PROGRAM PROGRAMME
EXCELLENCE
RED SEAL · SCEAU ROUGE

CURRICULUM OUTLINE

Construction Electrician

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PROGRAM PROGRAMME
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CONSTRUCTION ELECTRICIAN

CURRICULUM OUTLINE

STRUCTURE OF THE CURRICULUM OUTLINE

To facilitate development of apprenticeship technical training, this guide 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

Sequencing of Apprenticeship Training and Subtasks: A chart which outlines the model for apprenticeship training sequencing and a cross-reference of the sub-tasks covered by each topic.

Task Matrix and Recommended Training Levels: a chart which outlines graphically the Major Work Activities, Tasks and Sub tasks along with the recommended level for training

Major Work Activity (MWA): largest division in the standard comprised of a distinct set of trade activities

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

Task Descriptor: a general description of the task

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

Essential Skills: the three most important essential skills that are used in this sub-task

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

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

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

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

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

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

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 languages of business as well as languages of instruction in apprenticeship programs.

SEQUENCING OF APPRENTICESHIP TRAINING TOPICS AND RELATED SUBTASKS

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

Level One	Level Two	Level Three	Level Four
Organizes Work	**Organizes Work**	**Organizes Work**	**Organizes Work**
Protection Devices	**Protection Devices**	**Protection Devices**	**Protection Devices**
Plans, Drawings and Specifications	**Plans, Drawings and Specifications**	**Plans, Drawings and Specifications**	**Plans, Drawings and Specifications**
Electronics (No task in the RSOS)	**Electronics** (No task in the RSOS)	**Electronics** (No task in the RSOS)	**Electronics** (No task in the RSOS)
Canadian Electrical Code (No task in the RSOS)	**Canadian Electrical Code** (No task in the RSOS)	**Canadian Electrical Code** (No task in the RSOS)	**Canadian Electrical Code** (No task in the RSOS)
	Support Components	**Support Components**	**Support Components**
		Raceways, Cables, Conductors and Enclosures	**Raceways, Cables, Conductors and Enclosures**
Commissions and Decommissions Systems	**Commissions and Decommissions Systems**	**Commissions and Decommissions Systems**	**Commissions and Decommissions Systems**

Safety

1.01 Uses personal protective equipment (PPE) and safety equipment.
1.02 Maintains safe work environment.
1.03 Performs lock-out and tag-out procedures.

Tools and Equipment

2.01 Uses common and specialty tools and equipment.
2.02 Uses access equipment.
2.03 Uses rigging, hoisting and lifting equipment.

Support Components

4.01 Fabricates support structures.
4.02 Installs brackets, hangers and fasteners
4.03 Installs seismic restraint systems.

Level One	Level Two	Level Three	Level Four
Communication and Mentoring Techniques 6.01 Uses communication techniques.		**Communication and Mentoring Techniques** 6.02 Uses mentoring techniques.	
Grounding, Bonding 11.01 Installs grounding and bonding systems.	**Grounding, Bonding (Single-Phase)** 11.01 Installs grounding and bonding systems. 11.02 Installs ground fault systems. 11.03 Installs lightning protection systems.	**Grounding, Bonding (Three-Phase)** 11.01 Installs grounding and bonding systems. 11.02 Installs ground fault systems. 11.03 Installs lightning protection systems.	**Grounding, Bonding Ground Fault Detection Systems** 11.04 Performs servicing and maintenance of bonding and grounding systems.
Raceways, Cables, Conductors and Enclosures 16.01 Installs conductors and cables 16.02 Installs conduit, tubing and fittings. 16.03 Installs raceways. 16.04 Installs boxes and enclosures. 16.05 Performs servicing and maintenance of raceways, cables and enclosures.	**Raceways, Cables, Conductors and Enclosures** 16.01 Installs conductors and cables 16.02 Installs conduit, tubing and fittings. 16.03 Installs raceways. 16.04 Installs boxes and enclosures. 16.05 Performs servicing and maintenance of raceways, cables and enclosures.		
Branch Circuitry and Devices (AC/DC introduction) 17.01 Installs luminaires. 17.02 Installs wiring devices 17.03 Installs lighting controls. 17.04 Installs lighting standards. 17.05 Performs servicing of branch circuitry.	**Branch Circuitry and Devices (Single-Phase)** 17.01 Installs luminaires. 17.02 Installs wiring devices 17.03 Installs lighting controls. 17.04 Installs lighting standards. 17.05 Performs servicing of branch circuitry.	**Branch Circuitry and Devices (Three-Phase)** 17.01 Installs luminaires. 17.02 Installs wiring devices 17.03 Installs lighting controls. 17.04 Installs lighting standards. 17.05 Performs servicing of branch circuitry.	**Branch Circuitry and Devices (Specialty)** 17.06 Installs, services and maintains airport runway lighting systems. 17.07 Installs, services and maintains traffic signal lights and controls.
Consumer/Supply Services and Metering Equipment (Single-Phase) 7.01 Installs single-phase consumer/supply services and metering equipment. 7.03 Performs servicing and maintenance of single-phase consumer/supply services and metering equipment.		**Consumer/Supply Services and Metering Equipment (Three-Phase)** 7.02 Installs three-phase consumer/supply services and metering equipment. 7.04 Performs servicing and maintenance of three-phase consumer/supply services and metering equipment.	
Distribution Equipment (Single-Phase) 9.01Installs power distribution equipment. 9.02 Performs servicing and maintenance of power distribution equipment.		**Distribution Equipment (Three-Phase)** 9.01Installs power distribution equipment. 9.02 Performs servicing and maintenance of power distribution equipment.	

