

# **Power Electrician**

**Provincial Occupational Standard      2017**

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## ACKNOWLEDGEMENTS

Apprenticeship Manitoba wishes to express sincere appreciation for the contribution of the many tradespersons, industrial establishments, professional associations, labour organizations, provincial government departments and agencies, and all others who contributed to this publication.

Special acknowledgement is extended by Apprenticeship Manitoba to the following representatives from the trade.

Rick Etsell	<i>Manitoba Hydro</i>
David Ferguson	<i>Manitoba Hydro</i>
Kim Gibson	<i>Manitoba Hydro</i>
Don Malchuk	<i>Manitoba Hydro</i>
Kevin McLennan	<i>Manitoba Hydro</i>

This occupational standard was prepared by the Training Standards Unit of Apprenticeship Manitoba. The coordinating, facilitating and processing of this standard were undertaken by Gabriel Chung and Joefrey Castillo.

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## STRUCTURE OF THE OCCUPATIONAL STANDARD

To facilitate the understanding of the occupation, the work performed by tradespersons is divided into the following categories:

<b>Major Work Activity</b>	the largest division within the occupational standard that is comprised of a distinct set of trade activities
<b>Tasks</b>	distinct actions that describe the activities within a major work activity
<b>Sub-Tasks</b>	distinct actions that describe the activities within a task
<b>Key Competencies</b>	activities that a person should be able to do in order to be called 'competent' in the trade

The occupational standard also provides the following information:

<b>Trends</b>	changes identified that impact or will impact the trade including work practices, technological advances, and new materials and equipment
<b>Context</b>	information to clarify the intent and meaning of tasks
<b>Required Knowledge</b>	the elements of knowledge that an individual must acquire to adequately perform a task

The appendices located at the end of the occupational standard are described as follows:

<b>Appendix A – Tools and Equipment</b>	a non-exhaustive list of tools and equipment used in this trade
<b>Appendix B – Glossary</b>	definitions or explanations of selected technical terms used in the occupational standard
<b>Appendix C – Acronyms</b>	a list of acronyms used in the with their full name
<b>Appendix D – Major Work Activity and Task Weighting</b>	the major work activity and task percentages which determine the number of questions for each major work activity and task in the Provincial exam
<b>Appendix E – Pie Chart</b>	a graph which depicts the percentages of exam questions assigned to major work activities
<b>Appendix F – Task Profile Chart</b>	a chart which outlines graphically the major work activities, tasks and sub-tasks of this occupational standard

## **OCCUPATIONAL STANDARD**

Safe working procedures and conditions, accident prevention, and the preservation of health are of primary importance to industry in Manitoba. These responsibilities are shared and require the joint efforts of government, employers and employees. It is imperative that all parties are aware of circumstances and conditions that may lead to injury or harm. Safe learning experiences and work environments can be created by controlling the variables and behaviours that may contribute to accidents or injury.

Safety-conscious attitudes and work practices contribute to a healthy, safe and accident-free work environment. It is imperative to apply and be familiar with workplace health and safety legislation and regulations including Workplace Hazardous Materials Information System (WHMIS) and transportation of dangerous goods (TDG) regulations. Power 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 power electricians be constantly aware of their surroundings and the hazards they may encounter.

Safety education is an integral part of training. As safety is an imperative part of all trades, it is assumed and therefore it is not included as a qualifier of any activities. However, the technical safety tasks and sub-tasks specific to the trade are included in this occupational standard.



## **SCOPE OF THE POWER ELECTRICIAN TRADE**

This occupational standard describes the work of power electricians who install, maintain and operate high and low voltage equipment within or connected to the bulk electrical system. This equipment includes generators, converters, transformers, interruptive equipment and auxiliary systems. This equipment is used to generate, transmit, distribute and convert electricity.

To fulfil their job responsibilities, power electricians must possess and apply a wide range of knowledge and competencies to undertake work in all of the following areas:

- Common Occupation Skills
- Power Utility Systems
- High Voltage Equipment
- Low Voltage Equipment
- Rotating Machines
- Signalling and Communication Systems

One important requirement of this trade, in addition to technical knowledge, is the need to observe and practice safety at all times because of the hazards and dangers associated with high-voltage electricity. Power electricians work both inside and outside buildings and structures such as thermal and hydraulic generating stations and sub-stations. Maintenance work takes place at various heights requiring power electricians to work from various aerial devices and work platforms.

This occupational standard is not a course of study and is not intended that the tasks and sub-tasks be mastered in the sequence shown. The primary purpose is to indicate the skills and abilities of a journeyman. The document may be used as a basis for defining the expected outcomes of institutional and on-the-job training programs.

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## **OCCUPATIONAL OBSERVATIONS**

The industry is moving toward energy saving, efficient and environmentally friendly construction techniques and devices such as alternative power and light emitting diode (LED) lighting.

Safety standards are becoming more emphasized and recognized in all aspects of the trade. Safety training is branching out to include new areas such as arc flash, safety management, and lock-out/tag-out. There is an understanding that power electricians have the responsibility to use their expertise on the worksite to assess risks, manage hazards and report issues as they arise.

More than ever, power electricians need to constantly upgrade their skills either through formal training, manufacturer's training or on the job training to stay current with new technologies such as test equipment, software, digital protection devices and insulating mediums.

Communication systems such as voice, data, audio, video and signalling are constantly evolving requiring power electricians to expand and upgrade their knowledge and abilities in fibre optics, satellite integration, and wireless and local area networks.

Power electricians use laptop or portable computers as a tool. They are used in daily tasks such as loading settings, transferring data and analyzing equipment.

## MAJOR WORK ACTIVITY A

## COMMON OCCUPATIONAL SKILLS

**Trends** Advancing technology in arc flash gear aids in worker safety. There are increased compliance requirements with health and safety regulations. New technology such as smartphones and electronic notebooks are being utilized to improve communication and completion of work tasks. Evolving technology increases efficiency of tools, equipment and materials used by power electricians.

### Task A-1

### Performs safety-related functions.

**Context** Power electricians are responsible for ensuring the safety of themselves and others in the work environment. It is critical that power electricians be constantly aware of their surroundings and the hazards they may encounter. They must comply with company and provincial regulations.

