conductors are installed without damage to insulation, without stress, and the neutral and phase conductors are identified, selected, and installed according to electrical drawings and specifications, and CEC requirements
C-17.01.06P	install luminaire and support	luminaire is installed and supported according to electrical drawings and specifications, and client requirements
C-17.01.07P	terminate conductors	conductors and cables are terminated leaving no excessive bare conductor or loose strands, and function according to the application
C-17.01.08P	test for required operation	operation is confirmed by testing operation and lighting levels
C-17.01.09P	determine requirements for removal of luminaires	removal requirements are determined according to client requirements and considering the impact removal will have on the facility
C-17.01.10P	remove existing luminaires when replacing and update documentation	luminaires are removed and remaining installations are terminated according to industry expected performance requirements
C-17.01.11P	dispose of lamps and ballasts	lamps and ballasts are disposed of according to local codes and waste disposal requirements

RANGE OF VARIABLES

installation requirements include: purpose of the luminaire, equipment required for installation, seismic requirements, installation environment in locations such as hazardous, wet, underground, outdoor, category 1, category 2

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-17.01.01L	demonstrate knowledge of luminaires, their applications and operation	identify types of luminaires and describe their applications and operation
		identify luminaire components and describe their characteristics and applications
		interpret codes, regulations and standards pertaining to luminaires
		interpret information pertaining to luminaires found on drawings and specifications
C-17.01.02L	demonstrate knowledge of the procedures used to remove and/or install and support luminaires	identify the considerations and requirements for the removal of luminaires and their components

	identify the considerations and requirements for selecting luminaires and their components
	describe the procedures to remove luminaires and their components
	describe the procedures used to install and support luminaires and their components
	describe the procedures used to perform tests related to luminaires

C-17.02 Installs wiring devices.

Essential Skills	Thinking Skills, Reading, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-17.02.01P	determine type of ***wiring devices*** required and the associated ***installation requirements***	size and type of ***wiring devices*** are selected for the application and according to drawings, specifications and CEC requirements
C-17.02.02P	determine installation location for ***wiring devices***	***wiring devices*** locations are determined considering manufacturers' specifications and client requirements
C-17.02.03P	select branch circuit wiring	branch circuit wiring is selected according to electrical drawings and specifications, and CEC requirements
C-17.02.04P	install branch circuit wiring	branch circuit wiring conductors are installed without damage to insulation, without stress, and all conductors are colour-coded, selected and installed according to electrical drawings and specifications, and CEC requirements
C-17.02.05P	install ***wiring devices***	***wiring devices*** are installed according to manufacturers' specifications
C-17.02.06P	terminate conductors	conductors and cables are terminated leaving no excessive bare conductor or loose strands and are functional according to the application
C-17.02.07P	test required operation	operation is confirmed by testing the circuit for specified voltage and phasing (if applicable)

C-17.02.08P	select and install faceplate if applicable	faceplate is selected and installed to the industry expected performance requirements
C-17.02.09P	determine requirements for removal of wiring devices	removal requirements are determined according to client requirements and considering the impact removal will have on the facility
C-17.02.10P	remove existing wiring devices when replacing and update documentation	wiring devices are removed and remaining installations are terminated according to industry expected performance requirements

RANGE OF VARIABLES

wiring devices include: lampholders, switches, timers, sensors, relays, controllers, safety switches, power outlets, receptacles

installation requirements include: purpose of the wiring device, equipment required for installation, installation environment in locations such as hazardous, wet, outdoor, category 1, category 2

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-17.02.01L	demonstrate knowledge of ***wiring devices***, their applications and operation	identify types of ***wiring devices*** and describe their applications and operation
		interpret codes, regulations and standards pertaining to wiring devices
		interpret information pertaining to wiring devices found on drawings and specifications
C-17.02.02L	demonstrate knowledge of the procedures used to remove and install wiring devices	identify the considerations and requirements for the removal of wiring devices
		identify the considerations and requirements for selecting wiring devices
		describe the procedures to remove wiring devices
		describe the procedures used to install wiring devices

RANGE OF VARIABLES

wiring devices include: lampholders, switches, timers, sensors, relays, controllers, safety switches, power outlets, receptacles

C-17.03 Installs lighting controls.

Essential Skills	Thinking Skills, Numeracy, Digital Technology

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-17.03.01P	**determine control requirements and select lighting control components**	**lighting controls that match the required rating and match the required functionality for the application are selected**
C-17.03.02P	determine circuitry and load requirements	calculations are completed based on the voltage and amperage requirements
C-17.03.03P	assemble and install control components	control components are assembled and installed according to manufacturers' specifications and industry expected performance requirements
C-17.03.04P	label and terminate conductors	conductors and cables are labeled and terminated leaving no excessive bare conductor or loose strands and are functional according to the application
C-17.03.05P	program (if applicable) and test lighting controls	program is verified by required operation of the lighting controls according to specifications and client requirements and test results are documented
C-17.03.06P	determine requirements for removal of existing lighting controls if applicable when performing an upgrade	removal requirements are determined according to client requirements and considering the impact removal will have on the facility
C-17.03.07P	remove existing lighting controls when replacing and update documentation	lighting controls are removed and remaining installations are terminated according to industry expected performance requirements

RANGE OF VARIABLES

lighting control components include: low-voltage switching, line voltage switching, time clocks, ambient light sensor, programmable controller, photo cells and motion sensors, relays

control requirements include: number and types of functions, loads controlled, number of circuits controlled, number of switching locations

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-17.03.01L	demonstrate knowledge of types of ***lighting control components,*** their applications and operation	identify types of ***lighting control components*** and describe their characteristics and applications
		interpret information pertaining to ***lighting control components*** found on drawings and specifications
		interpret codes and regulations pertaining to lighting control components
C-17.03.02L	demonstrate knowledge of the procedures used to remove and/or install, connect and test ***lighting control components***	identify considerations and requirements for removal of ***lighting control components***
		identify considerations and requirements for selecting ***lighting control components***
		describe the procedures used to remove ***lighting control components***
		describe the procedures used to install ***lighting control components***
		describe the procedures used to connect ***lighting control components***
		describe the procedures used to test ***lighting control components***

RANGE OF VARIABLES

lighting control components include: low-voltage switching, line voltage switching, time clocks, ambient light sensor, programmable controller, photo cells and motion sensors, relays

C-17.04 Installs lighting standards.

Essential Skills	Thinking Skills, Document Use, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
C-17.04.01P	determine type of ***lighting standards*** required and the associated installation requirements for the application	size and type of ***lighting standards*** are selected for the application and according to drawings and specifications and CEC requirements
C-17.04.02P	determine installation location for lighting standards	lighting standard locations are determined considering client requirements and the design criteria for the lighting standard
C-17.04.03P	assemble, erect and secure ***lighting standards***	***lighting standards*** are assembled, erected and secured according to manufacturers' specifications
C-17.04.04P	determine requirements for removal of ***lighting standards***	removal requirements are determined according to client requirements and considering the impact removal will have
C-17.04.05P	remove existing ***lighting standards*** when replacing and update documentation	***lighting standards*** are removed and remaining installations are terminated according to manufacturers' specifications

RANGE OF VARIABLES

lighting standards include: traffic signal poles, roadway lighting, parking lot lighting, driveway lighting, decorative aerial lighting, decorative area lighting, security lighting

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-17.04.01L	demonstrate knowledge of ***lighting standards*** and their applications	identify types of ***lighting standards*** and describe their applications
		identify lighting standard components and describe their characteristics and applications
		interpret regulations pertaining to lighting standards
		interpret information pertaining to ***lighting standards*** found on drawings and specifications
C-17.04.02L	demonstrate knowledge of the procedures used to remove and install ***lighting standards***	identify the considerations and requirements for the removal of ***lighting standards*** and their components

	identify the considerations and requirements for selecting ***lighting standards*** and their components
	describe the procedures used for rigging and hoisting ***lighting standards*** for erection and dismantling
	describe the procedures to remove ***lighting standards*** and their components
	describe the procedures used to assemble, erect and secure ***lighting standards*** and their components

RANGE OF VARIABLES

lighting standards include: traffic signal poles, roadway lighting, parking lot lighting, driveway lighting, decorative aerial lighting, decorative area lighting, security lighting

C-17.05 Performs servicing of branch circuitry.

Essential Skills	Digital Technology, Thinking Skills, Reading

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
C-17.05.01P	conduct ***field assessments*** using ***diagnostic and test equipment*** to determine source of malfunction	source of malfunction is identified based on inspection and ***diagnostic and test equipment*** results
C-17.05.02P	identify and remove defective components of ***branch circuitry***	defective component is removed without damage to system or other components
C-17.05.03P	select replacement components	replacement components match the application
C-17.05.04P	install replacement components	components are installed with minimal disruptions and interruptions
C-17.05.05P	conduct tests of ***branch circuitry*** after repair	***branch circuitry*** is functional and connected according to manufacturers' specifications

RANGE OF VARIABLES

field assessments include: sensory and technical inspections

diagnostic and test equipment includes: multimeters, thermographic imaging devices

branch circuitry, for the purpose of this sub-task, does not include airport runway lighting or traffic signals, which are covered in sub-tasks 17.06 and 17.07

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-17.05.01L	demonstrate knowledge of ***branch circuitry*** and branch circuitry components	identify types of branch circuitry components and describe their applications and operation
C-17.05.02L	demonstrate knowledge of the procedures used to service ***branch circuitry*** and branch circuitry components	describe the procedures used to diagnose branch circuitry components
		describe the procedures used to repair/replace branch circuitry components

RANGE OF VARIABLES

branch circuitry, for the purpose of this sub-task, does not include airport runway lighting or traffic signals, which are covered in sub-tasks 17.06 and 17.07

C-17.06 Installs, services and maintains airport runway lighting systems.

Essential Skills	Thinking Skills, Numeracy, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-17.06.01P	determine ***installation requirements*** and select ***airport runway lighting system components*** and ***control components***	***airport runway lighting system components*** and ***control components*** are selected according to rating, the required functionality for the application, and according to drawings, specifications and CEC requirements
C-17.06.02P	determine circuitry and load requirements	calculations are completed based on the voltage and amperage requirements
C-17.06.03P	assemble and install ***airport runway lighting system components***	***airport runway lighting system components*** are assembled and installed according to manufacturers' specifications
C-17.06.04P	label and terminate conductors	conductors and cables are labeled and terminated using termination kits that match the conductor and terminal requirements
C-17.06.05P	test lighting and controls	tests verify specified operation of the lighting and controls, and test results are documented

C-17.06.06P	service and maintain airport runway lighting systems and ***control components***	airport runway lighting systems and ***control components*** are maintained in accordance with client requirements and manufacturers' specifications
C-17.06.07P	determine requirements for removal of existing airport runway lighting systems and ***components*** if applicable when performing an upgrade	removal requirements are determined according to client requirements and considering the impact removal will have
C-17.06.08P	remove existing airport runway lighting systems and ***components*** when replacing and update documentation	airport runway lighting systems are removed and remaining installations are terminated according to industry expected performance requirements

RANGE OF VARIABLES

installation requirements include: purpose of the wiring device, equipment required for installation, installation environment in locations such as hazardous, wet, outdoor, category 1, category 2

airport runway lighting system components include: constant current regulator (CCR), lighting transformers, medium intensity runway lights, high intensity runway lights, pull pits, ground counter poise

control components include: aircraft radio control of aerodrome lighting (ARCAL)

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-17.06.01L	demonstrate knowledge of airport runway lighting systems, their ***components***, applications and operation	identify types of airport runway lighting systems and describe their applications and operation
		identify ***airport runway lighting system components*** and describe their characteristics and applications
		interpret codes, regulations and standards pertaining to airport runway lighting systems
		interpret information pertaining to airport runway lighting system found on drawings and specifications
C-17.06.02L	demonstrate knowledge of the procedures used to remove and/or install and airport runway lighting system and ***components***	identify the considerations and requirements for the removal of airport runway lighting systems and their ***components***
		identify the considerations and requirements for selecting airport runway lighting systems and their ***components***
		describe the procedures to remove airport runway lighting systems and their ***components***

	describe the procedure used to install and airport runway lighting systems and their ***components***
	describe the procedures used to perform tests related to airport runway lighting systems

RANGE OF VARIABLES

airport runway lighting system components include: CCR, lighting transformers, medium intensity runway lights, high intensity runway lights, pull pits, ground counter poise

C-17.07 Installs, services and maintains traffic signal lights and controls.

Essential Skills	Thinking Skills, Numeracy, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
C-17.07.01P	determine installation requirements and select traffic signal light system and ***control components***	traffic signal light systems and ***control components*** are selected according to the required rating and functionality for the application, drawings, specifications and CEC requirements
C-17.07.02P	determine circuitry and load requirements	calculations are completed based on the voltage and amperage requirements
C-17.07.03P	assemble and install ***system components*** and ***control components***	***system components*** and ***control components*** are assembled and installed according to manufacturers' specifications
C-17.07.04P	label and terminate conductors	conductors and cables are labeled and terminated leaving no excessive bare conductor or loose strands and are functional according to the application
C-17.07.05P	program (if applicable) and test traffic signal lights and controls	program is verified by operation of the traffic signal lights and controls according to specifications and client requirements and test results are documented
C-17.07.06P	service and maintain traffic signal lights and controls	traffic signal lights and ***control components*** are maintained in accordance with client requirements and manufacturers' specifications

C-17.07.07P	determine requirements for removal of existing traffic signal light systems and ***control components*** if applicable when performing an upgrade	removal requirements are determined according to client requirements and considering the impact of removal
C-17.07.08P	remove existing traffic signal lights and ***control components*** when replacing and update documentation	traffic signal lights and ***control components*** are removed and remaining installations are terminated

RANGE OF VARIABLES

system components include: signal heads, luminaires, pedestrian push buttons, audible devices, lighting standards, signal arms, pre-cast bases, traffic signal cables

control components include: vehicle sensors, cameras, traffic signal controllers, modems

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-17.07.01L	demonstrate knowledge of types of traffic signal light systems and ***control components,*** their applications and operation	identify types of traffic signal light systems and ***control components*** and describe their characteristics and applications
		interpret information pertaining to traffic signal light systems and controls found on drawings and specifications
		interpret codes and regulations pertaining to traffic signal light systems and ***control components***
C-17.07.02L	demonstrate knowledge of the procedures used to remove and/or install, connect and test traffic signal light systems and ***control components***	identify considerations and requirements for removal of traffic signal light systems and ***control components***
		identify considerations and requirements for selecting traffic signal light systems and ***control components***
		describe the procedures used to remove traffic signal lights and ***control components***
		describe the procedures used to install traffic signal light systems and ***control components***
		describe the procedures used to connect traffic signal light systems and ***control components***
		describe the procedures used to service and maintain traffic signal light systems and ***control components***
		describe the procedures used to test and document traffic signal light systems and ***control components***

RANGE OF VARIABLES

control components include: vehicle sensors, cameras, traffic signal controllers, modems

Task C-18 Installs, services and maintains power and controls for heating, ventilation and air-conditioning (HVAC) systems.