Level One	Level Two	Level Three	Level Four
	Power Generating Systems (DC) 12.03 Installs DC (direct current) generating systems. 12.04 Performs servicing and maintenance of DC generating systems.	**Power Generating Systems (AC)** 12.01 Installs AC (alternating current) generating systems. 12.02 Performs servicing and maintenance of AC generating systems.	
	Transformers (Single-Phase) 15.01 Installs extra-low voltage transformers. 15.02 Installs low-voltage single-phase transformers.	**Transformers (Three-Phase)** 15.03 Installs low-voltage three-phase transformers. 15.04 Installs high voltage transformers. 15.05 Performs servicing and maintenance of transformers.	
	Exit and Emergency Lighting Systems 20.01 Installs exit and emergency lighting. 20.02 Performs servicing and maintenance of exit and emergency lighting systems.		
	Cathodic Protection Systems 21.01 Installs cathodic protection systems. 21.02 Performs servicing and maintenance of cathodic protection systems.		
			Signaling Systems 26.01 Installs fire alarm systems. 26.02 Performs servicing and maintenance of fire alarm systems. 26.03 Installs security and surveillance systems. 26.04 Performs servicing and maintenance of security and surveillance systems.
	Electric Heating Systems and Controls 19.01 Installs electric heating systems. 19.02 Installs electric heating system controls. 19.03 Performs servicing and maintenance of electric heating systems and controls.		

Level One	Level Two	Level Three	Level Four
	Heating, Ventilation and Air Conditioning (HVAC) 18.01 Connects HVAC systems. 18.02 Installs HVAC controls. 18.03 Performs servicing and maintenance of HVAC systems and controls.		
	Motor Starters and Controls 22.01 Installs motor starters. 22.02 Performs servicing and maintenance of motor starters. 22.03 Installs motor controls. 22.04 Performs servicing and maintenance of motor controls.	**Motor Starters and Controls** 22.01 Installs motor starters. 22.02 Performs servicing and maintenance of motor starters. 22.03 Installs motor controls. 22.04 Performs servicing and maintenance of motor controls.	
	Motors (DC) 24.05 Installs DC motors. 24.06 Performs servicing and maintenance of DC motors.	**Motors (Single-Phase and Three-Phase)** 24.01 Installs single-phase motors. 24.02 Performs servicing and maintenance of single-phase 24.03 Installs three-phase motors. 24.04 Performs servicing and maintenance of three-phase motors. 24.05 Installs DC motors. 24.06 Performs servicing and maintenance of DC motors.	**Motors (Install/Maintain)** 24.01 Installs single-phase motors. 24.02 Performs servicing and maintenance of single-phase motors. 24.03 Installs three-phase motors. 24.04 Performs servicing and maintenance of three-phase motors. 24.05 Installs DC motors. 24.06 Performs servicing and maintenance of DC motors.
		(Motor) Drives 23.01 Installs AC drives. 23.02 Performs servicing and maintenance of AC drives. 23.03 Installs DC drives. 23.04 Performs servicing and maintenance of DC drives.	
			High Voltage Systems 14.01 Installs high voltage equipment. 14.02 Installs high voltage cables. 14.03 Performs servicing and maintenance of high voltage systems.
			UPS and Surge Suppression Systems 10.01 Installs power conditioning, UPS and surge suppression systems. 10.02 Performs servicing and maintenance of power conditioning, UPS and surge suppression systems.