#### Required Knowledge

- A-1.K1 types of PPE such as hard hats, safety glasses, safety footwear, gloves, fall arrest equipment, respiratory protection equipment and arc flash rated clothing
- A-1.K2 types of safety equipment such as first aid kits, eye wash stations and emergency spill kits
- A-1.K3 certification and training requirements for PPE and safety equipment such as fall arrest and fire extinguishing equipment
- A-1.K4 workplace health and safety legislation and regulations including Workplace Hazardous Materials Information System (WHMIS) and transportation of dangerous goods (TDG) regulations
- A-1.K5 arc flashing ratings and regulations such as National Fire Protection Association (NFPA) 70E and Canadian Standards Association (CSA) Z462
- A-1.K6 lock-out and tagging procedures and legislation governing minimum standards
- A-1.K7 company- and site-specific policies and procedures including worker protection codes
- A-1.K8 safe work, working alone and confined space procedures
- A-1.K9 equipotential bonding practices

**Sub-task****A-1.01 Uses personal protective equipment (PPE) and safety equipment.****Key Competencies**

- A-1.01.01 identify site hazards and regulations requiring the use of PPE and safety equipment
  - A-1.01.02 locate and select PPE and safety equipment such as arc flash kits, fall protection, fire extinguishers and signage appropriate for individual tasks and situations
  - A-1.01.03 ensure proper fit of PPE such as respirators and face shields
  - A-1.01.04 perform pre-use inspection of PPE and safety equipment such as high voltage rubber gloves and FRP tools
  - A-1.01.05 report and replace damaged or faulty equipment
  - A-1.01.06 organize and clean PPE and safety equipment according to specifications
  - A-1.01.07 apply jurisdictional safety regulations
- 

**Sub-task****A-1.02 Maintains safe work environment.****Key Competencies**

- A-1.02.01 perform housekeeping practices
  - A-1.02.02 identify, report and correct potential and existing hazards
  - A-1.02.03 store PPE and safety equipment according to specifications
  - A-1.02.04 set up and identify location of safety zone containing components such as first aid kits, fire extinguishers, material safety data sheets (MSDS) and eye wash stations
  - A-1.02.05 document items such as inspections, potential hazards, safety meetings, injuries and trainings according to regulations
  - A-1.02.06 participate in safety and job planning meetings
  - A-1.02.07 enforce safe work practices
-

### **Sub-task**

**A-1.03**            **Performs lock-out and tagging procedures.**

### **Key Competencies**

- A-1.03.01            coordinate lock-out and tagging requirements with appropriate authorities and other trades
  - A-1.03.02            identify energy source for lock-out and tagging, and recognize other equipment that may present a hazard
  - A-1.03.03            select approved device to ensure proper lock-out and tagging according to regulations
  - A-1.03.04            test system for zero energy using equipment such as pressure gauge, voltmeters and high voltage testers
  - A-1.03.05            verify proper lock-out and tagging
- 

### **Sub-task**

**A-1.04**            **Installs and maintains temporary protective grounds (TPGs).**

### **Key Competencies**

- A-1.04.01            coordinate TPG requirements with appropriate authorities
- A-1.04.02            identify and isolate energy source prior to installation of TPGs
- A-1.04.03            select appropriate TPGs based on application requirements
- A-1.04.04            test and maintain TPGs for structural integrity and electrical continuity
- A-1.04.05            verify proper installation of TPGs

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## **Task A-2**

### **Uses and maintains tools and equipment.**

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

### **Required Knowledge**

- A-2.K1                types of hand tools such as screwdrivers, pliers, wrenches and measuring tapes, and their limitations

A-2.K2	types of power tools such as drills and saws, and their limitations
A-2.K3	types of powder-actuated tools, and their applications and accessories
A-2.K4	certification requirements to operate powder-actuated tools
A-2.K5	manufacturer's specifications, and operating and maintenance instructions
A-2.K6	types of electrical measuring equipment such as multimeters, voltage testers, non-contact voltage testers, insulation resistance meters, clamp ammeters and phase rotation meters
A-2.K7	applications, limitations and ratings of electrical measuring equipment
A-2.K8	types and use of fibreglass reinforced plastic (FRP) tools such as hot sticks, telescoping sticks and station sticks
A-2.K9	types of specialty tools such as knock-out punches, compression tools, diagnostic tools, benders and cutters, and their limitations
A-2.K10	types of access equipment such as scissor lifts, lift tables, portable scaffolds and articulated boom lifts, and their limitations
A-2.K11	certification requirements and regulations regarding the use of access equipment
A-2.K12	types of rigging, hoisting and lifting equipment and their limitations
A-2.K13	certification requirements regarding rigging, hoisting and lifting equipment

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### **Sub-task**

#### **A-2.01            Maintains tools and equipment.**

#### **Key Competencies**

A-2.01.01	organize and store tools and components according to specifications
A-2.01.02	clean, sharpen, lubricate and adjust tools and equipment according to specifications
A-2.01.03	calibrate measuring equipment according to specifications
A-2.01.04	identify worn, damaged and defective tools and equipment
A-2.01.05	change tool components such as bits, blades and crimping dies
A-2.01.06	replace tool components such as cords and attachment plugs

- A-2.01.07 repair tools according to specifications
  - A-2.01.08 identify hazards associated with tools and equipment
- 

**Sub-task**

**A-2.02 Uses access equipment.**

**Key Competencies**

- A-2.02.01 identify traffic areas and potential hazards such as confined spaces and trenches
  - A-2.02.02 install barricades and signage to contain work zone
  - A-2.02.03 select access equipment such as ladders, scissor-lifts, portable scaffolds, articulating booms, and confined entry equipment according to task
  - A-2.02.04 set up and secure step ladders and extension ladders
  - A-2.02.05 visually and mechanically inspect for worn, damaged and defective access equipment according to specifications, and update documentation
  - A-2.02.06 report, tag and decommission unsafe, worn, damaged and defective access equipment
  - A-2.02.07 organize and store access equipment according to specifications
- 

**Sub-task**

**A-2.03 Uses rigging, hoisting and lifting equipment.**

**Key Competencies**

- A-2.03.01 identify traffic areas and potential hazards such as confined spaces and trenches
- A-2.03.02 install barricades and signage to contain work zone
- A-2.03.03 use and interpret hand and audible signals
- A-2.03.04 select and secure rigging, hoisting and lifting equipment according to application
- A-2.03.05 ensure capacity of rigging, hoisting and lifting equipment according to specifications and provincial regulations
- A-2.03.06 visually and mechanically inspect for worn, damaged and defective rigging, hoisting and lifting equipment according to specifications