TASK DESCRIPTOR

Cooling and ventilation systems can be installed by other trades, but are electrically connected by construction electricians. Construction electricians connect HVAC systems and install, service and maintain HVAC system controls.

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

Construction electricians service HVAC system controls by performing visual inspections, troubleshooting, diagnosing faults, and repairing them. They also perform maintenance to ensure HVAC system controls are in good operating condition.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

C-18.01 Connects HVAC systems.

Essential Skills	Document Use, Thinking Skills, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-18.01.01P	determine connected load requirements	connected load requirements are determined by interpreting nameplate ratings
C-18.01.02P	select branch circuit wiring including disconnect means if required	branch circuit wiring and disconnect means are selected according to drawings, specifications, and client and CEC requirements

C-18.01.03P	install branch circuit wiring including disconnect means if required	branch circuit wiring conductors are installed without damage to insulation, without stress and the neutral and phase conductors are colour-coded, selected and installed according to electrical drawings and specifications, and CEC requirements
C-18.01.04P	terminate and label conductors	conductors and cables are labeled and terminated leaving no excessive bare conductor or loose strands, and phased and torqued according to electrical, client and manufacturers' specifications
C-18.01.05P	test operation	operation is confirmed by testing the circuit for specified voltage, amperage and rotation
C-18.01.06P	determine requirements for disconnection of HVAC systems	disconnection requirements are determined according to client requirements and considering the impact disconnection will have on the facility
C-18.01.07P	disconnect existing HVAC systems when replacing and update documentation	HVAC systems are disconnected and remaining installations are terminated

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-18.01.01L	demonstrate knowledge of HVAC systems, their applications and operation	identify types of HVAC systems and describe their characteristics and applications
		interpret information pertaining to HVAC systems found on drawings, specifications and nameplates
		interpret codes, standards and regulations pertaining to HVAC systems
C-18.01.02L	demonstrate knowledge of the procedures to disconnect and/or connect HVAC systems	identify considerations and requirements for disconnecting HVAC systems and their components
		identify considerations and requirements for connecting HVAC systems and their components
		describe the procedures used to connect HVAC systems and their components
		describe the procedures used to disconnect HVAC systems and their components

C-18.02 Installs HVAC controls.

Essential Skills	Numeracy, Document Use, Digital Technology

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
C-18.02.01P	determine HVAC ***control requirements*** and select ***control components***	HVAC controls are selected that match required ratings and functionality for the application
C-18.02.02P	determine circuitry and load requirements	calculations are completed based on the voltage and amperage requirements
C-18.02.03P	assemble and install ***control components***	***control components*** are assembled and installed according to the client requirements and manufacturers' specifications
C-18.02.04P	label and terminate conductors	conductors and cables are labeled and terminated leaving no excessive bare conductor or loose strands and are functional according to the application
C-18.02.05P	program (if applicable) and test HVAC controls	program is verified by operation of the HVAC controls according to specifications and client requirements, and test results are documented
C-18.02.06P	determine requirements for removal of existing HVAC controls if applicable when performing an upgrade	removal requirements are determined according to client requirements and considering the impact removal will have on the facility
C-18.02.07P	remove existing HVAC controls when replacing and update documentation	HVAC controls are removed and remaining installations are terminated

RANGE OF VARIABLES

control requirements include: number and types of functions, occupancy rates

control components include: time clocks, relays, thermostats, sensors, actuators, electrical interlocks, multiple function controllers, variable frequency drives (VFD)

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-18.02.01L	demonstrate knowledge of types of ***HVAC control components,*** their applications and operation	identify types of ***HVAC control components*** and describe their characteristics and applications
		interpret information pertaining to ***HVAC control components*** found on drawings and specifications

		interpret codes and regulations pertaining to ***HVAC control components***
C-18.02.02L	demonstrate knowledge of the procedures used to remove and/or install, connect and test ***HVAC control components***	identify the considerations and requirements for removal of ***HVAC control components***
		identify considerations and requirements for selecting ***HVAC control components***
		describe the procedures used to remove ***HVAC control components***
		describe the procedures used to install ***HVAC control components***
		describe the procedures used to connect ***HVAC control components***
		describe the procedures used to test ***HVAC control components***

RANGE OF VARIABLES

HVAC control components include: time clocks, relays, thermostats, sensors, actuators, electrical interlocks, multiple function controllers, VFDs

C-18.03 Performs servicing and maintenance of HVAC systems and controls.

Essential Skills	Digital Technology, Thinking Skills, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
C-18.03.01P	conduct ***field assessments*** using ***diagnostic and test equipment*** to determine source of malfunction	source of malfunction is identified based on inspection and ***diagnostic and test equipment*** results
C-18.03.02P	identify and remove defective electrical components and ***equipment*** of ***HVAC systems and controls***	defective component is removed without damage to system or other components
C-18.03.03P	repair malfunctioning electrical components and equipment	repaired electrical components and equipment are operational
C-18.03.04P	select replacement electrical components and equipment	replacement electrical components and equipment (OEM replacement when mandated) match the application
C-18.03.05P	install replacement electrical components and equipment and reprogram if necessary	electrical components and equipment are installed with minimal disruptions and interruptions

C-18.03.06P	conduct tests of ***HVAC systems and controls*** after repair	***HVAC systems and controls*** are connected and function according to manufacturers' and client specifications
C-18.03.07P	record tests in maintenance schedule	operational problems are identified in maintenance schedule data with detailed notations

RANGE OF VARIABLES

field assessments include: sensory and technical inspections

diagnostic and test equipment includes: multimeters, clamp ammeters

equipment includes: air handling motors, evaporator fans, condenser fans

HVAC systems and controls include: chiller system, compressor unit, fan motor, thermostat, pressure switch, temperature switch, flow switch, level switch, VFDs, cooling tower heater, chiller heater

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-18.03.01L	demonstrate knowledge of ***HVAC systems and controls***	identify types of ***HVAC systems and controls*** and describe their applications and operation
		identify HVAC system and control components and describe their characteristics and applications
C-18.03.02L	demonstrate knowledge of the procedures used to service ***HVAC systems and controls***	describe the procedures used to diagnose ***HVAC systems and controls*** and their components
		describe the procedures used to repair ***HVAC systems and controls*** and their components
C-18.03.03L	demonstrate knowledge of the procedures used to maintain ***HVAC systems and controls***	describe the procedures used to maintain ***HVAC systems and controls*** and their components

RANGE OF VARIABLES

HVAC systems and controls include: chiller system, compressor unit, fan motor, thermostat, pressure switch, temperature switch, flow switch, level switch, VFDs, cooling tower heater, chiller heater

Task C-19 Installs, services and maintains electric heating systems.

TASK DESCRIPTOR

Electric heating systems and their associated control devices are installed and connected by construction electricians.

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

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

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

C-19.01 Installs electric heating systems.

Essential Skills Thinking Skills, Numeracy, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-19.01.01P	determine type of ***electric heating system*** required and the associated ***installation requirements*** for the system	size and type of ***electric heating system*** are selected to match the application
C-19.01.02P	calculate demand load and determine branch circuit requirements	calculations are completed based on the voltage and wattage requirements
C-19.01.03P	determine installation location for heating device	heating device locations are determined considering manufacturers' specifications and client requirements
C-19.01.04P	select branch circuit wiring	branch circuit wiring is selected according to drawings, specifications, client and CEC requirements
C-19.01.05P	install branch circuit wiring	branch circuit wiring conductors are installed without damage to insulation, without stress and the neutral and phase conductors are colour-coded, selected and installed according to electrical drawings and specifications, and CEC requirements

C-19.01.06P	install heating device	heating device is installed according to manufacturers' specifications
C-19.01.07P	terminate conductors	conductors and cables are terminated leaving no excessive bare conductor or loose strands and are functional according to the application
C-19.01.08P	test operation	operation is confirmed by testing the circuit voltage, amperage and controls
C-19.01.09P	determine requirements for removal of electric heating systems	removal requirements are determined according to client requirements and considering the impact removal will have on the facility
C-19.01.10P	remove existing electric heating systems when replacing and update documentation	electric heating systems are removed and remaining installations are terminated

RANGE OF VARIABLES

electric heating systems include: electric forced air furnace, electric boiler, convection heaters, radiant heaters, heat tracing cables, duct heater, heating cables

installation requirements include: heat loss calculations, available space for the heating device, application

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-19.01.01L	demonstrate knowledge of ***electric heating systems***, their applications and operation	identify types of ***electric heating systems*** and describe their applications and operation
		identify electric heating system components and describe their characteristics and applications
		interpret codes, regulations and standards pertaining to ***electric heating systems***
		interpret information pertaining to ***electric heating systems*** found on drawings and specifications
C-19.01.02L	demonstrate knowledge of the procedures used to remove and/or install ***electric heating systems***	identify the considerations and requirements for the removal of ***electric heating systems*** and their associated components
		identify the considerations and requirements for selecting ***electric heating systems*** and their components
		describe the procedures used to calculate heat loss

	describe the procedures to remove ***electric heating systems*** and their components
	describe the procedures used to install ***electric heating systems*** and their components

RANGE OF VARIABLES

electric heating systems include: electric forced air furnace, electric boiler, convection heaters, radiant heaters, heat tracing cables, duct heater, heating cables

C-19.02 Installs electric heating system controls.

Essential Skills	Thinking Skills, Numeracy, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-19.02.01P	**determine control requirements and select electric heating system control components**	**electric heating system control components are selected that match the required rating and functionality for the application**
C-19.02.02P	determine circuitry and load requirements	calculations are completed based on the voltage and wattage requirements
C-19.02.03P	assemble and install ***control components***	***control components*** are assembled and installed according to the client and manufacturers' specifications
C-19.02.04P	label and terminate conductors	conductors and cables are labeled and terminated leaving no excessive bare conductor or loose strands and are functional according to the application
C-19.02.05P	program (if applicable) and test ***electric heating system control components***	program is verified by operation of the ***electric heating system control components*** according to specifications and client requirements

C-19.02.06P	determine requirements for removal of existing electric heating system controls if applicable when performing an upgrade	removal requirements are determined according to client requirements and considering the impact removal will have on the facility
C-19.02.07P	remove existing ***electric heating system control components*** when replacing and update documentation	***electric heating system control components*** are removed and remaining installations are terminated

RANGE OF VARIABLES

control requirements include: number and types of functions

electric heating system control components include: thermostats, heating relays, sensors, contactors, electrical interlocks, semiconductor controls, web-based controls

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-19.02.01L	demonstrate knowledge of types of ***electric heating system control components***, their applications and operation	identify types of ***electric heating system control components*** and describe their characteristics and applications
		interpret information pertaining to ***electric heating system control components*** found on drawings and specifications
		interpret codes and regulations pertaining to ***electric heating system control components***
C-19.02.02L	demonstrate knowledge of the procedures used to remove and/or install, connect and test ***electric heating system control components***	identify the considerations and requirements for removal of ***electric heating system control components***
		identify considerations and requirements for selecting ***electric heating system control components***
		describe the procedures used to remove ***electric heating system control components***
		describe the procedures used to install ***electric heating system control components***
		describe the procedures used to connect ***electric heating system control components***
		describe the procedures used to test ***electric heating system control components***

RANGE OF VARIABLES

electric heating system control components include: thermostats, heating relays, sensors, contactors, electrical interlocks, semiconductor controls, web-based controls

C-19.03 Performs servicing and maintenance of electric heating systems and controls.

Essential Skills	Digital Technology, Thinking Skills, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
C-19.03.01P	conduct ***field assessments*** using ***diagnostic and test equipment*** to determine source of malfunction	source of malfunction is identified based on inspection and ***diagnostic and test equipment*** results
C-19.03.02P	identify and remove defective electric heating system components and controls	defective component is removed without damage to system or other components
C-19.03.03P	select replacement components	replacement components (OEM replacement when mandated) match the application
C-19.03.04P	install replacement components	components are installed with minimal disruptions and interruptions
C-19.03.05P	conduct tests of electric heating systems and controls after repair	electric heating systems and controls are connected and functioning according to manufacturers' and client specifications
C-19.03.06P	clean and adjust components	electric heating system and control components are restored to optimal conditions
C-19.03.07P	record tests in maintenance schedule	operational problems are identified in maintenance schedule data with detailed notations

RANGE OF VARIABLES

field assessments include: sensory and technical inspections

diagnostic and test equipment includes: multimeters, clamp ammeters

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-19.03.01L	demonstrate knowledge of ***electric heating systems*** and ***control components***	identify types of ***electric heating systems*** and ***control components*** and describe their applications and operation
		identify ***electric heating systems*** and ***control components*** and describe their characteristics and applications
C-19.03.02L	demonstrate knowledge of the procedures used to service ***electric heating systems*** and ***control components***	describe the procedures used to diagnose ***electric heating systems*** and ***control components***
		describe the procedures used to repair ***electric heating systems*** and ***control components***
C-19.03.03L	demonstrate knowledge of the procedures used to maintain ***electric heating systems*** and ***control components***	describe the procedures used to maintain ***electric heating systems*** and ***control components***

RANGE OF VARIABLES

electric heating systems include: electric forced air furnace, electric boiler, convection heaters, radiant heaters, heat tracing cables, duct heater, heating cables

control components include: thermostats, heating relays, sensors, contactors, electrical interlocks, semiconductor controls, web-based controls

Task C-20 Installs, services 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 batteries or generators and the required size and placement are determined by building code requirements. Construction electricians install exit and emergency lighting systems.

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

Construction electricians service exit and emergency lighting systems by performing visual inspections, troubleshooting, diagnosing faults, and repairing them. They also perform maintenance to ensure exit and emergency lighting systems are in good operating condition.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

C-20.01 Installs exit and emergency lighting.