Level One	Level Two	Level Three	Level Four
	Renewable Energy Generating and Storage Systems 13.01 Installs renewable energy systems. 13.02 Performs servicing and maintenance of renewable energy systems.		**Renewable Energy Generating and Storage Systems** 13.01 Installs renewable energy systems. 13.02 Performs servicing and maintenance of renewable energy systems.
Communication Systems 27.01 Installs voice/data/video (VDV) and community antenna television (CATV) systems. 27.02 Installs public address (PA) and intercom systems. 27.03 Installs nurse call systems.			**Communication Systems** 27.01 Installs voice/data/video (VDV) and community antenna television (CATV) systems. 27.02 Installs public address (PA) and intercom systems. 27.03 Installs nurse call systems 27.04 Performs servicing and maintenance of communication systems.
			Building Automation Systems (Integrated Control Systems) 28.01 Installs building automation systems. 28.02 Installs building control systems. 28.03 Performs servicing and maintenance of integrated control systems
			Automated Control Systems 25.01 Installs automated control systems. 25.02 Performs servicing and maintenance of automated control systems. 25.03 Programs and configures automated control systems.

CONSTRUCTION ELECTRICIAN
TASK MATRIX AND RECOMMENDED TRAINING LEVELS

A - PERFORMS COMMON OCCUPATIONAL SKILLS

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

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

Task B-7 **Installs, services and maintains consumer/supply services and metering equipment.**	1 **B-7.01 Installs single-phase consumer/supply services and metering equipment.**	3 **B-7.02 Installs three-phase consumer/supply services and metering equipment.**	1 **B-7.03 Performs servicing and maintenance of single-phase services and metering equipment.**
	3 **B-7.04 Performs servicing and maintenance of three-phase services and metering equipment.**		
Task B-8 **Installs, services and maintains protection devices.**	1,2,3,4 **B-8.01 Installs overcurrent protection devices.**	1,2,3,4 **B-8.02 Installs ground fault, arc fault and surge protection devices.**	1,2,3,4 **B-8.03 Performs servicing and maintenance of protection devices.**
Task B-9 **Installs, services and maintains distribution equipment.**	1,3 **B-9.01 Installs power distribution equipment.**	1,3 **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.**	4 **B-10.01 Installs power conditioning, UPS and surge suppression systems.**	4 **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.**	1,2,3 **B-11.01 Installs grounding and bonding systems.**	1,2,3 **B-11.02 Installs ground fault systems.**	1,2,3 **B-11.03 Installs lightning protection systems.**
	4 **B-11.04 Performs servicing and maintenance of bonding and grounding systems.**		
Task B-12 **Installs, services and maintains power generation systems.**	3 **B-12.01 Installs AC (alternating current) generating systems.**	3 **B-12.02 Performs servicing and maintenance of AC generating systems.**	2 **B-12.03 Installs DC (direct current) generating systems.**

	2 B-12.04 Performs servicing and maintenance of DC generating systems.		
Task B-13 Installs, services and maintains renewable energy systems.	4 B-13.01 Installs renewable energy systems.	4 B-13.02 Performs servicing and maintenance of renewable energy systems.	
Task B-14 Installs, services and maintains high voltage systems.	4 B-14.01 Installs high voltage equipment.	4 B-14.02 Installs high voltage cables.	4 B-14.03 Performs servicing and maintenance of high voltage systems.
Task B-15 Installs, services and maintains transformers.	2 B-15.01 Installs extra-low voltage transformers.	2 B-15.02 Installs low-voltage single-phase transformers.	3 B-15.03 Installs low-voltage three-phase transformers.
	3 B-15.04 Installs high voltage transformers.	3 B-15.05 Performs servicing and maintenance of transformers.	