- A-2.03.07 report, tag and decommission unsafe, worn, damaged and defective rigging, hoisting and lifting equipment
  - A-2.03.08 secure load for application according to specifications, provincial regulations and company policy
  - A-2.03.09 clean, lubricate and store rigging, hoisting and lifting equipment
  - A-2.03.10 move load and secure at final position
- 

### **Sub-task**

#### **A-2.04 Uses technical instruments and testers.**

##### **Key Competencies**

- A-2.04.01 organize and store instruments and testers according to specifications
- A-2.04.02 calibrate instruments and testers according to specifications
- A-2.04.03 identify faulty, damaged and defective instruments and testers
- A-2.04.04 repair and maintain instruments, testers and their components according to specifications
- A-2.04.05 identify hazards associated with instruments and testers
- A-2.04.06 select appropriate instrument or tester based on application

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### **Task A-3**

#### **Organizes work and handles materials.**

**Context** Power electricians must be able to organize work and handle materials in a safe and effective manner relevant to the task performed. In addition, they must be able to safely fill and recover insulated gas- and oil-filled equipment.

##### **Required Knowledge**

- A-3.K1 company- and site-specific policies, procedures, operating manuals and other documentation
- A-3.K2 sources of reference information such as manufacturer's specifications, test results and internal bulletins
- A-3.K3 code rules and jurisdictional regulations



A-3.K4	scheduling and document retention protocols
A-3.K5	filling and recovering requirements for insulating gas- and oil-filled equipment
A-3.K6	related environmental hazards
A-3.K7	types and classifications of gas- and oil-filled equipment
A-3.K8	arc flash requirements

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### **Sub-task**

**A-3.01 Organizes work and uses documentation and reference materials.**

### **Key Competencies**

A-3.01.01	identify and select materials and supplies according to specifications and regulations
A-3.01.02	locate, order and schedule delivery of materials and supplies according to criteria such as storage availability, site schedule and product availability
A-3.01.03	load, unload and store materials and supplies according to factors such as installation sequence and specifications
A-3.01.04	coordinate shipping and receiving of materials and supplies
A-3.01.05	retrieve, record and distribute required documentation

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### **Sub-task**

**A-3.02 Finalizes required documentation.**

### **Key Competencies**

A-3.02.01	compile maintenance manuals from the manufacturer's specifications of installed equipment
A-3.02.02	submit required final documentation, including as-built drawings, and test results and procedures
A-3.02.03	retrieve, record and distribute required documentation
A-3.02.04	review final documentation and commissioning certificates
A-3.02.05	establish protocols for document revisions

- A-3.02.06 create station write ups and other technical documents
  - A-3.02.07 create instructions and procedures for operations and maintenance
- 

**Sub-task**

**A-3.03 Fills and recovers insulating gas-filled equipment.**

**Key Competencies**

- A-3.03.01 follow manufacturer's procedures for filling, recovering and drying insulating and inert gases
  - A-3.03.02 follow environmental regulations including proper documentation protocols
  - A-3.03.03 perform temperature correction calculations and percentage ratio by volume or weight
  - A-3.03.04 perform initial insulating gas sampling to check for moisture, gas percentage and presence of hazardous arc by-products
  - A-3.03.05 identify and select tools, fittings and specialized test equipment
  - A-3.03.06 handle, transport and store insulating and inert gas cylinders according to jurisdictional regulations
  - A-3.03.07 troubleshoot, test, locate, and repair leaks in the insulating gas-filled equipment
- 

**Sub-task**

**A-3.04 Fills and recovers insulating oil-filled equipment.**

**Key Competencies**

- A-3.04.01 follow manufacturer's procedures for filling, recovering and processing of insulating oil
- A-3.04.02 follow environmental regulations including proper documentation protocols
- A-3.03.03 test insulating oil for dielectric strength and submit for further analysis
- A-3.04.04 identify and select tools, fittings and specialized test equipment
- A-3.04.05 handle, transport and store insulating oil according to jurisdictional regulations
- A-3.04.06 troubleshoot, locate, and repair leaks in the insulating oil-filled equipment

- A-3.04.07 compare oil sample test results against established specifications and levels of contaminants, and take corrective actions
- A-3.04.08 perform routine and non-routine oil, syringe and gas sampling on insulating oil-filled equipment

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## **Task A-4**

### **Uses communication and mentoring techniques.**

**Context** Power electricians must be able to communicate and actively listen at different levels for work assignments, meetings, and working with others. Coaching and mentoring skills are essential to this trade when training apprentices.

#### **Required Knowledge**

- A-4.K1 trade terminology
- A-4.K2 effective verbal and non-verbal communication
- A-4.K3 types of communication and learning styles
- A-4.K4 personal responsibilities and attitudes including continuing education for effective work performance
- A-4.K5 harassment and discrimination policies
- A-4.K6 mentoring techniques and strategies for teaching workplace skills
- A-4.K7 techniques for providing feedback
- A-4.K8 organizational structure and communication protocols

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#### **Sub-task**

**A-4.01 Uses communication techniques.**

#### **Key Competencies**

- A-4.01.01 demonstrate two-way communication practices
- A-4.01.02 use active listening practices
- A-4.01.03 receive and respond to feedback on work

- A-4.01.04 use questioning to improve communication
  - A-4.01.05 participate in safety and information meetings
- 

### **Sub-task**

#### **A-4.02 Uses mentoring techniques.**

#### **Key Competencies**

- A-4.02.01 identify and communicate learning objectives
- A-4.02.02 demonstrate performance of a skill to an apprentice
- A-4.02.03 set up conditions required for an apprentice to practice a skill
- A-4.02.04 assess apprentice's ability to perform tasks with increasing independence
- A-4.02.05 give supportive and corrective feedback
- A-4.02.06 support apprentices in pursuing technical training opportunities
- A-4.02.07 support equity group apprentices
- A-4.02.08 implement probationary period for apprentices to assess their suitability to the trade

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### **Task A-5**

#### **Applies knowledge and technical skills.**

**Context** Power electricians must be able to interpret plans and drawings to install, maintain and troubleshoot electrical systems. Computers and specialized software are used to install and test electrical equipment and components. It is also important to be able to apply project management skills and use maintenance management software to complete project tasks and procedures on time.