Essential Skills Thinking Skills, Numeracy, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-20.01.01P	determine type of ***exit and emergency lighting system*** required and the associated installation requirements	size and type of ***exit and emergency lighting system*** is selected for the application according to drawings, specifications and building code requirements
C-20.01.02P	calculate connected load and determine branch circuit requirements	calculations are completed based on the voltage and wattage requirements with consideration of voltage drop
C-20.01.03P	determine installation location for ***exit and emergency lighting system***	exit and emergency lighting system locations are determined according to drawings and specifications, and AHJ requirements
C-20.01.04P	select branch circuit wiring	branch circuit wiring is selected according to CEC requirements

C-20.01.05P	install branch circuit wiring	branch circuit wiring conductors are installed without damage to insulation, without stress and all conductors are colour-coded, selected and installed according to electrical drawings and specifications, and CEC requirements
C-20.01.06P	install ***exit and emergency lighting system***	***exit and emergency lighting system*** is installed according to manufacturers' specifications
C-20.01.07P	terminate conductors	conductors and cables are terminated leaving no excessive bare conductor or loose strands and are functional according to the application
C-20.01.08P	test operation and complete documentation	operation is confirmed by testing the circuit for specified voltage, lighting levels and duration of operation and test results are documented
C-20.01.09P	determine requirements for removal of ***exit and emergency lighting system***	removal requirements are determined according to AHJ and client requirements, and considering the impact removal will have on the facility
C-20.01.10P	remove and dispose of existing ***exit and emergency lighting system*** when replacing and update documentation	***exit and emergency lighting system*** is removed and disposed of and remaining installations are terminated according to CEC requirements

RANGE OF VARIABLES

exit and emergency lighting systems include: self-contained, central-powered, remote lighting units

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-20.01.01L	demonstrate knowledge of ***exit and emergency lighting systems***, their applications and operation	identify types of ***exit and emergency lighting systems*** and describe their applications and operation
		identify exit and emergency lighting components and describe their characteristics and applications
		interpret codes, regulations and standards pertaining to ***exit and emergency lighting systems***
		interpret information pertaining to ***exit and emergency lighting systems*** found on drawings and specifications
C-20.01.02L	demonstrate knowledge of the procedures used to remove and/or install ***exit and emergency lighting systems*** and their components	identify the considerations and requirements for the removal and disposal of ***exit and emergency lighting systems*** and their associated components

	identify the considerations and requirements for selecting ***exit and emergency lighting systems*** and their components
	describe the procedures to remove ***exit and emergency lighting systems*** and their components
	describe the procedure used to install ***exit and emergency lighting systems*** and their components
	describe the procedures used to test ***exit and emergency lighting systems*** and their components and complete the required documentation

RANGE OF VARIABLES

exit and emergency lighting systems include: self-contained, central-powered, remote lighting units

C-20.02 Performs servicing and maintenance of exit and emergency lighting systems.

Essential Skills	Digital Technology, Document Use, Thinking Skills

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-20.02.01P	conduct ***field assessments*** using ***diagnostic and test equipment*** to determine source of malfunction	source of malfunction is identified based on inspection and ***diagnostic and test equipment*** results
C-20.02.02P	identify, remove and dispose of defective components of ***exit and emergency lighting systems***	defective component is removed and disposed of without damage to system or other components
C-20.02.03P	repair malfunctioning components	repaired components are operational
C-20.02.04P	select replacement components	replacement components (OEM replacement when mandated) match the application
C-20.02.05P	install replacement components	components are installed with minimal disruptions and interruptions

C-20.02.06P	conduct tests of ***exit and emergency lighting system*** after repair	***exit and emergency lighting system*** is functional and tested to ensure AHJ-mandated lighting levels and duration of operation
C-20.02.07P	record tests in maintenance schedule	operational problems are identified in maintenance schedule data with detailed notations

RANGE OF VARIABLES

field assessments include: sensory and technical inspections
diagnostic and test equipment includes: multimeters
exit and emergency lighting systems include: self-contained, central-powered, remote lighting units

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-20.02.01L	demonstrate knowledge of ***exit and emergency lighting systems***, their applications and operation	identify types of ***exit and emergency lighting systems*** 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 service ***exit and emergency lighting systems***	describe the procedures used to diagnose ***exit and emergency lighting systems*** and their components
		describe the procedures used to repair/replace ***exit and emergency lighting systems*** and their components
C-20.02.03L	demonstrate knowledge of the procedures used to maintain ***exit and emergency lighting systems***	describe the procedures used to maintain ***exit and emergency lighting systems*** and their components

RANGE OF VARIABLES

exit and emergency lighting systems include: self-contained, central-powered, remote lighting units

Task C-21 Installs, services and maintains cathodic protection systems.

TASK DESCRIPTOR

Cathodic protection systems introduce a current onto a tank, pipe or structure to limit corrosion and oxidization. Construction electricians install these systems in various environments according to specifications.

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

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

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

C-21.01 Installs cathodic protection systems.

Essential Skills	Document Use, Numeracy, Thinking Skills

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-21.01.01P	determine installation location for **cathodic protection systems**	***cathodic protection system*** locations are determined considering manufacturers' specifications and client requirements
C-21.01.02P	select branch circuit wiring	branch circuit wiring is selected to the industry expected performance requirements
C-21.01.03P	install branch circuit wiring	branch circuit wiring conductors are installed without damage to insulation, without stress and all conductors are colour-coded, selected and installed according to electrical drawings and specifications, and CEC requirements
C-21.01.04P	install ***cathodic protection systems***	***cathodic protection systems*** are installed according to manufacturers' specifications

C-21.01.05P	terminate conductors	conductors and cables are terminated leaving no excessive bare conductor or loose strands and are functional according to the application
C-21.01.06P	test operation	operation is confirmed by checking the reference points and testing the circuit for specified voltage and amperage levels for the complete installation
C-21.01.07P	determine requirements for removal of ***cathodic protection systems***	removal requirements are determined according to client requirements and considering the impact removal will have on the installation
C-21.01.08P	remove existing ***cathodic protection systems*** when replacing and update documentation	***cathodic protection systems*** are removed and remaining installations are isolated

RANGE OF VARIABLES

cathodic protection systems include: active rectifier, sacrificial anode

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-21.01.01L	demonstrate knowledge of ***cathodic protection systems***, their applications and operation	identify types of ***cathodic protection systems*** and describe their characteristics, applications and operation
		identify ***cathodic protection system components*** 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 ***components***
		describe the procedures used to test ***cathodic protection systems*** and their ***components***

RANGE OF VARIABLES

cathodic protection systems include: active rectifier, sacrificial anode

cathodic protection system components include: rectifier, insulation kits, cabling, breaker, anode connection cable, remote reference points, tap settings in the rectifier enclosure

C-21.02 Performs servicing and maintenance of cathodic protection systems.

Essential Skills	Digital Technology, Numeracy, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
no	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
C-21.02.01P	conduct ***field assessments*** using ***diagnostic and test equipment*** to determine source of malfunction	source of malfunction is identified based on inspection and ***diagnostic and test equipment*** results
C-21.02.02P	identify and remove defective components of ***cathodic protection system***	defective components are removed without damage to system or other components
C-21.02.03P	repair malfunctioning components	repaired components are operational
C-21.02.04P	select replacement components	replacement components (OEM replacement when mandated) match the application
C-21.02.05P	install replacement components	components are installed with minimal disruptions and interruptions
C-21.02.06P	conduct tests of ***cathodic protection systems*** after repair	***cathodic protection systems*** are connected and function according to manufacturers' specifications
C-21.02.07P	record tests in maintenance schedule	operational problems are identified in maintenance schedule data with detailed notations

RANGE OF VARIABLES

field assessments include: sensory and technical inspections
diagnostic and test equipment includes: multimeters
cathodic protection systems include: active rectifier, sacrificial anode

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-21.02.01L	demonstrate knowledge of ***cathodic protection systems***, their applications and operation	identify types of ***cathodic protection systems*** and ***components*** and describe their applications and operation
C-21.02.02L	demonstrate knowledge of the procedures used to service and maintain ***cathodic protection systems***	describe the procedures used to diagnose and repair ***cathodic protection systems***
		describe the procedures used to maintain ***cathodic protection systems***

RANGE OF VARIABLES

cathodic protection systems include: active rectifier, sacrificial anode

cathodic protection system components include: rectifier, insulation kits, cabling, breaker, anode connection cable, remote reference points, tap settings in the rectifier enclosure

MAJOR WORK ACTIVITY D

INSTALLS, SERVICES AND MAINTAINS MOTORS AND CONTROL SYSTEMS

Task D-22 Installs, services and maintains motor starters and controls.

TASK DESCRIPTOR

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

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

Construction electricians service motor starters and controls by troubleshooting, diagnosing faults, and repairing them. They also perform maintenance to ensure motor starters and controls are in good operating condition.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

D-22.01 Installs motor starters.

Essential Skills Thinking Skills, Document Use, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-22.01.01P	determine type of ***motor starter*** for specific application	**motor *starter*** is selected and sized according to the application and according to drawings, specifications and CEC requirements
D-22.01.02P	determine size and function of ***motor starter***	size and function are determined according to motor ***manufacturers' nameplate data***

D-22.01.03P	calculate conductor requirements	conductor type and size match the application and CEC requirements
D-22.01.04P	position, mount and assemble ***starter assembly***	***starter assembly*** is placed in locations according to electrical drawings and job and client requirements
D-22.01.05P	terminate conductors	conductors and cables are terminated leaving no excessive bare conductor or loose strands and are functional according to the application
D-22.01.06P	set up and adjust ***motor starters***	overloads are sized for the application and adjusted to provide maximum motor protection
D-22.01.07P	interconnect starter with ***peripheral devices***	interconnections are completed and equipment functions as intended
D-22.01.08P	conduct tests of ***motor starter*** after installation and record results	***motor starter*** is connected and functions according to manufacturers' and client specifications
D-22.01.09P	remove existing equipment when replacing and update documentation	equipment is removed with minimal impact to the environment and drawings reflect operational changes

RANGE OF VARIABLES

motor starters include: starters for AC/DC motors, single phase, 3-phase AC, line voltage starters, soft starters, reduced-voltage starters

manufacturers' nameplate data includes: size of motor, full load amps (FLA), full load current (FLC), service factor, voltage

starter assembly includes: fittings, enclosures, raceways, control transformers, overcurrent protection, overload protection, terminations

peripheral devices include: start/stop stations, emergency stop stations, limit switches

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-22.01.01L	demonstrate knowledge of ***motor starters*** and their applications	interpret information pertaining to ***motor starters*** found on motor nameplate, drawings and specifications
		describe ***motor starters*** and their applications
		interpret codes and regulations pertaining to ***motor starters***
D-22.01.02L	demonstrate knowledge of procedures used to install and connect ***motor starters***	describe the procedures used to install ***motor starters***, their components and accessories
		describe the procedures used to connect ***motor starters***, 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, 3-phase AC, line voltage starters, soft starters, reduced-voltage starters

D-22.02 Performs servicing and maintenance of motor starters.

Essential Skills	Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-22.02.01P	obtain detailed description of operation and malfunction of motor starters	required information about equipment operation is gathered from end user
D-22.02.02P	conduct ***field assessments*** using ***diagnostic and test equipment*** to determine source of malfunction	source of malfunction is identified based on diagnostic equipment results
D-22.02.03P	identify and remove defective components of motor starters	defective component is removed without damage to system or other components
D-22.02.04P	repair malfunctioning components	repaired components are operational
D-22.02.05P	select replacement components	replacement components (OEM replacement when mandated) match the application
D-22.02.06P	install replacement components	components are installed with minimal disruptions and interruptions
D-22.02.07P	conduct tests of motor starters after repair	starter assembly is connected and functions according to manufacturers' and client specifications
D-22.02.08P	clean, lubricate and ***adjust*** components	motor starter components are restored to optimal ***conditions***
D-22.02.09P	record tests in maintenance schedule	operational problems are identified in maintenance schedule data with detailed notations
D-22.02.10P	compare and analyze maintenance test results	maintenance is performed when required based on analysis of test results and comparison with specifications

RANGE OF VARIABLES

adjust includes: re-torquing of terminations, overload settings, timing settings
component conditions include: contact pressure, carbon build-up, pitting on contacts
field assessments include: sensory and technical inspections
diagnostic and test equipment include: multimeters, thermographic imaging devices, ammeters

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-22.02.01L	demonstrate knowledge of ***motor starters*** and their applications	interpret information pertaining to ***motor starters*** found on drawings and specifications
		describe ***motor starters*** and their applications
		interpret codes and regulations pertaining to ***motor starters***
D-22.02.02L	demonstrate knowledge of procedures used to service and maintain ***motor starters***	describe the procedures used to service ***motor starters***, their components and accessories
		describe the procedures used to maintain ***motor starters***, their components and accessories

RANGE OF VARIABLES

motor starters include: line-voltage starters, reduced-voltage starters

D-22.03 Installs motor controls.

Essential Skills	Thinking Skills, Numeracy, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-22.03.01P	determine type of ***motor control devices*** and ***function*** for specific application	***motor control device*** is selected according to the application
D-22.03.02P	determine ***motor control circuit*** types required for specific application	***motor control circuit*** types are selected for the specific application
D-22.03.03P	calculate conductor requirements	conductor type and size match the application and CEC requirements
D-22.03.04P	position, mount and assemble ***motor control device***	***motor control device*** is placed in locations according to electrical drawings, job and client requirements
D-22.03.05P	terminate conductors	conductors and cables are terminated leaving no excessive bare conductor or loose strands and are functional according to the application
D-22.03.06P	set up and adjust ***motor control devices***	***motor control devices*** operate according to application and intended function

D-22.03.07P	interconnect motor control devices with ***peripheral devices***	interconnections are completed and equipment functions as intended
D-22.03.08P	interconnect ***motor control devices*** with overload protection	interconnections are completed and equipment functions as intended
D-22.03.09P	conduct tests of ***motor control devices*** after installation and record results	***motor control devices*** are connected and function according to manufacturers' and client specifications
D-22.03.10P	remove existing equipment when replacing and update documentation	equipment is removed with minimal impact to the environment and drawings reflect operational changes

RANGE OF VARIABLES

motor control devices include: flow switches, push buttons, relays, limit switches, proximity switches, pressure switches, level switches

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

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

peripheral devices include: indicating lights, audible devices

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-22.03.01L	demonstrate knowledge of ***motor control devices*** and their applications	interpret information pertaining to motor control devices found on drawings and specifications
		describe ***motor control devices*** and their applications
		interpret codes and regulations pertaining to ***motor control devices***
D-22.03.02L	demonstrate knowledge of ***motor control circuits***, their characteristics and applications	interpret codes and regulations pertaining to ***motor control circuits***
		identify ***circuit types*** and describe their characteristics and applications
		describe ***circuit functional features*** of common hard wired motor control circuits
		identify the methods used to determine the number of conductors required between controls and controller locations
		identify ***protection devices*** for ***motor control circuits*** and describe characteristics and applications

RANGE OF VARIABLES

motor control devices include: flow switches, push buttons, relays, limit switches, proximity switches, pressure switches, level switches

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, overheating, phase loss, phase reversal

D-22.04 Performs servicing and maintenance of motor controls.