C - INSTALLS, SERVICES AND MAINTAINS WIRING SYSTEMS

Task C -6 **Installs, services and maintains raceways, cables and enclosures.**	1,2 **C-16.01 Installs conductors and cables.**	1,2 **C-16.02 Installs conduit, tubing and fittings.**	1,2 **C-16.03 Installs raceways.**
	1,2 **C-16.04 Installs boxes and enclosures.**	1,2 **C-16.05 Performs servicing and maintenance of raceways, cables and enclosures.**	
Task C-17 **Installs, services and maintains branch circuitry.**	1,2,3 **C-17.01 Installs luminaires.**	1,2,3 **C-17.02 Installs wiring devices.**	1,2,3 **C-17.03 Installs lighting controls.**
	1,2,3 **C-17.04 Installs lighting standards.**	1,2,3 **C-17.05 Performs servicing of branch circuitry.**	4 **C-17.06 Installs, services and maintains airport runway lighting systems.**
	4 **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.**	2 **C-18.01 Connects HVAC systems.**	2 **C-18.02 Installs HVAC controls.**	2 **C-18.03 Performs servicing and maintenance of HVAC systems and controls.**
Task C-19 **Installs, services and maintains electric heating systems.**	2 **C-19.01 Installs electric heating systems.**	2 **C-19.02 Installs electric heating system controls.**	2 **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.**	2 **C-20.01 Installs exit and emergency lighting.**	2 **C-20.02 Performs servicing and maintenance of exit and emergency lighting systems.**	
Task C-21. **Installs, services and maintains cathodic protection systems.**	2 **C-21.01 Installs cathodic protection systems.**	2 **C-21.02 Performs servicing and maintenance of cathodic protection systems.**	

D - INSTALLS, SERVICES AND MAINTAINS MOTORS AND CONTROL SYSTEMS

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

E - INSTALLS, SERVICES AND MAINTAINS SIGNALLING AND COMMUNICATION SYSTEMS

Task E-26 **Installs, services and maintains signaling systems.**	4 **E-26.01 Installs fire alarm systems.**	4 **E-26.02 Performs servicing and maintenance of fire alarm systems.**	4 **E-26.03 Installs security and surveillance systems.**
	4 **E-26.04 Performs servicing and maintenance of security and surveillance systems.**		
Task E-27 **Installs, services and maintains communication systems.**	1,4 **E-27.01 Installs voice/data/video (VDV) and community antenna television (CATV) systems.**	1,4 **E-27.02 Installs public address (PA) and intercom systems.**	1,4 **E-27.03 Installs nurse call systems.**
	1,4 **E-27.04 Performs servicing and maintenance of communication systems.**		
Task E-28 **Installs, services and maintains integrated control systems.**	4 **E-28.01 Installs building automation systems.**	4 **E-28.02 Installs building control systems.**	4 **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.

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

Essential Skills	Thinking Skills, Document Use, Reading

	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

	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

	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.

A-2.01 Uses common and specialty tools and equipment.

Essential Skills	Thinking Skills, Document Use, Reading

	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

	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

	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.

A-3.01 Interprets plans, drawings and specifications.

Essential Skills	Document Use, Reading, Numeracy

	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

	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

	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

	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

	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.

A-4.01 Fabricates support structures.

Essential Skills	Numeracy, Document Use, Thinking Skills

	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

	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

	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.

A-5.01 Performs startup and shutdown procedures.

Essential Skills	Document Use, Thinking Skills, Oral Communication

	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

	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.

A-6.01 Uses communication techniques.

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

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-6.01.01L	demonstrate knowledge of trade terminology	define terminology used in the trade
A-6.01.02L	demonstrate knowledge of effective communication practices	describe the importance of using effective verbal and non-verbal communication with ***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

	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.

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

Essential Skills	Numeracy, Thinking Skills, Reading

	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

	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

	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

	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.

B-8.01 Installs overcurrent protection devices.

Essential Skills	Document Use, Numeracy, Thinking Skills

	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

	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

	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.

B-9.01 Installs power distribution equipment.

Essential Skills	Document Use, Thinking Skills, Numeracy

	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

	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.