#### **Required Knowledge**

- A-5.K1 trade terminology and types of nomenclature
- A-5.K2 company- and site-specific policies and procedures
- A-5.K3 sources of reference information such as manufacturer's specifications, test results, internal bulletins
- A-5.K4 code rules and jurisdictional regulations

A-5.K5	scheduling and project management
A-5.K6	types of blueprints and schematics
A-5.K7	types of computer programs and software
A-5.K8	mathematical concepts and scientific principles related to the power electrician trade

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### **Sub-task**

#### **A-5.01            Interprets plans, drawings and specifications.**

#### **Key Competencies**

A-5.01.01	identify American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE) standard C37.2 Electrical Power System device function numbers and acronyms found in drawings
A-5.01.02	scale dimensions to determine location of devices
A-5.01.03	locate and cross-reference information on plans, drawings, specifications and equipment manuals
A-5.01.04	utilize engineered and as-built drawings to troubleshoot, maintain and install equipment
A-5.01.05	determine if drawings are current and correct
A-5.01.06	document alterations by modifying drawings to reflect changes and additions made to original application

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### **Sub-task**

#### **A-5.02            Analyses and troubleshoots problems.**

#### **Key Competencies**

A-5.02.01	read and interpret drawings
A-5.02.02	identify problems and develop strategy to resolve
A-5.02.03	select tools, equipment and personnel to address the problem
A-5.02.04	determine if plans, schematics and drawings are current

- A-5.02.05 apply component- and system-level troubleshooting techniques
  - A-5.02.06 perform root cause analysis
- 

**Sub-task**

**A-5.03 Uses computers and software.**

**Key Competencies**

- A-5.03.01 configure ports for communication between computer and equipment such as relays, controllers, test equipment, and remote terminal units (RTUs)
  - A-5.03.02 diagnose and resolve problems
  - A-5.03.03 transmit and receive setting files, test plans, file extensions and databases using desktop, laptop, mobile and handheld computer devices
  - A-5.03.04 operate approved standard and proprietary software applications
  - A-5.03.05 access general office applications using desktop, laptop, mobile and handheld computer devices
  - A-5.03.06 apply electronic file management protocols
- 

**Sub-task**

**A-5.04 Plans project tasks and procedures.**

**Key Competencies**

- A-5.04.01 visually inspect work environment to determine scope of work from approved documentation
- A-5.04.02 determine labour and equipment requirements according to specifications
- A-5.04.03 establish and maintain schedules to meet project milestones and requirements
- A-5.04.04 coordinate work with other work groups and customers for requirements such as power outages and installation sequencing

**Trends** Arc flash reduction measures are increasingly emphasized and becoming the focus of training. There are increased regulatory requirements when performing energy control such as lock-out and tag-out procedures. Power electricians must have the ability to apply technical knowledge to maintain and operate aging power utility infrastructure to accommodate ever-increasing electricity requirements.

**Task B-6****Analyses system requirements**

**Context** Power electricians must be able to perform measurements and use the information obtained to perform three-phase loading calculations. It is also important to be able to write power system operating procedures.

**Required Knowledge**

- B-6.K1 load calculations
- B-6.K2 transfer schemes and alternate sources
- B-6.K3 system requirements, protocols and operating authority
- B-6.K4 station normal operating characteristics such as ampacity of conductors, rating and ampacity of transformers, circuit breakers, switches and fuses
- B-6.K5 station abnormal operating characteristics and limitations such as critical loads, vital issues and warning cards
- B-6.K6 equipment operation and interlocking mechanisms

**Sub-task**

**B-6.01 Determines operating procedures.**

**Key Competencies**

- B-6.01.01 verify the status of station equipment and compare to normal operating conditions
- B-6.01.02 compare load to system capacity
- B-6.01.03 determine alternate sources using single line station drawings

- B-6.01.04 determine tie points using system drawings
- B-6.01.05 develop contingency plans for potential failures

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**Sub-task**

**B-6.02 Performs loading calculations.**

**Key Competencies**

- B-6.02.01 perform single-phase and three-phase loading calculations
- B-6.02.02 interpret station loading using instruments such as panel meters, human machine interfaces (HMIs), ammeters, and other handheld devices
- B-6.02.03 interpret station drawings
- B-6.02.04 apply technical knowledge such as AC/DC theory
- B-6.02.05 use station readings and compare to system requirements for voltage, current and power
- B-6.02.06 interpret load profile templates and compare to historical and seasonal data

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**Task B-7**

**Performs energy control.**

**Context** Power electricians must be able to perform energy control according to established protocols and requirements. High voltage switching is performed when removing and restoring high voltage equipment and lines from the bulk electrical system. Low voltage switching is performed when removing and restoring low voltage equipment from the local distribution system.

**Required Knowledge**

- B-7.K1 local switching authorities and protocol
- B-7.K2 system switching authorities and protocol
- B-7.K3 station normal operating characteristics such as ampacity of conductors, rating and ampacity of transformers, circuit breakers, switches and fuses
- B-7.K4 station abnormal operating characteristics and limitations such as critical loads, vital issues and warning cards



B-7.K5	equipment operation and interlocking mechanisms
B-7.K6	safe work procedures including lock-out and tag-out procedures
B-7.K7	arc flash requirements
B-7.K8	types of mechanical systems and equipment such as air (compressed), gas (SF <sub>6</sub> , CF <sub>4</sub> , N <sub>2</sub> ), water and oil (hydraulic)

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### Sub-task

#### **B-7.01 Performs high voltage switching.**

#### **Key Competencies**

B-7.01.01	initiate operating procedures according to operating authority processes and information and data collected on-site
B-7.01.02	verify correctness of operating procedure based on information and data collected
B-7.01.03	communicate with operating authority
B-7.01.04	verify integrity of PPE such as rubber gloves, arc flash clothing and protective eyewear
B-7.01.05	verify functionality of potential indicators, TPG, and FRP tools
B-7.01.06	verify and adhere to electrical limits of approach for personal safety
B-7.01.07	perform high voltage switching techniques
B-7.01.08	perform testing and grounding techniques on de-energized equipment
B-7.01.09	determine documentation requirements according to operating authority and jurisdictional requirements such as station logbooks

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### Sub-task

#### **B-7.02 Performs low voltage switching.**

#### **Key Competencies**

B-7.02.01	perform operating procedures according to operating authority processes and information and data collected on-site
B-7.02.02	verify correctness of operating procedure based on information and data collected
B-7.02.03	communicate with operating authority