Essential Skills	Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-22.04.01P	obtain detailed description of operation and malfunction of motor controls	required information about equipment operation is gathered from end user
D-22.04.02P	conduct ***field assessments*** using ***diagnostic and test equipment*** to determine source of malfunction	source of malfunction is identified based on ***diagnostic and test equipment*** results
D-22.04.03P	identify and remove defective components of motor controls	defective component are removed without damage to system or other components
D-22.04.04P	select replacement components	replacement components are selected according to application
D-22.04.05P	install replacement components	components are installed with minimal disruptions and interruptions
D-22.04.06P	conduct tests of motor controls after repair	control assembly is connected and functions according to manufacturers' and client specifications
D-22.04.07P	clean, lubricate and ***adjust*** components	motor control devices are restored to optimal ***conditions***
D-22.04.08P	record tests in maintenance schedule	operational problems are identified in maintenance schedule data with detailed notations
D-22.04.09P	compare and analyze maintenance test results	maintenance is performed when required based on analysis of test results and comparison with specifications

RANGE OF VARIABLES

field assessments include: sensory and technical inspections
diagnostic and test equipment include: multimeters, thermographic imaging devices, ammeters
adjustments include: re-torquing of terminations, calibration of components
conditions include: carbon or dust build-up, pitting on contacts, worn or dirty contacts

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

RANGE OF VARIABLES

motor control devices include: flow switches, push buttons, relays, limit switches, pressure switches, level switches, motion sensors

Task D-23 Installs, services 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. Construction electricians install, service and maintain these drives in the motor circuits.

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

Construction electricians service motor drives by troubleshooting, diagnosing faults, and repairing them. They also perform maintenance to ensure motor starters and controls are in good operating condition.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

D-23.01 Installs AC drives.

Essential Skills	Document Use, Numeracy, Thinking Skills

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-23.01.01P	determine type of AC drive for specific application	AC drive is selected according to the application
D-23.01.02P	determine size and function of AC drive	size and function are determined according to ***manufacturers' nameplate data***
D-23.01.03P	calculate conductor requirements	conductor type and size match the application and take into account ***special conditions*** and CEC requirements
D-23.01.04P	position, mount and assemble AC drives	AC drive is placed in locations according to electrical drawings, job and client requirements
D-23.01.05P	terminate conductors	conductors and cables are terminated leaving no excessive bare conductor or loose strands and are functional according to the application
D-23.01.06P	calibrate and program AC drives	calibration and programming meet functionality and established parameters

D-23.01.07P	interconnect AC drives with ***peripheral devices*** with required cables, raceways and conductors	interconnections are completed and equipment functions as intended
D-23.01.08P	conduct tests of AC drive after installation and record results	AC drive is connected and functions according to manufacturers' and client specifications
D-23.01.09P	remove existing AC drives when replacing and update documentation	AC drive is removed with minimal impact to the environment and drawings reflect operational changes

RANGE OF VARIABLES

manufacturers' nameplate data includes: size of motor, full load current (FLC), inverter duty rated, voltage

special conditions that affect conductor requirements include: shielding requirements, length of cable, type of VFD rated cable, reactor use, equipment bonding

peripheral devices include: start/stop stations, emergency stop stations, speed control, sensing devices, encoders, tachometers, limit switches

	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 ***AC drive components*** 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
		explain operating principles of AC drives and their impact on motor performance
D-23.01.02L	demonstrate knowledge of procedures used to install and connect AC drives	identify the considerations and requirements for selecting AC drives, their ***components*** and accessories
		describe the procedures used to install AC drives, their ***components*** and accessories
		describe the procedures used to connect AC drives, their ***components*** and accessories
		describe the procedures used to adjust AC drives, their ***components*** and accessories

RANGE OF VARIABLES

AC drive components include: rectifiers, electro-magnetic compatibility (EMC) filters, DC circuits, inverters

D-23.02 Performs servicing and maintenance of AC drives.

Essential Skills	Oral Communication, Digital Technology, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
D-23.02.01P	obtain detailed description of operation and malfunction of AC drives	required information about equipment operation is gathered from end user
D-23.02.02P	conduct ***field assessments*** using ***diagnostic and test equipment*** to determine source of malfunction	source of malfunction is identified based on diagnostic equipment results
D-23.02.03P	identify and remove defective components of AC drives	defective components are removed without damage to system or other components
D-23.02.04P	repair malfunctioning components	repaired components are operational
D-23.02.05P	select replacement components	replacement components (OEM replacement when mandated) match the application
D-23.02.06P	install replacement components	components are installed with minimal disruptions and interruptions
D-23.02.07P	conduct ***tests*** of AC drives after repair	AC drive assembly is connected and functions according to manufacturers' and client specifications
D-23.02.08P	***clean, lubricate and adjust*** components	AC drive components are restored to optimal conditions
D-23.02.09P	record ***tests*** in maintenance schedule	operational problems are identified in maintenance schedule data with detailed notations
D-23.02.10P	compare and analyze maintenance test results	maintenance is performed when required based on analysis of test results and comparison with specifications

RANGE OF VARIABLES

cleaning, lubricating and adjustment procedures include: re-torquing of terminations, cleaning filters and cooling fans, checking door seals

cleaning, lubricating and adjustment procedures include: re-torquing of terminations, cleaning filters and cooling fans, checking door seals

diagnostic and test equipment include: multimeters, thermographic imaging devices, ammeters, oscilloscopes

tests include: resistance tests of power semiconductors

	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 ***AC drive components*** 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
		explain operating principles of AC drives and their impact on motor performance
D-23.02.02L	demonstrate knowledge of procedures used to service and maintain AC drives	describe the procedures used to service and maintain AC drives, their ***components*** and accessories

RANGE OF VARIABLES

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

D-23.03 Installs DC drives.

Essential Skills	Document Use, Numeracy, Thinking Skills

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
no	yes	no	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
D-23.03.01P	determine type of DC drive for specific application	DC drive is selected and sized according to the application
D-23.03.02P	determine size and function of DC drive	size and function are determined according to ***manufacturers' nameplate data***
D-23.03.03P	calculate conductor requirements	conductor type and size match the application and take into account ***special conditions*** and CEC requirements
D-23.03.04P	position, mount and assemble DC drives	DC drive is placed in locations according to electrical drawings, job and client requirements
D-23.03.05P	terminate conductors	conductors and cables are terminated leaving no excessive bare conductor or loose strands and are functional according to the application
D-23.03.06P	calibrate and program DC drives	calibration and programming meets functionality and established parameters
D-23.03.07P	interconnect DC drives with ***peripheral devices*** with required cables, raceways and conductors	interconnections are completed and equipment functions as intended
D-23.03.08P	conduct tests of DC drive after installation and record results	DC drive is connected and functions according to manufacturers' and client specifications
D-23.03.09P	remove existing DC drives when replacing and update documentation	DC drive is removed with minimal impact to the environment and drawings reflect operational changes

RANGE OF VARIABLES

manufacturers' nameplate data includes: size of motor, FLA, voltage

special conditions that affect feeder requirements include: shielding requirements, length of cable, line reactor

peripheral devices include: start/stop stations, emergency stop stations, speed control, sensing devices, encoders, tachometers, limit switches

	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 ***DC drive components*** and accessories 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
		explain operating principles of DC drives and their impact on motor performance
D-23.03.02L	demonstrate knowledge of procedures used to install and connect DC drives	identify the considerations and requirements for selecting DC drives, their ***components*** and accessories
		describe the procedures used to install DC drives, their ***components*** and accessories
		describe the procedures used to connect DC drives, their ***components*** and accessories
		describe the procedures used to adjust DC drives, their ***components*** and accessories

RANGE OF VARIABLES

DC drive components include: converters and regulators

D-23.04 Performs servicing and maintenance of DC drives.

Essential Skills	Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
no	yes	no	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-23.04.01P	obtain detailed description of operation and malfunction of DC drives	required information about equipment operation is gathered from end user
D-23.04.02P	conduct ***field assessments*** using ***diagnostic and test equipment*** to determine source of malfunction	source of malfunction is identified based on diagnostic equipment results
D-23.04.03P	identify and remove defective components of DC drives	defective components are removed without damage to system or other components
D-23.04.04P	repair malfunctioning components	repaired components are operational
D-23.04.05P	select replacement components	replacement components (OEM replacement when mandated) match the application
D-23.04.06P	install replacement components	components are installed with minimal disruptions and interruptions
D-23.04.07P	conduct tests of DC drives after repair	DC drive assembly is connected and functions according to manufacturers' and client specifications
D-23.04.08P	***clean, lubricate and adjust*** components	DC drive components are restored to optimal conditions
D-23.04.09P	record tests in maintenance schedule	operational problems are identified in maintenance schedule data
D-23.04.10P	compare and analyze maintenance test results	maintenance is performed when required based on analysis of test results and comparison with specifications

RANGE OF VARIABLES

cleaning, lubrication and adjustment procedures include: re-torquing of terminations, cleaning filters and cooling fans, checking door seals

field assessments include: sensory and technical inspections

diagnostic and test equipment include: multimeters, thermographic imaging devices, ammeters, oscilloscopes

	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 ***DC drive components*** and accessories 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
		explain operating principles of DC drives and their impact on motor performance
D-23.04.02L	demonstrate knowledge of procedures used to service and maintain DC drives	describe the procedures used to service and maintain DC drives, their ***components*** and accessories

RANGE OF VARIABLES

DC drive components include: converters and regulators

Task D-24 Installs, services and maintains motors.

TASK DESCRIPTOR

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

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

Construction electricians service motors by troubleshooting, diagnosing faults, and repairing them. They also perform maintenance to ensure motors are in good operating condition.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

D-24.01 Installs single-phase motors.

Essential Skills Document Use, Thinking Skills, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-24.01.01P	determine type of ***single-phase motor*** required	type of ***single-phase motor*** meets ***criteria for operation***
D-24.01.02P	calculate conductor requirements	conductor type and size match the application and CEC requirements
D-24.01.03P	determine and install overload and overcurrent devices based on requirements	overload and overcurrent devices are installed such that the motor is protected
D-24.01.04P	position and mount ***single-phase motor***	***single-phase motor*** is mounted according to the application
D-24.01.05P	connect motor leads	motor leads are connected according to the application
D-24.01.06P	conduct tests of ***single-phase motor*** after installation and record results	***single-phase motor*** is connected and functions according to manufacturers' and client specifications
D-24.01.07P	remove existing ***single-phase motor*** when replacing and update documentation	***single-phase motor*** is removed with minimal impact to the environment and drawings reflect operational changes

RANGE OF VARIABLES

single-phase motors include: hermetically sealed, dual capacitor, reluctance, capacitor start/induction run, split phase, universal, resistance split phase, permanent split capacitor, shaded pole

criteria for operation of single-phase motors include: voltage availability, motor function, rotation, location

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-24.01.01L	demonstrate knowledge of ***single-phase motors***, their applications and operation	identify types of ***single-phase motors*** and describe their characteristics
		identify single-phase motor components and accessories and describe their applications
		interpret codes and regulations pertaining to ***single-phase motors***
		interpret information pertaining to ***single-phase motors*** found on drawings and specifications
		explain the construction and operating principles of ***single-phase motors***
		interpret information contained on single-phase motor nameplates
D-24.01.02L	demonstrate knowledge of procedures used to install and connect ***single-phase motors***	describe procedures used to install ***single-phase motors***
		describe procedures used to connect ***single-phase motors***
		identify ***coupling methods*** for ***single-phase motors*** and describe their characteristics and applications
		identify the considerations and requirements for selecting ***single-phase motors*** and their components

RANGE OF VARIABLES

single-phase motors include: hermetically sealed, dual capacitor, reluctance, capacitor start/induction run, split phase, universal, resistance split phase, permanent split capacitor, shaded pole

coupling methods include: flexible couplings, fixed couplings, magnetic couplings, belts and chains

D-24.02 Performs servicing and maintenance of single-phase motors.

Essential Skills	Oral Communication, Digital Technology, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
D-24.02.01P	obtain detailed description of operation and malfunction of single-phase motors	required information about equipment operation is gathered from end user
D-24.02.02P	conduct ***field assessments*** using ***diagnostic and test equipment*** to determine source of malfunction	source of malfunction is identified based on ***diagnostic and test equipment*** results
D-24.02.03P	identify and remove defective components of single-phase motors	defective components are removed without damage to system or other components
D-24.02.04P	select replacement components	replacement components match the application
D-24.02.05P	install replacement components	components are installed with minimal disruptions and interruptions
D-24.02.06P	conduct tests of single-phase motors after repair	single-phase motor assembly is connected and functions according to specifications to match the application
D-24.02.07P	***clean, lubricate and adjust*** components	single-phase motor components are restored to optimal conditions
D-24.02.08P	record ***tests*** in maintenance schedule	operational problems are identified in maintenance schedule data
D-24.02.09P	compare and analyze maintenance test results	maintenance is performed when required based on analysis of test results and specifications

RANGE OF VARIABLES

cleaning, lubrication and adjustment procedures include: cleaning cooling fans, adjusting belt tensioners, lubricating bearings and bushings, cleaning switches

field assessments include: sensory and technical inspections

diagnostic and test equipment includes: multimeters, thermographic imaging devices, ammeters, insulation resistance testers

tests include: vibration, insulation, current, rotation, alignment, baseline motor diagnostic test

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-24.02.01L	demonstrate knowledge of ***single-phase motors***, their applications and operation	identify types of ***single-phase motors*** and describe their characteristics
		identify ***single-phase motor components*** and describe their applications
		interpret codes and regulations pertaining to ***single-phase motors***
		interpret information pertaining to ***single-phase motors*** found on drawings and specifications
		explain the construction and operating principles of ***single-phase motors***
		interpret information contained on single-phase motor nameplates
D-24.02.02L	demonstrate knowledge of procedures used to service and maintain ***single-phase motors***	describe the procedures used to service ***single-phase motors*** and their ***components***
		describe the procedures used to maintain ***single-phase motors*** and their ***components***

RANGE OF VARIABLES

single-phase motors include: hermetically sealed, dual capacitor, capacitor start/induction run, split phase, universal, permanent split capacitor, shaded pole

single-phase motor components include: frame, centrifugal switch, armature, rotor, stator, end bells, yoke, fans, brushes, bearings, bushings

D-24.03 Installs three-phase motors.