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

Essential Skills	Thinking Skills, Numeracy, Document Use

	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

	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.

B-11.01 Installs grounding and bonding systems.

Essential Skills	Digital Technology, Document Use, Reading

	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

	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

	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

	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.

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

Essential Skills	Numeracy, Document Use, Thinking Skills

	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

	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.

Essential Skills	Thinking Skills, Numeracy, Document Use

	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.

Essential Skills	Oral Communication, Digital Technology, Writing

	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.

B-13.01 Installs renewable energy systems.

Essential Skills	Thinking Skills, Numeracy, Document Use

	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

	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.

B-14.01 Installs high voltage equipment.

Essential Skills	Reading, Digital Technology, Document Use

	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

	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

	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.

B-15.01 Installs extra-low voltage transformers.

Essential Skills	Thinking Skills, Numeracy, Document Use

	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

	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

	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

	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-15.03 Performs servicing and maintenance of transformers.

Essential Skills	Oral Communication, Digital Technology, Writing

	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.

C-16.01 Installs conductors and cables.

Essential Skills	Thinking Skills, Numeracy, Document Use

	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

	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

	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

	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

	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.

C-17.01 Installs luminaires.

Essential Skills	Numeracy, Thinking Skills, Document Use

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

	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

	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

	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

	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

	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

	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.

C-18.01 Connects HVAC systems.

Essential Skills	Document Use, Thinking Skills, Numeracy

	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

	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

	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.

C-19.01 Installs electric heating systems.

Essential Skills	Thinking Skills, Numeracy, Document Use

	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

	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

	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.

C-20.01 Installs exit and emergency lighting.

Essential Skills	Thinking Skills, Numeracy, Document Use

	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

	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.

C-21.01 Installs cathodic protection systems.

Essential Skills	Document Use, Numeracy, Thinking Skills

	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

	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.

D-22.01 Installs motor starters.

Essential Skills	Thinking Skills, Document Use, Numeracy

	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

	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

	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

	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.

D-23.01 Installs AC drives.

Essential Skills	Document Use, Numeracy, Thinking Skills

	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

	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

	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

	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.

D-24.01 Installs single-phase motors.

Essential Skills	Document Use, Thinking Skills, Numeracy

	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

	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

	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

	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

	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

	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.

D-25.01 Installs automated control systems.

Essential Skills	Document Use, Numeracy, Digital Technology

	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

	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 system include: PLC, SCADA system, DCS

programming languages used to program automated control systems include: ladder diagram (LD), function block diagram (BD), structured text (ST), instruction list (IL) sequential function chart (SFC)

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

procedures for programming and configuration of automated control systems include: I/O configuration, data table, user program, communication interface

basic instruction sets for ladder logic include: XIO, XIC, OTE

number systems include: binary, decimal, hexadecimal, octal

code systems include: BCD, ASCII

control circuit logic includes: relay logic, AND, OR, NOT, NOR and MEMORY

D-25.03 Programs and configures automated control systems.

Essential Skills	Document Use, Reading, Digital Technology

	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 signalling systems.

TASK DESCRIPTOR

Construction electricians install, upgrade, service and maintain signalling systems such as fire alarm systems, and security and surveillance systems which allow for the protection and management of people and property. These types of systems may be low voltage 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.

E-26.01 Installs fire alarm systems.

Essential Skills	Document Use, Thinking Skills, Numeracy

	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 signalling 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

	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 signalling 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

	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

	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.

E-27.01 Installs voice/data/video (VDV) and community antenna television (CATV) systems.

Essential Skills	Oral Communication, Digital Technology, Numeracy

	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

	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

	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

	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.

E-28.01 Installs building automation systems.

Essential Skills	Document Use, Digital Technology, Numeracy

	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

	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

	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
lanyard
life line
lock-out kit
portable GFCI
portable light
pylons
respirator
restraint device
rope grab
safety belt (travel restraint)

first aid equipment
fume and toxic gas detector
gloves
goggles
grounding straps
hard hat
insulated gloves
knee pads
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
powder-actuated tools
reel jacks
rope
shackles
shovels
sledgehammer

hot stick
inverters
laser level
manual hoist
picks
pneumatic hoist
portable generator
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