- B-7.02.04 verify integrity of PPE such as rubber gloves, arc flash clothing and protective eyewear
- B-7.02.05 verify functionality of potential indicators, temporary protective ground (TPG), and FRP tools
- B-7.02.06 verify and adhere to electrical limits of approach for personal safety
- B-7.02.07 perform low voltage switching techniques
- B-7.02.08 perform testing and grounding techniques on de-energized equipment
- B-7.01.09 determine documentation requirements according to operating authority and jurisdictional requirements such as station logbooks

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**Sub-task**

**B-7.03 Controls mechanical systems.**

**Key Competencies**

- B-7.03.01 perform mechanical systems control procedures according to operating authority processes and information and data collected on-site
- B-7.03.02 verify correctness of isolation procedures based on information and data collected
- B-7.03.03 communicate with operating authority
- B-7.03.04 verify integrity of PPE such as protective eyewear, hearing protection and arc flash clothing
- B-7.03.05 perform mechanical systems control operating techniques on systems such as compressed air systems, deluge and fire suppression systems and hydraulic systems
- B-7.03.06 perform testing and troubleshooting techniques on equipment such as air compressors, high voltage breakers, deluge and fire suppression equipment and hydraulic governors
- B-7.03.07 determine documentation requirements according to operating authority and jurisdictional requirements such as station logbooks

**Trends**

There has been an increased deployment of distribution supply centres (DSCs) that require different commissioning and maintenance procedures. Gas insulated switchgears (GIS) are replacing traditional open-air and oil-filled transmission equipment. There has been greater use of digital controls on all equipment such as protective relays, control and test equipment. Finally, there has also been an increased use of static VAR compensators (SVCs).

**Task C-8****Installs and maintains interruptive high voltage equipment.****Context**

Power electricians must have the knowledge and understanding of different types of interruptive high voltage equipment, their applications and limitations. Interruptive high voltage equipment is used to isolate and control the flow of electricity through the power utility system. Power electricians assemble, install, and maintain interruptive high voltage equipment where they use specific equipment, tests and procedures.

**Required Knowledge**

- C-8.K1 types and classification of interruptive high voltage equipment
- C-8.K2 types of arc extinguishing media
- C-8.K3 operating mechanisms for interruptive high voltage equipment such as solenoid, air and hydraulic
- C-8.K4 installation procedures for interruptive high voltage equipment
- C-8.K5 maintaining, troubleshooting, repairing and dismantling procedures
- C-8.K6 protocols for conducting integrity checks
- C-8.K7 components associated with interruptive high voltage equipment such as relays, metering and controls
- C-8.K8 test equipment procedures and manufacturer's specifications
- C-8.K9 code rules and jurisdictional regulations
- C-8.K10 related environmental hazards

**Sub-task****C-8.01            Installs and maintains automatic circuit reclosers (ACRs).****Key Competencies**

- C-8.01.01            distinguish between different types of ACRs such as oil, hydraulic, vacuum and gas.
  - C-8.01.02            determine installation requirements for ACRs
  - C-8.01.03            lay out and connect ACR control wiring
  - C-8.01.04            ground and bond according to specifications
  - C-8.01.05            operate computer software to install and test control settings
  - C-8.01.06            perform diagnostic testing with equipment such as electronic recloser tester, high potential tester, current injection and capacitance bridge
  - C-8.01.07            recover, install and test different types of arc extinguishing media such as gas, vacuum and insulating oil
- 

**Sub-task****C-8.02            Installs and maintains breakers and circuit switchers.****Key Competencies**

- C-8.02.01            install breaker and circuit switcher support structures
  - C-8.02.02            determine operating procedures for several types of breakers and circuit switchers
  - C-8.02.03            ground and bond according to specifications
  - C-8.02.04            determine installation requirements for breakers and circuit switchers
  - C-8.02.05            lay out and connect control wiring
  - C-8.02.06            perform diagnostic testing with equipment such as motion and timing analyzer, high potential tester, current injection, micro-ohmmeter and capacitance bridge
  - C-8.02.07            perform test analysis and compare to manufacturer's specifications
  - C-8.02.08            conduct visual test to ensure integrity and performance of all components
  - C-8.02.09            recover, install and test arc extinguishing media such as gas, vacuum and insulating oil
  - C-8.02.10            select and use gas-recovery apparatus
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## Sub-task

### **C-8.03            Installs and maintains disconnects.**

#### **Key Competencies**

- C-8.03.01            install disconnect and support structure
- C-8.03.02            determine operating procedures for several types of disconnects
- C-8.03.03            ground and bond according to specifications
- C-8.03.04            determine installation requirements for disconnects
- C-8.03.05            lay out and connect control wiring
- C-8.03.06            perform diagnostic testing with equipment such as a micro-ohmmeter
- C-8.03.07            perform test analysis and compare to manufacturer's specifications
- C-8.03.08            conduct visual test to ensure integrity and performance of all components
- C-8.03.09            maintain, replace and test vacuum interrupters
- C-8.03.10            maintain and test motor operated disconnect (MOD) drive mechanisms such as wiring, motors, interlock cam switches and dynamic brakes
- C-8.03.11            determine maintenance requirements for disconnects and related components such as bearings and drive linkages

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## **Task C-9**

### **Installs and maintains reactive high voltage equipment.**

**Context**            Power electricians must have the knowledge and understanding of different types of reactive high voltage equipment, their applications and limitations. Reactive high voltage equipment is used to condition or alter voltage and current in the power utility system. Power electricians assemble, install, and maintain reactive high voltage equipment where they use specific equipment, tests and procedures.

#### **Required Knowledge**

- C-9.K1            types and classification of reactive equipment such as power transformers, instrument transformers (current and potential), reactors, tap changers and regulators
- C-9.K2            characteristics of insulating oil and safe handling requirements

C-9.K3	reactive equipment and related components such as conservator, bushings, pressure relief devices (PRD), breathers and fast gas relays
C-9.K4	installation procedures for new reactive equipment
C-9.K5	maintaining, troubleshooting, repairing and dismantling procedures
C-9.K6	protocols for conducting integrity checks
C-9.K7	components associated with reactive high voltage equipment such as relays, metering and controls
C-9.K8	test equipment procedures and manufacturer's specifications
C-9.K9	code rules and jurisdictional regulations
C-9.K10	related environmental hazards
C-9.K11	equipment nameplate data
C-9.K12	commissioning and acceptance testing procedures