Essential Skills Document Use, Numeracy, Thinking Skills

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-24.03.01P	determine type of ***three-phase motor*** required	type of three-phase motor meets ***criteria for operation***
D-24.03.02P	calculate conductor requirements	conductor type and size match the application and CEC requirements

D-24.03.03P	determine and install overload and overcurrent devices based on requirements	overload and overcurrent devices are installed such that the motor is protected
D-24.03.04P	determine and install ***motor protection devices***	***motor protection devices*** are installed such that motor is protected
D-24.03.05P	position and mount ***three-phase motor***	***three-phase motor*** is mounted according to the application
D-24.03.06P	connect motor leads	motor leads are connected according to the application
D-24.03.07P	conduct ***tests*** of ***three-phase motors*** after installation and record results	***three-phase motors*** are connected and function according to specifications to match the application
D-24.03.08P	remove existing ***three-phase motors*** when replacing and update documentation	***three-phase motors*** are removed with minimal impact to the environment and drawings reflect operational changes

RANGE OF VARIABLES

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

criteria for operation of three-phase motors includes: voltage availability, motor function, rotation, location

motor protection devices include: phase loss/reversal protection, high temperature sensors

tests include: vibration, insulation, current, rotation, alignment, baseline motor diagnostic test

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-24.03.01L	demonstrate knowledge of ***three-phase motors***, their applications and procedures for use	identify types of ***three-phase motors*** and describe their characteristics
		identify three-phase motor components and describe their applications
		interpret codes and regulations pertaining to ***three-phase motors***
		interpret information pertaining to ***three-phase motors*** found on drawings and specifications
		explain the construction and operating principles of ***three-phase motors***
		interpret information contained on three-phase motor nameplates
D-24.03.02L	demonstrate knowledge of procedures used to install and connect ***three-phase motors***	describe procedures used to install ***three-phase motors***
		describe procedures used to connect ***three-phase motors***

	identify ***coupling methods*** for ***three-phase motors*** and describe their characteristics and applications
	identify the considerations and requirements for selecting ***three-phase motors*** and their components

RANGE OF VARIABLES

three-phase motors include: squirrel cage induction, synchronous, wound rotor induction
coupling methods include: flexible couplings, fixed couplings, magnetic couplings, belts and chains

D-24.04 Performs servicing and maintenance of three-phase motors.

Essential Skills	Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
D-24.04.01P	obtain detailed description of operation and malfunction of three-phase motors	required information about equipment operation is gathered from end user
D-24.04.02P	conduct ***field assessments*** using ***diagnostic and test equipment*** to determine source of malfunction	source of malfunction is identified based on ***diagnostic and test equipment*** results
D-24.04.03P	identify and remove defective components of three-phase motors	defective components are removed without damage to system or other components
D-24.04.04P	select replacement components	replacement components match the application
D-24.04.05P	install replacement components	components are installed with minimal disruptions and interruptions
D-24.04.06P	conduct tests of three-phase motors after repair	three-phase motor assembly is connected and functions according to specifications to match the application
D-24.04.07P	***clean, lubricate and adjust*** components	three-phase motor components are restored to optimal conditions
D-24.04.08P	record ***tests*** in maintenance schedule	operational problems are identified in maintenance schedule data
D-24.04.09P	compare and analyze maintenance test results	maintenance is performed when required based on analysis of test results and specifications

RANGE OF VARIABLES

cleaning, lubrication and adjustment procedures include: cleaning cooling fans, adjusting belt tensioners, lubricating bearings and bushings, cleaning switches

field assessments include: sensory and technical inspections

diagnostic and test equipment include: multimeters, thermographic imaging devices, ammeters, insulation resistance testers, growlers

tests include: vibration, insulation, current, rotation, alignment, baseline motor diagnostic test

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-24.04.01L	demonstrate knowledge of ***three-phase motors***, their applications and operation	identify types of ***three-phase motors*** and describe their characteristics
		identify ***three-phase motor components*** and describe their applications
		interpret codes and regulations pertaining to ***three-phase motors***
		interpret information pertaining to ***three-phase motors*** found on drawings and specifications
		explain the construction and operating principles of ***three-phase motors***
		interpret information contained on three-phase motor nameplates
D-24.04.02L	demonstrate knowledge of procedures used to service and maintain three-phase motors	describe the procedures used to service ***three-phase motors*** and their ***components***
		describe the procedures used to maintain, repair and test ***three-phase motors*** and their ***components***

RANGE OF VARIABLES

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

three-phase motor components include: frame, armature, rotor, stator, end bells, yoke, fans, brushes, bearings, bushings

D-24.05 Installs DC motors.

Essential Skills	Numeracy, Digital Technology, Document Use

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
D-24.05.01P	determine type of DC motor required	DC motor to be installed meets ***criteria for operation***
D-24.05.02P	calculate conductor requirements	conductor type and size match the application and CEC requirements
D-24.05.03P	determine and install overload and overcurrent devices based on requirements	overload and overcurrent devices are installed such that the motor is protected
D-24.05.04P	position and mount DC motor	DC motor is mounted according to the application
D-24.05.05P	connect motor leads	motor leads are connected according to the application
D-24.05.06P	conduct tests of DC motor after installation and record results	DC motor is connected and functions according to manufacturers' and client specifications
D-24.05.07P	remove existing DC motors when replacing and update documentation	DC motors are removed with minimal impact to the environment and drawings reflect operational changes

RANGE OF VARIABLES

criteria for operation of DC motors include: voltage availability, motor function, rotation, location

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-24.05.01L	demonstrate knowledge of DC motors, their applications and procedures for use	identify types of ***DC motors*** and describe their characteristics and applications
		identify ***DC motor components*** and describe their characteristics and applications
		interpret codes and regulations pertaining to ***DC motors***
		interpret information pertaining to ***DC motors*** found on drawings and specifications
		explain the construction and operating principles of ***DC motors***

		interpret information contained on DC motor nameplates
D-24.05.02L	demonstrate knowledge of procedures used to install and connect ***DC motors***	identify considerations and requirements for selecting ***DC motors*** and controls, and their ***components***
		describe the procedures used to install ***DC motors*** and controls, and their ***components***
		describe the procedures used to connect ***DC motors*** and controls and their ***components***

RANGE OF VARIABLES

DC motors include: self-excited, separately excited, series, shunt, compound

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

D-24.06 Performs servicing and maintenance of DC motors.

Essential Skills	Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
D-24.06.01P	obtain detailed description of operation and malfunction of DC motors	required information about equipment operation is gathered from end user
D-24.06.02P	conduct ***field assessments*** using ***diagnostic and test equipment*** to determine source of malfunction	source of malfunction is identified based on diagnostic equipment results
D-24.06.03P	identify and remove defective components of DC motors	defective components are removed without damage to system or other components
D-24.06.04P	select replacement components	replacement components (OEM replacement when mandated) are selected to match the application
D-24.06.05P	install replacement components	components are installed with minimal disruptions and interruptions
D-24.06.06P	conduct tests of DC motors after repair	DC motor assembly is connected and functions according to manufacturers' and client specifications
D-24.06.07P	***clean, lubricate and adjust*** components	DC motor components are restored to optimal conditions

D-24.06.08P	record tests in maintenance schedule	operational problems are identified in maintenance schedule data
D-24.06.09P	compare and analyze maintenance test results	maintenance is performed when required based on analysis of test results and specifications

RANGE OF VARIABLES

cleaning, lubrication and adjustment procedures include: cleaning cooling fans, adjusting belt tensioners, lubricating bearings and bushings, and cleaning switches, cleaning and adjusting brushes, cleaning commutator segments

field assessments include: sensory and technical inspections

diagnostic and test equipment include: multimeters, thermographic imaging devices, ammeters, insulation resistance testers

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-24.06.01L	demonstrate knowledge of ***DC motors***, their applications and procedures for use	identify types of ***DC motors*** and describe their characteristics and applications
		identify ***DC motor components*** and describe their characteristics and applications
		interpret codes and regulations pertaining to ***DC motors***
		interpret information pertaining to ***DC motors*** found on drawings and specifications
		explain the construction and operating principles of ***DC motors***
		interpret information contained on DC motor nameplates
D-24.06.02L	demonstrate knowledge of procedures used to service and maintain ***DC motors***	describe the procedures used to service ***DC motors*** and their ***components***
		describe the procedures used to maintain ***DC motors*** and their ***components***
D-24.06.01L	demonstrate knowledge of ***DC motors***, their applications and procedures for use	identify types of ***DC motors*** and describe their characteristics and applications

RANGE OF VARIABLES

DC motors include: self-excited, separately excited, series, shunt, compound

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

Task D-25 Installs, programs, services and maintains automated control systems.

TASK DESCRIPTOR

All electrical motors need a method to be started and controlled. These controls can be complex automated systems. Automated control systems are often programmable systems such as PLC and distributed control system (DCS).

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

Construction electricians install and service automated control systems by troubleshooting, diagnosing faults, and repairing them. They perform maintenance to ensure automated control systems are in good operating condition. They also program and configure the automated control systems to meet operational requirements.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

D-25.01 Installs automated control systems.

Essential Skills Document Use, Numeracy, Digital Technology

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-25.01.01P	determine type of ***automated control system*** and function for specific application	***automated control system*** is selected according to the application
D-25.01.02P	calculate conductor and cabling requirements	conductor and cable type and size match the application and CEC requirements
D-25.01.03P	position, mount and assemble automated control system	***automated control system*** is placed in locations according to electrical drawings, job and client requirements; is level, square, and secure, and follows building lines
D-25.01.04P	terminate conductors	conductors and cables are terminated leaving no excessive bare conductor or loose strands and is functional and connected as required by the application
D-25.01.05P	bond automated control system to ground	control system is bonded to ground based on code and manufacturers' specifications

D-25.01.06P	set up and adjust ***automated control system***	***automated control system*** operates according to application and intended function
D-25.01.07P	interconnect ***automated control system*** with ***peripheral devices***	interconnections are completed and equipment functions as intended
D-25.01.08P	conduct tests of automated control system after installation and record results	***automated control system*** is connected and functions according to manufacturers' and client specifications
D-25.01.09P	remove existing equipment when replacing and update documentation	equipment is removed with minimal impact to the environment and drawings reflect operational changes

RANGE OF VARIABLES

automated control systems include: PLC, Supervisory Control and Data Acquisition (SCADA) system, DCS

peripheral devices of automated control systems may be analog or digital and include: input devices (flow switches, push buttons, limit switches, pressure switches, level switches), output devices (pilot lights, audible devices, relays)

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-25.01.01L	demonstrate knowledge of ***automated control systems***, their applications and operation	identify types of ***automated control systems*** and describe their characteristics
		identify ***automated control system components*** and describe their purpose and operation
		interpret information pertaining to ***automated control systems*** found on drawings and specifications
		interpret codes and regulations pertaining to ***automated control systems***
		identify sources of information pertaining to automated control system service, maintenance, configuration and programming
		identify ***number*** and ***code systems*** and describe their applications
		perform conversions between number systems
		explain and interpret ***control circuit logic***
D-25.01.02L	demonstrate knowledge of ***automated control system data highway systems***	identify types of ***automated control system data highway systems*** and describe their characteristics, applications and operation

		identify automated control system data highway system components and describe their characteristics, applications and operation
		identify ***methods used to communicate*** with automated control systems
		identify ***basic instruction sets for ladder logic*** and describe their applications
D-25.01.03L	demonstrate knowledge of procedures used to install and connect ***automated control systems*** and their ***components***	describe the procedures used to install ***automated control systems*** and their ***components***
		describe the procedures used to connect ***automated control systems*** and their ***components***

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, AND, OR, NOT, NOR and MEMORY

automated control system data highway systems include: Ethernet, Modbus, Profibus, BACnet, Fieldbus, DeviceNet

methods used to communicate with automated control systems include handheld, computer, human machine interfacing (HMI)

basic instruction sets for ladder logic include: examine if opened (XIO), examine if closed (XIC), output energized (OTE)

D-25.02 Performs servicing and maintenance of automated control systems.

Essential Skills	Oral Communication, Digital Technology, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
D-25.02.01P	obtain detailed description of operation and malfunction of automated control systems	required information about equipment operation is gathered from end user and CPU diagnostics
D-25.02.02P	conduct ***field assessments*** using ***diagnostic and test equipment*** to determine source of malfunction	source of malfunction is identified based on ***diagnostic and test equipment*** results, and sensory and technical observations

D-25.02.03P	identify and remove defective components of automated control systems	defective components are removed without damage to system or other components
D-25.02.04P	repair malfunctioning components	repaired components are operational
D-25.02.05P	select replacement components	replacement components (OEM replacement when mandated) match the application
D-25.02.06P	install replacement components	components are installed with minimal disruptions and interruptions
D-25.02.07P	conduct tests of automated control systems after repair	automated control system is connected and functions according to manufacturers' and client specifications
D-25.02.08P	***clean and adjust*** components	automated control systems are restored to optimal conditions
D-25.02.09P	complete backups and record tests in maintenance schedule	operational problems are identified in maintenance schedule data
D-25.02.10P	compare and analyze maintenance test results	maintenance is performed when required based on analysis of test results and specifications

RANGE OF VARIABLES

cleaning and adjustment procedures include: cleaning fans and filters, adjusting cabinets and door seals

field assessments include: sensory and technical inspections

diagnostic and test equipment includes: multimeters, thermographic imaging devices, ammeters, laptops

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-25.02.01L	demonstrate knowledge of ***automated control systems***, their applications and operation	identify types of ***automated control systems*** and describe their characteristics, applications and operation
		identify ***automated control system components*** and describe their purpose and operation
		interpret information pertaining to ***automated control systems*** found on drawings and specifications
		interpret codes and regulations pertaining to ***automated control systems***
		identify sources of information pertaining to automated control system service, maintenance, configuration and programming
		identify ***number*** and ***code systems*** and describe their applications
		perform conversions between number systems

		explain and interpret ***control circuit logic***
D-25.02.02L	demonstrate knowledge of ***automated control system data highway systems***	identify types of ***automated control system data highway systems*** and describe their characteristics, applications and operation
		identify automated control system data highway system components and describe their characteristics, applications and operation
		identify ***methods used to communicate*** with automated control systems
		identify ***basic instruction sets for ladder logic*** and describe their applications
D-25.02.03L	demonstrate knowledge of procedures for service and maintenance of ***automated control systems***	describe the procedures used to service and maintain ***automated control systems*** and their ***components***

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

control circuit logic includes: relay logic, AND, OR, NOT, NOR and MEMORY

automated control system data highway 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: XIO, XIC, OTE

D-25.03 Programs and configures automated control systems.