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### **Sub-task**

**C-9.01            Installs and maintains transformers and reactors.**

### **Key Competencies**

C-9.01.01	perform vacuum filling and processing techniques such as filling and draining insulating oil
C-9.01.02	interpret nameplate data such as ratios, vectors and transformer rating capacity
C-9.01.03	apply technical knowledge such as AC theory
C-9.01.04	maintain and test transformer and reactor components such as windings, bushings and insulating oil
C-9.01.05	conduct and analyse results from winding resistance, winding ratio and capacitance bridge tests
C-9.01.06	perform maintenance procedures on auxiliary components such as cooling fans, gas relays and fire suppression systems
C-9.01.07	conduct visual tests to ensure integrity and performance of all components
C-9.01.08	determine installation requirements for transformers and reactors

- C-9.01.09 lay out and connect control wiring
  - C-9.01.10 ground and bond according to specifications
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**Sub-task**

**C-9.02 Installs and maintains regulating and capacitive equipment.**

**Key Competencies**

- C-9.02.01 perform techniques such as filling and draining insulating oil
  - C-9.02.02 interpret nameplate data such as ratios, connection schemes and rating capacity
  - C-9.02.03 apply technical knowledge such as AC theory
  - C-9.02.04 maintain and test regulator components such as connections, bushings and insulating oil
  - C-9.02.05 conduct and analyse results from winding resistance and winding ratio tests on tap changers
  - C-9.02.06 perform maintenance procedures on controls
  - C-9.02.07 conduct visual tests to ensure integrity and performance of all components
  - C-9.02.08 conduct and analyse results from capacitance bridge tests on capacitive equipment
  - C-9.02.09 ground and bond according to specifications
- 

**Sub-task**

**C-9.03 Installs and maintains instrument transformers.**

**Key Competencies**

- C-9.03.01 perform commissioning and acceptance testing
- C-9.03.02 interpret nameplate data such as volt amp (VA) rating, burden, per-unit value and basic impulse level (BIL)
- C-9.03.03 apply technical knowledge such as AC theory
- C-9.03.04 install and maintain instrument transformer components such as windings, bushings and insulating oil
- C-9.03.05 conduct visual tests to ensure integrity and performance of all components

- C-9.03.06 determine installation requirements for instrument transformers
- C-9.03.07 lay out and connect secondary wiring
- C-9.03.08 conduct and analyse results from ratio, polarity, current injection and capacitance bridge tests
- C-9.03.09 ground and bond according to specifications

## **Task C-10**

### **Installs and maintains other high voltage equipment.**

#### **Context**

Power electricians must have the knowledge and understanding of different types of high voltage equipment, their applications and limitations. Other high voltage equipment includes grounding system, buswork, lightning arrestors, SVCs and HVDC equipment.

Grounding systems and lightning and surge arrestors are used for protection of personnel and equipment from hazardous voltages created by abnormal conditions within a power electrical system. HVDC equipment is used to convert high voltage alternating current to direct current for efficient long distance transmission in an electrical utility system.

#### **Required Knowledge**

- C-10.K1 types and classification of high voltage equipment such as buswork, lightning and surge arrestors, SVCs, HVDC equipment and grounding grid systems
- C-10.K2 installation procedures for other high voltage equipment such as buswork, lightning and surge arrestors, SVCs, HVDC equipment and grounding grid systems
- C-10.K3 maintaining, troubleshooting, repairing and dismantling procedures
- C-10.K4 protocols for conducting integrity checks
- C-10.K5 components associated with other high voltage equipment such as controls, high voltage connections and insulators
- C-10.K6 test equipment procedures and manufacturer's specifications
- C-10.K7 equipment nameplate data
- C-10.K8 commissioning and acceptance testing procedures
- C-10.K9 operating procedures for manufacturer-specific software



- C-10.K10 operating procedures for SVC and HVDC equipment
- C-10.K11 high-voltage concepts and related theory pertaining to AC/DC conversion processes
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**Sub-task**

**C-10.01 Installs and maintains grounding systems.**

**Key Competencies**

- C-10.01.01 applying grounding and bonding conductor size and ampacity
- C-10.01.02 maintain various grounding grid components
- C-10.01.03 identify equal-potential and step-potential hazards
- C-10.01.04 ground using specialized tools and techniques such as thermite welding, crimping and bolting
- C-10.01.05 perform micro-ohmmeter testing on grounding grid components
- C-10.01.06 detection of circulating currents
- C-10.01.07 conduct visual tests to ensure integrity and performance of all components
- C-10.01.08 perform measurements to determine appropriate applications of grounding systems such as soil resistivity and fall of potential
- 

**Sub-task**

**C-10.02 Installs and maintains buswork.**

**Key Competencies**

- C-10.02.01 install and maintain various types of buswork and related components according to manufacturer's specifications such as bus support clamps and insulators, gas insulated switchgear (GIS) and isolated phase buses
- C-10.02.02 determine installation requirements for buswork such as electrical clearances, ampacities, and environmental conditions
- C-10.02.03 ground and bond according to specifications
- C-10.02.04 perform diagnostic testing with equipment such as infrared scanner, high potential tester, micro-ohmmeter and capacitance bridge
- C-10.02.05 select appropriate buswork terminations to compensate for physical and

environmental factors such as oxidization, thermal expansion and contraction, and stress alleviation

C-10.02.06 conduct visual test to ensure integrity and performance of all components

C-10.02.07 install, test and recover gas insulating media

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### **Sub-task**

**C-10.03 Installs and maintains lightning and surge arrestors.**

### **Key Competencies**

C-10.03.01 install lightning and surge arrestors and support structures

C-10.03.02 ground and bond according to specifications

C-10.03.03 determine installation requirements for lightning and surge arrestors

C-10.03.04 conduct visual test to ensure integrity and performance of all components

C-10.03.05 perform diagnostic testing such as infrared scanning

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### **Sub-task**

**C-10.04 Installs and maintains static VAR compensators (SVCs).**

### **Key Competencies**

C-10.04.01 install SVCs and related components according to engineered specifications

C-10.04.02 apply operating procedures for SVCs

C-10.04.03 ground and bond according to specifications

C-10.04.04 lay out and connect control wiring

C-10.04.05 perform computer-based diagnostic tests, including fault tracing and alarm troubleshooting

C-10.04.06 perform test analysis and compare to manufacturer's specifications

C-10.04.07 conduct visual and electrical tests to ensure integrity and performance of all components

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**Sub-task**

**C-10.05            Installs and maintains high voltage direct current (HVDC) equipment.**

**Key Competencies**

- C-10.05.01        install HVDC equipment and related components according to engineered specifications
- C-10.05.02        apply operating procedures for HVDC equipment
- C-10.05.03        ground and bond according to specifications
- C-10.05.04        lay out and connect control wiring
- C-10.05.05        perform computer-based diagnostic tests, including fault tracing and alarm troubleshooting
- C-10.05.06        perform test analysis and compare to manufacturer's specifications
- C-10.05.07        conduct visual and electrical tests to ensure integrity and performance of all components
- C-10.05.08        maintain operation and functionality of the HVDC equipment

## MAJOR WORK ACTIVITY D

## LOW VOLTAGE EQUIPMENT

**Trends** There has been an increased deployment of light emitting diode (LED) lighting and other energy efficient lighting technologies. Increasing emphasis on solid-state module systems such as rectifiers and chargers. Greater use of digital controls on all equipment such as protective relays, control and test equipment.

### Task D-11

#### Installs and maintains low voltage distribution equipment.

**Context** Power electricians assemble, install, and maintain low voltage distribution equipment to ensure the integrity of the distribution system. The distribution system is comprised of low voltage transformers, breakers, buswork and load centers. This allows power to be safely distributed throughout switchyards, substations and generating stations to be used by auxiliary systems.

#### Required Knowledge

- D-11.K1 types and classification of low voltage distribution equipment
- D-11.K2 maintenance, troubleshooting and repair procedures
- D-11.K3 components associated with distribution equipment such as relays, metering, and power transfer schemes
- D-11.K4 test equipment procedures and manufacturer's specifications
- D-11.K5 installation according to code rules including conductor, raceway and protective device requirements
- D-11.K6 related environmental hazards
- D-11.K7 arc flash requirements

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#### Sub-task

**D-11.01 Installs and maintains transformers.**

#### Key Competencies

- D-11.01.01 determine installation requirements for transformers such as size, capacity and location

- D-11.01.02 interpret nameplate data such as ratios, vectors and transformer rating capacity
  - D-11.01.03 apply technical knowledge such as AC theory
  - D-11.01.04 ground and bond according to specifications
  - D-11.01.05 verify accuracy of installation and compliance with electrical code and engineered specifications
- 

**Sub-task**

**D-11.02 Installs and maintains breakers.**

**Key Competencies**

- D-11.02.01 install breakers and related components
  - D-11.02.02 determine operating procedures for low voltage breakers
  - D-11.02.03 lay out and connect control wiring
  - D-11.02.04 perform diagnostic testing with equipment such as breaker analyzer, high potential tester, current injection and micro-ohmmeter
  - D-11.02.05 perform test analysis and compare to manufacturer's specifications
  - D-11.02.06 determine installation requirements for low voltage breakers such as size, capacity and type
  - D-11.02.07 interpret nameplate data
  - D-11.02.08 apply technical knowledge such as AC and DC theory
  - D-11.02.09 ground and bond according to specifications
  - D-11.02.10 maintain and repair spring or solenoid operating mechanisms for breakers
  - D-11.02.11 verify accuracy of installation and compliance with electrical code and engineered specifications
- 

**Sub-task**

**D-11.03 Installs and maintains buswork and load centers.**

**Key Competencies**

- D-11.03.01 determine installation requirements for buswork such as electrical clearances, ampacities, and environmental conditions

- D-11.03.02 select appropriate buswork terminations to compensate for physical and environmental factors such as oxidization, thermal expansion and contraction, and stress alleviation
- D-11.03.03 install and maintain buswork, load centres and related components according to engineered specifications
- D-11.03.04 determine operating procedures for load centres such as low voltage transfer and load shedding schemes
- D-11.03.05 lay out and connect control wiring
- D-11.03.06 perform diagnostic testing with equipment such as infrared scanner, high potential tester and current injection
- D-11.03.07 interpret nameplate data
- D-11.03.08 apply technical knowledge such as AC, DC and three-phase theory
- D-11.03.09 ground and bond according to specifications
- D-11.03.10 verify accuracy of installation and compliance with electrical code and engineered specifications

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## **Task D-12**

### **Installs and maintains other low voltage equipment.**

**Context** Power electricians install and maintain customer metering to comply with government regulations. They install and maintain battery banks and power supplies for equipment operation and backup to ensure integrity of the system. Finally, power electricians install and maintain cathodic protection systems to prevent corrosion on underground equipment.

#### **Required Knowledge**

- D-12.K1 types and classification of other low voltage equipment
  - D-12.K2 installation, maintenance, troubleshooting and repair procedures
  - D-12.K3 components associated with low voltage equipment such as metering, battery banks and chargers, power supplies and cathodic protection
  - D-12.K4 test equipment procedures and manufacturer's specifications
  - D-12.K5 installation according to code rules and customer metering standards
  - D-12.K6 related environmental hazards
  - D-12.K7 arc flash requirements
-

**Sub-task****D-12.01            Installs and maintains metering systems.****Key Competencies**

- D-12.01.01        determine installation requirements for customer metering systems
  - D-12.01.02        select appropriate current transformer (CT), potential transformer (PT) and meter
  - D-12.01.03        interpret nameplate data such as ratios, vectors and polarity markings
  - D-12.01.04        apply technical knowledge such as single-phase and three-phase theory
  - D-12.01.05        ground and bond according to specifications
  - D-12.01.06        perform audit test with power circuit analyzer to verify accuracy of installation and compliance with jurisdictional requirements
- 

**Sub-task****D-12.02            Installs and maintains battery banks and chargers, and power supplies.****Key Competencies**

- D-12.02.01        determine installation requirements for battery banks and chargers such as size, capacity and location
  - D-12.02.02        determine installation requirements for inverters, rectifiers and uninterruptible power supplies (UPS) such as size, capacity and location
  - D-12.02.03        interpret nameplate data such as amp-hour rating (AHR), voltage levels, load amps and installation data
  - D-12.02.04        apply technical knowledge such as AC and DC theory
  - D-12.02.05        ground and bond according to specifications
  - D-12.02.06        perform diagnostic tests such as load test, specific gravity, voltage, ripple and output and battery conductivity
  - D-12.02.07        verify accuracy of installation and compliance with electrical code and engineered specifications
-

## Sub-task

**D-12.03 Installs and maintains cathodic protection systems.**

### Key Competencies

- D-12.03.01 determine installation and maintenance requirements for cathodic protection systems
- D-12.03.02 troubleshoot the cathodic protection system using equipment such as digital multi-meters (DVM), scope meters and other handheld instrument
- D-12.03.03 interpret nameplate data such as voltage and current
- D-12.03.04 apply technical knowledge such as AC and DC theory
- D-12.03.05 ground and bond according to specifications
- D-12.03.06 perform routine diagnostic tests to ensure system operates within engineered parameters
- D-12.03.07 verify accuracy of installation and compliance with electrical code and engineered specifications

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## **Task D-13**

### **Installs and maintains building systems equipment.**

**Context** Power electricians install and maintain building systems equipment such as HVAC and lighting in substations, HVDC and generating stations.