Essential Skills	Document Use, Reading, Digital Technology

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
D-25.03.01P	set inputs and outputs and create I/O tables	tables include all required parameters
D-25.03.02P	set names for variables	all variables are named according to client naming application
D-25.03.03P	write and verify automated control program	automated control program operates according to specified logic

D-25.03.04P	set parameters for automated control program	technical and operating parameters are set as required by the installation and operation
D-25.03.05P	test and adjust automated control program	operation of system meets design

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-25.03.01L	demonstrate knowledge of ***automated control systems***, their applications and operation	identify automated control system ***programming languages*** and describe their applications
		explain the difference between PLC and DCS systems
D-25.03.02L	demonstrate knowledge of ***automated control system data highway systems***	identify types of automated control system data highway systems and describe their characteristics, applications and operation
D-25.03.03L	demonstrate knowledge of procedures for programming and configuring automated control systems	describe the ***procedures*** used to perform programming, editing and configuration of ***automated control systems*** (online and offline)
		interpret codes and regulations pertaining to ***automated control systems***
		identify ***basic instruction sets for ladder logic*** and describe their applications
		identify ***number*** and ***code systems*** and describe their applications
		perform conversions between ***number systems***
		explain and interpret ***control circuit logic***

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

control circuit logic includes: relay logic, AND, OR, NOT, NOR and MEMORY

automated control system data highway 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: XIO, XIC, OTE

MAJOR WORK ACTIVITY E

INSTALLS, SERVICES AND MAINTAINS SIGNALLING AND COMMUNICATION SYSTEMS.

Task E-26 Installs, services and maintains signaling systems.

TASK DESCRIPTOR

Construction electricians install, upgrade, service and maintain signaling 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 circuit, extra-low voltage circuit, Class 1 or Class 2 circuits.

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

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

For this task these include the Underwriters Laboratories of Canada (ULC) standard, National Building Code (NBC) and National Fire Code (NFC). Sub-task 26.01 and 26.02 specifically include the ULC standards for the installation, inspection, testing and verification of fire alarms (CAN/ULC-S524, S536 and S537).

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

E-26.01 Installs fire alarm systems.

Essential Skills	Document Use, Thinking Skills, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
E-26.01.01P	identify type of ***fire alarm system*** required for new installation	type of ***fire alarm system*** is identified according to electrical drawings, specifications and job requirements
E-26.01.02P	remove and dispose of existing ***fire alarm system*** when replacing and update documentation	all ***fire alarm system components*** are disposed of according to local codes and waste disposal requirements
E-26.01.03P	determine ***fire alarm system*** layout	***fire alarm system*** layout is determined according to walkthrough of building to identify and mark interference locations on drawings
E-26.01.04P	select ***fire alarm system components***	***fire alarm system components*** are selected according to electrical drawings, specifications and job requirements
E-26.01.05P	position, mount and assemble ***fire alarm system components***	***fire alarm system components*** are placed in locations according to electrical drawings and job requirements
E-26.01.06P	terminate and interconnect ***fire alarm system components*** and ***associated systems***	***fire alarm system components*** and associated system devices are terminated and interconnected according to electrical drawings, specifications and job requirements
E-26.01.07P	test ***fire alarm system components*** to ensure functionality	***fire alarm systems*** function as required by drawings and specifications
E-26.01.08P	test conductors for opens and ground continuity	conductors have no opens and all components are bonded to ground and are clear of obstructions
E-26.01.09P	conduct initial ***fire alarm system*** tests	sensory and spot tests are performed, and initial ***fire alarm system*** tests are performed according to electrical drawings and specifications
E-26.01.10P	participate in startup, commissioning and verification	verification is conducted on ***fire alarm systems***, ***fire alarm system components*** and ***associated systems*** according to regulatory standards and devices function as intended

RANGE OF VARIABLES

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

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 signaling devices (horns, strobes, bells), panels (fire alarm panels [stand-by batteries], annunciator panels), relays

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

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-26.01.01L	demonstrate knowledge of types of ***fire alarm systems***, their applications and operation	interpret ***codes and regulations*** pertaining to ***fire alarm systems***
		interpret information pertaining to ***fire alarm systems*** found on drawings and specifications
		identify types of ***fire alarm systems*** and describe their characteristics and applications
		describe types of ***associated systems*** that are interconnected with ***fire alarm systems***
		identify ***fire alarm system components*** and describe their characteristics and applications
		identify the considerations and requirements for selecting ***fire alarm systems***, and their ***components***
E-26.01.02L	demonstrate knowledge of the procedures used to install, upgrade and connect ***fire alarm systems*** and their ***components***	describe the procedures used to install, upgrade and connect ***fire alarm systems*** and their ***components***
		describe procedures for testing ***fire alarm systems*** and their ***components***
		describe the procedures for the commissioning and verification of ***fire alarm systems***

RANGE OF VARIABLES

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

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

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

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 signaling devices (horns, strobes, bells), panels (fire alarm panels [stand-by batteries], annunciator panels), relays

E-26.02 Performs servicing and maintenance of fire alarm systems.

Essential Skills Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
E-26.02.01P	obtain detailed description of malfunction of ***fire alarm system*** from client	malfunction issues and ***information*** is obtained and description of problem is noted
E-26.02.02P	identify existing ***fire alarm system*** and ***components***	existing ***fire alarm system*** and ***components*** are identified from as-built drawings, maintenance log and site visit
E-26.02.03P	test ***fire alarm system***	tests are performed according to maintenance schedule; sensory inspections and technical inspections are performed using ***diagnostic and test equipment***
E-26.02.04P	analyze test results	test results are compared to manufacturers' certification report and communication log, and client requirements
E-26.02.05P	participate in periodic inspections	***fire alarm system, fire alarm system components,*** and ***associated systems*** function according to manufacturers' specifications and are inspected according to maintenance schedule

E-26.02.06P	replace ***fire alarm system*** components as required	replacement ***components*** are tested and verified
E-26.02.07P	update ***documentation*** to reflect servicing, testing, inspections or maintenance performed	***documentation*** is clear, detailed and includes systems and components tested, the test results and changes that were completed

RANGE OF VARIABLES

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

information includes: where and when problem occurred, has problem happened before, is it intermittent or consistent in nature, have any changes recently been made to the system, associated systems or building (painting or removing partitions), latest inspection report, maintenance logs

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 signaling devices (horns, strobes, bells), panels (fire alarm panels [stand-by batteries], annunciator panels), relays

diagnostic and test equipment includes: multimeters, voltage testers, sound pressure level (SPL) meters, heat lamp, smoke canisters

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

documentation includes: maintenance logs, inspection reports, as-built drawings, panel schedules

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-26.02.01L	demonstrate knowledge of ***fire alarm systems***, their applications and operation	interpret ***codes and regulations*** pertaining to ***fire alarm systems***
		interpret information pertaining to ***fire alarm systems*** found on drawings and specifications
		identify types of ***fire alarm systems*** and describe their characteristics and applications
		identify ***fire alarm system components*** and describe their characteristics and applications
		identify the considerations and requirements for selecting ***fire alarm systems*** and ***components***
		describe types of ***associated systems*** that interconnect with ***fire alarm systems***

E-26.02.02L	demonstrate knowledge of the procedures used to service and maintain ***fire alarm systems***	describe possible effects of ***fire alarm system*** service and maintenance on ***associated systems***
		describe the procedures used to service and maintain ***fire alarm systems*** and ***components***
		describe procedures for testing ***fire alarm systems*** and their ***components***

RANGE OF VARIABLES

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

codes 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 signaling devices (horns, strobes, bells), panels (fire alarm panels [stand-by batteries], annunciator panels), relays

associated systems include: fire suppression systems, emergency power supplies fan shutdown/startup, PA systems, local fire department, magnetic door holders, elevator homing contactors, egress door securing and releasing devices, building automation systems

E-26.03 Installs security and surveillance systems.

Essential Skills	Document Use, Digital Technology, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
no	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
E-26.03.01P	identify type of ***security and surveillance system*** required for new installation	type of ***security and surveillance system*** is identified according to electrical drawings, specifications and job requirements
E-26.03.02P	remove and dispose of existing ***security and surveillance system*** when replacing and update documentation	all ***security and surveillance system components*** are disposed of in an environmentally conscious manner
E-26.03.03P	determine ***security and surveillance system*** layout	***security and surveillance system*** layout is determined according to architectural and client requirements
E-26.03.04P	select ***security and surveillance system components***	***security and surveillance system components*** are selected according to electrical drawings, specifications, job and client requirements

E-26.03.05P	position, mount and assemble ***security and surveillance system components***	***security and surveillance system components*** are placed in locations according to electrical drawings, specifications, job and client requirements
E-26.03.06P	terminate and interconnect ***security and surveillance system components*** and ***associated systems***	***security and surveillance system components*** and ***associated system*** devices are terminated and interconnected according to electrical drawings, specifications, and job requirements
E-26.03.07P	program and configure ***security and surveillance system***	***security and surveillance system*** is programmed and configured according to job and client requirements, and manufacturers' specifications
E-26.03.08P	test ***security and surveillance components*** to ensure functionality	continuity and polarity of video data wiring is tested using ***diagnostic equipment*** and ***security and surveillance system components*** function as required
E-26.03.09P	test conductors for opens and ground continuity	conductors have no opens and all components are bonded to ground and are clear of obstructions
E-26.03.10P	conduct initial ***security and surveillance system*** tests	sensory and spot tests are performed, and ***security and surveillance system*** tests are performed according to electrical drawings and specifications
E-26.03.11P	participate in startup and commissioning inspections	devices are activated to trigger events such as system surveillance logs, notifications and alarms, and ***associated systems'*** responses

RANGE OF VARIABLES

security and surveillance systems include: perimeter, space, spot

security and surveillance system components include: cameras, monitors, digital video recorders (DVR), motion sensors, card readers, bio-scanners, voice recognitions, electronic locks, horns, panels, proximity sensors, glass break sensors, pressure sensors, radio frequency identification (RFID) tags, key pads, power supplies, servers, graphical user interfaces (GUI)

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

diagnostic equipment includes: multimeters, cable analyzers

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

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

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, 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

E-26.04 Performs servicing and maintenance of security and surveillance systems.

Essential Skills	Oral Communication, Digital Technology, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
no	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
E-26.04.01P	obtain detailed description of malfunction of ***security and surveillance system*** from client	***information*** is obtained and description of problem is noted
E-26.04.02P	identify existing ***security and surveillance system*** and ***components***	as-built drawings and maintenance log are referenced to identify existing ***security and surveillance system;*** walkthrough is conducted
E-26.04.03P	program and configure ***security and surveillance system***	***security and surveillance system*** is programmed and configured according to job and client requirements
E-26.04.04P	conduct ***security and surveillance*** system tests	tests are performed according to sensory inspections and technical inspections using ***diagnostic equipment and software***
E-26.04.05P	analyze test results	test results are compared to security and surveillance log and client requirements
E-26.04.06P	replace defective ***security and surveillance system components***	replacement ***components*** are tested and verified
E-26.04.07P	clean and adjust ***components***	***component*** functionality (for example that sensors and recording devices cover required area) are restored to optimal conditions
E-26.04.08P	update ***documentation*** to reflect servicing, testing, inspections or maintenance performed	***documentation*** is clear and detailed and includes ***systems*** and ***components*** tested, the test results and changes that were completed
E-26.04.09P	notify and explain system changes to system monitor	system changes are explained to system monitor

RANGE OF VARIABLES

security and surveillance systems include: perimeter, space, spot

information includes: where and when problem occurred, has problem happened before, is it intermittent or consistent in nature, have any changes recently been made to the system, associated systems or building (painting or removing partitions), latest inspection report, maintenance logs

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

diagnostic equipment and software includes: multimeters, voltage testers, network cable analyzers, internal diagnostic software

documentation includes: maintenance logs, as-builts

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-26.04.01L	demonstrate knowledge of ***security and surveillance systems***, their applications and operation	interpret codes and regulations pertaining to ***security and surveillance systems***
		interpret information pertaining to ***security and surveillance systems*** found on drawings and specifications
		identify types of ***security and surveillance systems*** and describe their characteristics and applications
		identify ***security and surveillance system components*** and describe their characteristics and applications
		identify the considerations and requirements for selecting ***security and surveillance systems*** and their ***components***
		describe types of ***associated systems*** that often interconnect with ***security and surveillance systems***
E-26.04.02L	demonstrate knowledge of the procedures used to service and maintain ***security and surveillance systems***	describe possible effects of ***security and surveillance system*** service and maintenance on ***associated systems***
		describe the procedures used to service and maintain ***security and surveillance systems*** and their ***components***
		describe procedures for testing ***security and surveillance systems***, their ***components*** and conductors
		describe the procedures for the commissioning/verification of ***security and surveillance systems***

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, 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

Task E-27 Installs, services and maintains communication systems.

TASK DESCRIPTOR

Communication systems allow information to be transmitted from one point to another, using different media such as fiber optic, copper and coaxial cables. These types of systems may include low-voltage power circuit, extra-low voltage power circuit or low energy power circuit. They include voice/data/video (VDV), community antenna television (CATV), public address (PA), intercom and nurse call systems.

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

Construction electricians service communication systems by troubleshooting, diagnosing faults and repairing them. They also perform maintenance to ensure communication systems are in good operating condition.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

Specific standards that pertain to sub-task 27.01 are American National Standards Institute/Telecommunications Industry Association (ANSI/TIA-568, 569, 606 and 607). All health and safety standards must be respected.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

E-27.01 Installs voice/data/video (VDV) and community antenna television (CATV) systems.

Essential Skills Oral Communication, Digital Technology, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
E-27.01.01P	determine ***VDV and CATV system*** required for new installation	type of ***VDV and CATV system*** is determined according to electrical and communication drawings, specifications, job and client requirements, codes and standards
E-27.01.02P	remove and dispose of existing ***VDV and CATV system*** when replacing and update documentation	***VDV and CATV system components*** are disposed of according to local codes and waste disposal requirements
E-27.01.03P	determine ***VDV and CATV system*** layout	***VDV and CATV system*** layout is determined according to electrical and communication drawings and specifications, client requirements and site visit

E-27.01.04P	select **VDV *and CATV* system *components***	**VDV *and CATV* system *components*** are selected according to electrical and communication drawings and specifications, building material finishes, drawings, job and client requirements
E-27.01.05P	position, mount and assemble ***communication cabling raceway***	***communication cabling raceway*** is positioned, mounted and assembled according to manufacturers' specifications, industry standards and CEC requirements
E-27.01.06P	temporarily label and install cabling	cabling is labeled and installed according to manufacturers' specifications and CEC requirements
E-27.01.07P	position, mount and assemble **VDV and CATV *system components***	***VDV and CATV system components*** are positioned, mounted and assembled according to electrical and communication drawings, and specifications, job and client requirements, codes and standards, are level, square, secure, follow building lines and functional and physically protected where required; all components are bonded
E-27.01.08P	terminate and interconnect **VDV and CATV *system components*** and ***associated systems***	***VDV* and CATV *components*** and ***associated system*** devices are terminated and interconnected according to ***standards***, electrical and communication drawings and specifications, and job requirements
E-27.01.09P	test and label **VDV and CATV *system components***	cable performance is confirmed to be within acceptable parameters using ***diagnostic and test equipment*** for the system
E-27.01.10P	update documentation for manufacturer certification	as-builts are updated and documentation to support certification is completed

RANGE OF VARIABLES

VDV and CATV systems include: unshielded twisted pair (UTP), screened twisted pair (ScTP), category 3, 5e, 6 and 6A, fiber optic, multi-mode and single-mode, coaxial, distributed antenna system (wireless)

VDV and CATV system components include: cabling, termination blocks, outlet jacks, patch panels, face plates, patch cables, cable supports, cable management devices, surge protection devices, connectors, splice trays, cabinets, racks, power supplies, broadcast transmitters, receiving equipment, noise suppressors, satellite dishes, amplifiers, splitters, attenuators, terminators, bonding hardware

communication cabling raceway include: cable trays, conduits, utility columns, finger rack/ducts, perimeter raceways, wire baskets

associated systems include: telecommunication bonding systems, telephone systems, data systems, security and surveillance systems

standards include: ANSI/TIA-568, 569, 606 and 607, Society of Cabling Telecommunications Engineers (SCTE) for CATV, Building Industry Consulting Services International (BICSI)

diagnostic and test equipment for systems include: Coaxial and CATV (time-domain reflectometers [TDRs]), UTP/ScTP systems (optical time-domain reflectometers [OTDRs], cable analyzers), fiber optic systems (light source power meters, wire map testers and CATV cable analyzers)

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-27.01.01L	demonstrate knowledge of ***VDV and CATV systems***, their applications and operation	interpret codes and ***standards*** pertaining to ***VDV and CATV systems***
		identify types of ***VDV and CATV systems*** and describe their characteristics and applications
		identify ***VDV and CATV system components*** and describe their characteristics and applications
		describe types of ***associated systems*** that often interconnect with ***VDV and CATV systems***
		identify the considerations and requirements for selecting ***VDV and CATV systems*** and their ***components***
E-27.01.02L	demonstrate knowledge of the procedures used to install ***VDV and CATV systems***	describe the procedures used to install ***VDV and CATV systems*** and their ***components***
		describe procedures for testing ***VDV and CATV systems*** and their ***components***
		describe the procedures for verification and certification of ***VDV and CATV systems***

RANGE OF VARIABLES

VDV and CATV systems include***:*** UTP, ScTP, category 3, 5e, 6 and 6A, fiber optic, multi-mode and single-mode, coaxial, distributed antenna system (wireless)

standards include: ANSI/TIA-568, 569, 606 and 607, SCTE for CATV, BICSI

VDV and CATV system components include: cabling, termination blocks, outlet jacks, patch panels, face plates, patch cables, cable supports, cable management devices, surge protection devices, connectors, splice trays, cabinets, racks, power supplies, broadcast transmitters, receiving equipment, noise suppressors, satellite dishes, amplifiers, splitters, attenuators, terminators, bonding hardware

associated systems include: telecommunication bonding systems, telephone systems, data systems, security and surveillance systems

E-27.02 Installs public address (PA) and intercom systems.

Essential Skills	Document Use, Digital Technology, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
E-27.02.01P	identify type of ***PA and intercom system*** required for new installation	type of ***PA and intercom system*** is identified according to electrical drawings, specifications, job and client requirements
E-27.02.02P	remove and dispose of existing ***PA and intercom system*** when replacing and update documentation	***PA and intercom system components*** are disposed of according to local codes and waste disposal requirements
E-27.02.03P	determine ***PA and intercom system*** layout	***PA and intercom system*** layout is determined according to drawings, job and client requirements and a site visit
E-27.02.04P	select ***PA and intercom system components***	***PA and intercom system components*** are selected to match electrical drawings, specifications, job and client requirements
E-27.02.05P	position, mount and assemble ***PA and intercom system components***	***PA and intercom system components*** are placed in locations according to electrical drawings, specifications, job and client requirements
E-27.02.06P	terminate and interconnect ***PA and intercom system components*** and ***associated systems***	***PA and intercom system components*** and ***associated system*** devices are terminated and interconnected according to electrical drawings, specifications and job requirements
E-27.02.07P	test conductors and ***PA and intercom system components*** to ensure functionality	continuity and speaker wiring tests are performed using ***diagnostic and test equipment*** and ***PA and intercom system components*** function as required
E-27.02.08P	test conductors for opens and ground continuity	conductors have no opens and all components are bonded to ground and are clear of obstructions
E-27.02.09P	conduct initial ***PA and intercom system*** tests	***PA and intercom system*** tests are performed according to electrical drawings and specifications, and sensory and spot tests are performed
E-27.02.10P	participate in startup, commissioning, inspections and verifications as required	devices are activated to trigger events such as notifications and ***associated systems*** response

RANGE OF VARIABLES

PA systems include: wired, wireless

intercom systems include: one to one

PA components include: microphones, speakers, amplifiers, bells, power supplies, tone generators, receivers

intercom components include: call panels, unit panels, microphones, speakers, tone generators, handsets, door release strikes, GUIs, shielded conductors

associated systems include: fire alarm systems, audio systems, telephone systems, security and surveillance systems

diagnostic and test equipment includes: multimeters, ohmmeters

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-27.02.01L	demonstrate knowledge of ***PA and intercom systems***, their applications and operation	interpret codes and regulations pertaining to ***PA and intercom systems***
		interpret information pertaining to ***PA and intercom systems*** found on drawings and specifications
		identify types of ***PA and intercom systems*** and describe their characteristics and applications
		describe types of ***associated systems*** that interconnect with ***PA and intercom systems***
		identify ***PA and intercom system components*** and describe their characteristics and applications
		identify the considerations and requirements for selecting ***PA and intercom systems*** and their ***components***
E-27.02.02L	demonstrate knowledge of the procedures used to install, upgrade and connect ***PA and intercom systems***	describe the procedures used to install, upgrade and connect ***PA and intercom systems*** and their ***components***
		describe procedures for testing ***PA and intercom systems,*** their ***components*** and conductors

RANGE OF VARIABLES

PA systems include: perimeter, space

intercom systems include: one to one

associated systems include: fire alarm systems, audio systems, telephone systems, security and surveillance systems

PA components include: microphones, speakers, amplifiers, bells, power supplies, tone generators, receivers

intercom components include: call panels, unit panels, microphones, speakers, tone generators, handsets, door release strikes, GUIs, shielded conductors

E-27.03 Installs nurse call systems.

Essential Skills	Document Use, Digital Technology, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
E-27.03.01P	identify type of ***nurse call system*** required	type of ***nurse call system*** is identified according to electrical drawings, specifications, job and client requirements
E-27.03.02P	remove and dispose of existing ***nurse call system*** when replacing and update documentation	***nurse call system components*** are disposed of according to local codes and waste disposal requirements
E-27.03.03P	determine ***nurse call system*** layout	***nurse call system*** layout is determined according to drawings, client requirements and site visit
E-27.03.04P	select ***nurse call system components***	***nurse call system components*** are selected according to electrical drawings, specifications, job and client requirements
E-27.03.05P	position, mount and assemble ***nurse call system components***	***nurse call system components*** are placed in locations according to electrical drawings, job and client requirements and manufacturers' specifications
E-27.03.06P	terminate and interconnect ***nurse call system components*** and ***associated systems***	***nurse call system components*** and ***associated system*** devices are terminated and interconnected according to electrical drawings, specifications and job requirements
E-27.03.07P	test nurse call system components to ensure functionality	nurse call system components function as required
E-27.03.08P	test conductors for opens and ground continuity using ***diagnostic and test equipment***	conductors have no opens and all components are grounded and are clear of obstructions
E-27.03.09P	conduct initial ***nurse call system*** tests	***nurse call system*** tests are performed according to electrical drawings and specifications and all devices are tested
E-27.03.10P	label annunciation panels and devices for identification and servicing	initiating device and annunciating devices are labelled
E-27.03.11P	participate in startup and commissioning inspections	devices are activated to trigger events such as notifications and alarms, and associated system responses

RANGE OF VARIABLES

nurse call systems include: one-way, two-way, audible and visual, direct wire, internet protocol (IP) based/structured cabling

nurse call system components include: cameras, monitors, RFID tags, annunciators, panels, key pads, GUIs, power supplies

associated systems include: patient care LAN, emergency power supplies, security and surveillance systems

diagnostic and test equipment include: multimeters, cable analyzers

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-27.03.01L	demonstrate knowledge of ***nurse call systems***, their applications and operation	interpret codes and regulations pertaining to ***nurse call systems***
		interpret information pertaining to ***nurse call systems*** found on drawings and specifications
		identify types of ***nurse call systems*** and describe their characteristics and applications
		describe types of ***associated systems*** that often interconnect with ***nurse call systems***
		identify ***nurse call system components*** and describe their characteristics and applications
		identify the considerations and requirements for selecting ***nurse call systems*** and their ***components***
E-27.03.02L	demonstrate knowledge of the procedures used to install ***nurse call systems***	describe the procedures used to install ***nurse call systems*** and their ***components***
		describe the procedures for testing ***nurse call systems,*** their ***components*** and conductors
		describe the procedures for the commissioning/verification of ***nurse call systems***

RANGE OF VARIABLES

nurse call systems include: one-way, two-way, audible and visual, direct wire, IP-based/structured cabling

associated systems include: patient care LAN, emergency power supplies, security and surveillance systems

nurse call system components include: cameras, monitors, RFID tags, annunciators, panels, key pads, GUIs, power supplies

E-27.04 Performs servicing and maintenance of communication systems.

Essential Skills	Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
E-27.04.01P	obtain detailed description of malfunction of ***communication system*** from client	malfunction issues and information are identified and recorded
E-27.04.02P	identify existing ***communication system*** and ***components***	existing ***communication system*** and ***components*** are identified from as-built drawings, maintenance log and certification report; walkthrough is performed
E-27.04.03P	test ***communication system***	tests are performed according to sensory inspections and technical inspections using ***diagnostic and test equipment***
E-27.04.04P	analyze test results	test results are compared to relevant documents such as manufacturers' certification report, communication log and client requirements
E-27.04.05P	replace ***communication system components***	timing of replacement is scheduled with client; unintentional disruption of the system is avoided; replacement components are tested and verified
E-27.04.06P	update documentation to reflect servicing, testing, inspections or maintenance performed	documentation is clear and detailed and includes systems and components tested, test results and changes completed
E-27.04.07P	notify and explain system changes to client	client is informed of system changes

RANGE OF VARIABLES

communications systems include: VDV and CATV systems (UTP, ScTP, category 3, 5e, 6 and 6A, 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)

communications system components include: VDV and CATV system components (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), PA system components (microphones, speakers, amplifiers, bells, power supplies, tone generators, receivers), intercom components (call panels, unit panels, microphones, speakers, tone generators, handsets, door release strikes, GUIs, shielded conductors), nurse call system components (cameras, monitors, RFID tags, annunciator, panels, key pads, power supplies)

diagnostic and test equipment includes: VDV and CATV systems (TDRs, OTDRs, cable analyzers, light source power meters, wire map testers and CATV cable analyzers), PA systems (multimeters, ohmmeters), nurse call systems (multimeters, cable analyzers)

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-27.04.01L	demonstrate knowledge of ***communication systems***, their applications and operation	interpret codes, standards and regulations pertaining to communication systems
		interpret information pertaining to ***communication systems*** found on drawings and specifications
		identify types of ***communication systems*** and describe their characteristics and applications
		identify ***communication system components*** and describe their characteristics and applications
		describe types of ***associated systems*** that interconnect with ***communication systems***
E-27.04.02L	demonstrate knowledge of the procedures used to service and maintain ***communication systems***	describe possible effects of ***communication system*** service and maintenance on associated systems
		describe the procedures used to service and maintain ***communication systems*** and their ***components***
		describe procedures for testing ***communication systems,*** their ***components*** and conductors
		describe the procedures for verification of ***communication systems***

RANGE OF VARIABLES

communications systems include: VDV and CATV systems (UTP, ScTP, category 3, 5e, 6 and 6A, 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)

communications system components include: VDV and CATV system components (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), PA system components (microphones, speakers, amplifiers, bells, power supplies, tone generators, receivers), intercom components (call panels, unit panels, microphones, speakers, tone generators, handsets, door release strikes, GUIs, shielded conductors), nurse call system components (cameras, monitors, RFID tags, annunciator, panels, key pads, power supplies)

associated systems include: for VDV and CATV systems (telecommunication bonding systems, telephone systems, data systems, security and surveillance systems), for PA systems (fire alarm systems, audio systems, telephone systems, security and surveillance systems), for nurse call systems (patient care LAN, emergency power supplies, security and surveillance systems)

Task E-28 Installs, services and maintains integrated control systems.

TASK DESCRIPTOR

Integrated control systems and building automation systems involve connecting building components through a computerized system in order to achieve automated control over systems such as HVAC, lighting and security systems.

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

Construction electricians service integrated control systems and building automation systems by troubleshooting, diagnosing faults and repairing them. They also perform maintenance to ensure integrated control systems and building automation systems are in good operating condition.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. Building Automation and Control Network (BACnet) and ANSI/TIA- 862 are specific standards that pertain to this task. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or harm to the environment. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

E-28.01 Installs building automation systems.

Essential Skills Document Use, Digital Technology, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
E-28.01.01P	identify type of ***building automation system*** required for new installation	type of ***building automation system*** is identified according to electrical, communication and mechanical drawings, and specifications, and job and client specifications
E-28.01.02P	remove and dispose of existing ***building automation system*** when replacing and update documentation	***building automation system components*** are disposed of according to local codes and waste disposal requirements
E-28.01.03P	determine ***building automation system*** layout	***building automation system*** layout is determined according to architectural electrical, communication, and mechanical drawings and specifications, job and client requirements, and site visit

E-28.01.04P	select ***building automation system components***	***building automation system components*** are selected according to electrical, communication and mechanical drawings and specifications, and client requirements
E-28.01.05P	position, mount and assemble ***building automation system components***	***building automation system components*** are placed in locations according to architectural, electrical, communication and mechanical drawings and specifications, and job and client requirements
E-28.01.06P	terminate and interconnect ***building automation system components*** and ***associated systems***	***building automation system components*** and ***associated system*** devices are terminated and interconnected according to electrical, communication and mechanical drawings and specifications, and job requirements
E-28.01.07P	test ***building automation system components*** to ensure functionality	***building automation system components*** function as required
E-28.01.08P	test conductors for opens and ground continuity	conductors have no opens and all components are bonded to ground and are clear of obstructions
E-28.01.09P	test ***building automation system***	***building automation system*** tests are performed according to specific system being tested
E-28.01.10P	participate in startup and commissioning inspections	devices are activated to trigger functionality of ***building automation system*** and associated systems

RANGE OF VARIABLES

building automation systems include: energy management, security and surveillance systems

building automation system components include: network cabling, sensors such as occupancy and light levels, servers, Power over Ethernet (PoE) switches, GUIs

associated systems include: building control systems, LAN, elevator systems, fire alarm and suppression systems, security and surveillance systems

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-28.01.01L	demonstrate knowledge of ***building automation systems***, their applications and operation	interpret standards pertaining to ***building automation systems***
		interpret information pertaining to ***building automation systems*** found on drawings and specifications
		identify types of ***building automation systems*** and describe their characteristics and applications

		identify ***building automation system components*** and describe their characteristics and applications
		describe types of ***associated systems*** that interconnect with ***building automation systems***
		identify the considerations and requirements for selecting ***building automation systems*** and their ***components***
E-28.01.02L	demonstrate knowledge of the procedures used to install ***building automation systems***	describe the procedures used to install ***building automation systems*** and their ***components***
		describe procedures for testing ***building automation systems*** and their ***components***
		describe the procedures for the commissioning and verification of ***building automation systems***

RANGE OF VARIABLES

building automation systems include: energy management, security and surveillance systems

building automation system components include: network cabling, sensors such as occupancy and light levels, servers, PoE switches, GUIs

associated systems include: building control system, LAN, elevator systems, fire alarm and suppression systems, security and surveillance systems

E-28.02 Installs building control systems.

Essential Skills	Document Use, Digital Technology, Numeracy

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
E-28.02.01P	identify type of ***building control system*** required	type of ***building control system*** is identified according to electrical and mechanical drawings and specifications, and job and client specifications
E-28.02.02P	remove and dispose of existing ***building control system*** when replacing and update documentation	***building control system components*** are disposed of according to local codes and waste disposal requirements
E-28.02.03P	determine ***building control system*** layout	***building control system*** layout is determined according to electrical and communication drawings and specifications, client requirements and site visit
E-28.02.04P	select ***building control system components***	***building control system components*** are selected according to electrical and mechanical drawings and specifications, and job and client requirements
E-28.02.05P	position, mount and assemble ***building control system components***	***building control system components*** are placed in locations according to electrical drawings and specifications, and job and client requirements
E-28.02.06P	terminate and interconnect ***building control system components*** and ***associated systems***	***building control system components*** and ***associated system*** devices are terminated and interconnected according to electrical and mechanical drawings and specifications, and job requirements
E-28.02.07P	test building control system components to ensure functionality	building control system components function as required
E-28.02.08P	test conductors for opens and ground continuity using ***diagnostic and test equipment***	conductors have no opens and all components are bonded to ground and are clear of obstructions
E-28.02.09P	test ***building control system***	***building control system*** tests are performed according to electrical and mechanical drawings and specifications; functionality tests are performed
E-28.02.10P	participate in startup and commissioning inspections	devices are activated to trigger functionality of ***building control system*** and associated systems

RANGE OF VARIABLES

building control systems include: pneumatic, analog electrical and direct digital control (DDC), computer control

building control system components include: damper motors, valves, contactors, contacts, annunciators, thermostats, solenoids, flow and sail switches, and humidity, digital, analog, pressure differential, temperature, light level, occupancy and level/float sensors

associated systems include: building automation systems, HVAC, lighting, security and surveillance systems

diagnostic and test equipment include: multimeters

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-28.02.01L	demonstrate knowledge of ***building control systems***, their applications and operation	interpret ***standards*** pertaining to ***building control systems***
		interpret information pertaining to ***building control systems*** found on drawings and specifications
		identify types of ***building control systems*** and describe their characteristics and applications
		identify ***building control system components*** and describe their characteristics and applications
		describe types of ***associated systems*** that interconnect with ***building control systems***
		identify the considerations and requirements for selecting ***building control systems*** and their ***components***
E-28.02.02L	demonstrate knowledge of the procedures used to install ***building control systems***	describe the procedures used to install ***building control systems*** and their ***components***
		describe the procedures for testing ***building control systems,*** their ***components*** and conductors
		describe the procedures for the commissioning and verification of ***building control systems***

RANGE OF VARIABLES

building control systems include: pneumatic, analog electrical and DDC, computer control

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

building control system components include: damper motors, valves, contactors, contacts, annunciators, thermostats, solenoids, flow and sail switches, and humidity, digital, analog, pressure differential, temperature, light level, occupancy and level/float sensors

associated systems include: building automation systems, HVAC, lighting, security and surveillance systems

E-28.03 Performs servicing and maintenance of integrated control systems.

Essential Skills	Oral Communication, Digital Technology, Writing

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

SKILLS

	Performance Criteria	Evidence of Attainment
E-28.03.01P	obtain detailed description of malfunction of ***integrated control system*** from client	types of ***information*** are obtained and description of problem noted
E-28.03.02P	identify ***integrated control system*** and ***components***	***integrated control system*** and ***components*** are identified from as-built drawings, maintenance log and site visit
E-28.03.03P	test ***integrated control system***	***integrated control system*** is tested and system activation performed
E-28.03.04P	analyze test results	test results are compared to manufacturers' certification report, communication log and client requirements
E-28.03.05P	adjust ***components***	***components*** are adjusted
E-28.03.06P	replace ***integrated control system components***	replacement is scheduled with client and local monitoring station and replacement ***components*** are tested and verified
E-28.03.07P	update documentation to reflect servicing, testing, inspections and maintenance performed	required documentation is updated in a clear and detailed manner; documentation includes ***systems*** and ***components*** tested, the test results and changes that were completed
E-28.03.08P	notify and explain system changes to system operator	system changes are explained to system operator

RANGE OF VARIABLES

integrated control systems include: HVAC controls, lighting controls, energy management, elevator systems, and fire alarm and fire suppression systems, security and surveillance systems

information includes: where and when the problem occurred, frequency of problem, have any changes recently been made to the system or associated systems, latest inspection report and, maintenance and operation log

integrated control system components include: damper motors, valves, contactors, contacts, annunciators, thermostats, solenoids, flow and sail switches, and humidity, digital, analog, pressure differential, temperature, light level, occupancy and level/float sensors

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-28.03.01L	demonstrate knowledge of ***integrated control systems***, their applications and operation	interpret ***standards*** pertaining to integrated control systems
		interpret information pertaining to ***integrated control systems*** found on drawings and specifications
		identify types of ***integrated control systems*** and describe their characteristics and applications
		identify ***integrated control system components*** and describe their characteristics and applications
		identify the considerations and requirements for selecting ***integrated control systems*** and their ***components***
		describe types of ***associated systems*** that interconnect with ***integrated control systems***
E-28.03.02L	demonstrate knowledge of the procedures used to service and maintain ***integrated control systems***	describe possible effects of ***integrated control system*** service and maintenance on ***associated systems***
		describe the procedures used to service and maintain ***integrated control systems*** and their ***components***
		describe procedures for testing ***integrated control systems,*** their ***components*** and conductors
		describe the procedures for the commissioning and verification of ***integrated control systems***

RANGE OF VARIABLES

integrated control systems include: HVAC controls, lighting controls, energy management, elevator systems, and fire alarm and fire suppression systems, security and surveillance systems

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

integrated control system components include: damper motors, valves, contactors, contacts, annunciators, thermostats, solenoids, flow and sail switches, and humidity, digital, analog, pressure differential, temperature, light level, occupancy and level/float sensors

APPENDIX A
ACRONYMS

AC	alternating current
AFCI	arc fault circuit interrupter
AHJ	authority having jurisdiction
ANSI	American National Standards Institute
ARCAL	aircraft radio control of aerodrome lighting
AVR	Automatic Voltage Regulator
ASCII	American Standard Code for Information Interchange
BAC	Building Automation and Control
BCD	binary coded decimal
BD	block diagram
BICSI	Building Industry Consulting Services International
CAD	computer-aided design
CATV	community antenna television
CCR	constant current regulator
CEC	Canadian Electrical Code
CPU	central processing unit
CSA	Canadian Standards Association
CSC	Construction Specifications Canada
CT	current transformers
DC	direct current
DCS	distributed control system
DDC	direct digital control
DVR	digital video recorder
EMC	electro-magnetic compatibility
EMI	electro-magnetic interference
EV	electric vehicles
FLA	full load amps
FLC	full load current
GFCI	ground fault circuit interrupter
GUI	graphical user interface
HMI	human machine interfacing
HVAC	heating, ventilation and air-conditioning
I/O	input/output
IEEE	Institute of Electrical and Electronics Engineers
IL	instruction list
IP	Internet Protocol
kVA	kilovolt-amps
LAN	local area network
LD	ladder diagram
LED	light emitting diode
LEED	Leadership in Energy and Environmental Design
MCC	motor control centre

MOV	metal oxide varistor
MSDS	material safety data sheets
NBC	National Building Code
NEMA	National Electrical Manufacturers' Association
NETA	North American Electrical Testing Association
NFC	National Fire Code
O&M	operations and maintenance
OEM	original equipment manufacturer
OH&S	Occupational Health and Safety
OTDR	optical time-domain reflectometer
OTE	output energized
PA	public address
PDC	power distribution centre
PLC	programmable logic controller
PoE	power over Ethernet
PPE	personal protective equipment
PQA	Power Quality Analyzer
PT	potential transformers
RFID	radio frequency identification
SCADA	Supervisory Control and Data Acquisition
SCTE	Society of Cabling Telecommunications Engineers
ScTP	screened twisted pair
SPL	sound pressure level
SFC	sequential function chart
ST	structured test
TDR	time-domain reflectometer
TIA	Telecommunications Industry Association
ULC	Underwriters Laboratories of Canada
UPS	uninterruptible power supply
UTP	unshielded twisted pair
VDV	voice / data / video
VFD	variable frequency drive
WHMIS	Workplace Hazardous Materials Information System
WLL	working load limit
XIO	examine if opened
XIC	examine if closed

APPENDIX B

TOOLS AND EQUIPMENT

STANDARD TOOLS

adjustable wrench
cable cutter
camera
centre punch
chalk line
cold chisel
combination square
combination wrench set
crimping pliers
crowbar
drill bits
files
fish tape
flashlight
fuse puller
hack saw
hammers
hex key set
keyhole saw
knives
knockout punch set
level
lineman pliers
measuring tape
needle nose pliers
nut drivers
pipe benders
pipe cutters
pipe threader
pipe wrench
plumb bob
reamers
screwdrivers – Robertson, Phillips, torx, flat, tamper-proof
side/diagonal cutters
slip joint pliers
socket set
speed wrench
tap and die set
tin snips
tool belt
tool bucket
triple tap
trouble light
vise
wire strippers
wood chisel

PERSONAL PROTECTIVE EQUIPMENT AND SAFETY EQUIPMENT

arc flash equipment
barricades
confined space equipment
coveralls (fire retardant)
ear plugs and muffs
eye wash facilities
face shield
fall arresters
fire blanket
fire extinguisher
first aid equipment
fume and toxic gas detector
gloves
goggles
grounding straps
hard hat
insulated gloves
knee pads
lanyard
life line
lock-out kit
portable GFCI
portable light
pylons
respirator
restraint device
rope grab
safety belt (travel restraint)
safety boots
safety glasses
safety harness
safety vest
self-contained breathing apparatus
signage
ventilation equipment
warning tape

ACCESS EQUIPMENT

articulated boom lift
boom lifts
construction elevator
ladders (extension, fixed, step)
lift table
scaffolds (rolling, mechanical, stationary, ladder jack)
man basket
scissor lift
swing stage

POWER TOOLS AND EQUIPMENT

band saws
battery/rechargeable drill
bench grinder
cable puller
chop saw
circular saw
core drill
drill press
grinder
heat gun
hammer drill
hole saw kit
power crimper
jig saw
knock-out punch (powered)
magnetic drill
pneumatic hammer drill
power cable feeders
power drill
power pipe bender
power pipe cutters
power pipe threader
power puller
power reel lift
PVC bender
reciprocating saw
sump pump
vacuum

SPECIALTY TOOLS AND EQUIPMENT

chain falls
come-along
communication devices (cellphones and 2-way radio)
creepers and crawlers
extension cords
grip hoist
hot stick
inverters
laser level
manual hoist
picks
pneumatic hoist
portable generator
powder-actuated tools
reel jacks
rope
shackles
shovels
sledgehammer
slings
spud wrench
soldering apparatus
strain relief grips
thermit (thermal) welder
torque wrench
wire rack

MEASURING EQUIPMENT

ammeter
cable locator
clamp ammeter
fault locator
frequency meter
ground megohmmeter
high pot tester (dielectric tester)
inductive voltage detector (non-contact voltage detector)
insulation resistance tester
jumpers
LAN meter (cable analyzer)
light meter
megohmmeter (insulation tester)
multimeter
optical time-domain reflectometer (OTDR)
ohmmeter
oscilloscope
phase/motor rotation meter
power quality analyzer
recording meter (watts, volts and amps)
tachometer
thermographic imaging device
thermometer (infra-red and electronic)
ultrasonic testing equipment
voltage tester
voltmeter
watt meter

APPENDIX C
GLOSSARY

ancillary	functions performed by the fire alarm system as an output of the fire alarm system, controlled by a relay or similar device, for example, elevator recall, fan shut down and door release
bonding	a 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
cathodic protection	technique to control the corrosion of a metal surface by making that surface the cathode of an electrochemical cell
extra low voltage	any voltage not exceeding 30V
grounding	a 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
high voltage	any voltage exceeding 750V
low energy power circuit	a circuit where the power is limited to 100 Volt Amperes (VA) where V is the open circuit voltage
low voltage	any voltage exceeding 30V but not exceeding 750V
luminaires	a complete lighting unit designed to accommodate the lamp(s) and to connect the lamp(s) to circuit conductors, for example, florescent, High Intensity Discharge (HID) and incandescent
raceway	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 non-metallic tubing, underfloor raceways, cellular floors, surface raceways, wireways, cable trays, busways, and auxiliary gutters
specifications	an explicit set of requirements to be satisfied by a material, product or service including but not limited to local and national building codes, any documentation that holds legal obligations, schematics, manufacturers specs, local code, provincial/federal authority, engineered drawings and diagrams and schematics, client requirements, warranty documents, site drawings, shop drawings, company requirements