### Required Knowledge

- D-13.K1 types and classification of building systems equipment and lighting systems
  - D-13.K2 maintenance, troubleshooting and repair procedures
  - D-13.K3 components associated with building systems equipment such as lighting, HVAC, pressure systems and water systems
  - D-13.K4 test equipment procedures and manufacturer's specifications
  - D-13.K5 installation according to code rules including conductor, raceway and protective device requirements
  - D-13.K6 related environmental hazards and regulations
  - D-13.K7 arc flash requirements
  - D-13.K8 energy efficient lighting applications and technology such as LED
-



**Sub-task**

**D-13.01**            **Installs and maintains heating, ventilation and air conditioning (HVAC) systems.**

**Key Competencies**

- D-13.01.01        determine installation and maintenance requirements for HVAC systems
  - D-13.01.02        troubleshoot HVAC system using equipment such as DVM and other handheld instrument
  - D-13.01.03        interpret nameplate data such as heat output, air flow and temperature rise
  - D-13.01.04        apply technical knowledge such as AC and DC theory
  - D-13.01.05        ground and bond according to specifications
  - D-13.01.06        perform routine diagnostic tests to ensure system operates within engineered parameters
  - D-13.01.07        verify accuracy of installation and compliance with electrical code and engineered specifications
- 

**Sub-task**

**D-13.02**            **Installs and maintains lighting systems.**

**Key Competencies**

- D-13.02.01        determine installation and maintenance requirements for lighting systems
- D-13.02.02        troubleshoot lighting system using equipment such as DVM and other handheld instrument
- D-13.02.03        interpret nameplate data such as light output, current and voltage
- D-13.02.04        apply technical knowledge such as AC and DC theory
- D-13.02.05        ground and bond according to specifications
- D-13.02.06        verify accuracy of installation and compliance with electrical code

**Trends** Rotating machines are a mature technology but are benefiting from improved designs and construction methods. Power electricians must adapt new skills to operate and maintain rotating machines and related equipment. Excitation and governor systems are trending towards digital technology.

**Task E-14****Installs and maintains generators and synchronous condensers.**

**Context** Power electricians must have the knowledge to maintain and install governor and excitation systems related to hydraulic, thermal and combustion turbine generation. Synchronous condensers are used for system voltage stabilization and power factor correction. Power electricians must be able to connect and operate low voltage generators to provide power during emergency outages.

**Required Knowledge**

- E-14.K1 types and classification of rotating machines such as prime movers, generators and synchronous condensers
- E-14.K2 systems such as unit control monitoring systems (UCMS), excitation and governor systems, and related controls
- E-14.K3 theory and concepts associated with the operation of hydraulic, thermal, gas turbine and diesel prime movers
- E-14.K4 installation procedures for rotating machines
- E-14.K5 maintaining, troubleshooting, repairing and dismantling procedures
- E-14.K6 protocols for conducting integrity checks
- E-14.K7 auxiliary components associated with rotating machines such as head cover control, shaft seal and compressed air systems
- E-14.K8 test rotating machines using established procedures and manufacturer's specifications
- E-14.K9 code rules and jurisdictional regulations
- E-14.K10 related environmental hazards
- E-14.K11 operating procedures including stop-start, synchronizing generators

- E-14.K12 magnetism and AC and DC rotating machine theory
- E-14.K13 excitation equipment such as rotating exciters, solid-state excitation equipment, automatic voltage regulators (AVRs), amplidynes and pilot exciters
- E-14.K14 governor systems such as mechanical, hydraulic, electronic, digital and permanent magnet generators (PMGs)
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### **Sub-task**

**E-14.01 Installs and maintains high voltage generators and synchronous condensers.**

### **Key Competencies**

- E-14.01.01 adjust operating characteristics of high voltage generators and synchronous condensers including speed, power, frequency, voltage and power factor
- E-14.01.02 perform installation and related procedures for high voltage generators and synchronous condensers such as hydraulic, thermal, gas-turbine, wind-turbine and diesel prime movers
- E-14.01.03 perform operation of UCMS, and related controls
- E-14.01.04 apply theory and concepts associated with the operation of hydraulic, thermal, gas turbine and diesel prime movers
- E-14.01.05 perform maintenance, troubleshooting, repair and dismantling procedures
- E-14.01.06 conduct integrity checks
- E-14.01.07 measure speed, power, frequency, voltage and power factor
- E-14.01.08 perform diagnostic tests on high voltage generators and synchronous condensers
- E-14.01.09 identify and comply with related environmental licences and regulations
- E-14.01.10 perform operating procedures including stop-start, synchronizing generators
- E-14.01.11 apply magnetism and AC/DC rotating machine theory
- E-14.01.12 ground and bond according to specifications
- E-14.01.13 verify accuracy of installation and compliance with electrical code
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**Sub-task****E-14.02 Installs and maintains low voltage generators.****Key Competencies**

- E-14.02.01 adjust operating characteristics of low voltage generators including speed, power, frequency, voltage and power factor
  - E-14.02.02 perform installation and related procedures for low voltage generators, including prime power, portable, mobile and standby generators, and their prime movers
  - E-14.02.03 perform operation of low voltage generator system and related controls
  - E-14.02.04 apply theory and concepts associated with the operation of prime power, portable, mobile and standby generators
  - E-14.02.05 perform maintenance, troubleshooting, repair and dismantling procedures
  - E-14.02.06 conduct integrity checks
  - E-14.02.07 measure speed, power, frequency, voltage and power factor
  - E-14.02.08 perform diagnostic tests on low voltage generators
  - E-14.02.09 identify and comply with related environmental licences and regulations
  - E-14.02.10 perform operating procedures including stop-start, synchronizing generators
  - E-14.02.11 apply magnetism and AC/DC rotating machine theory
  - E-14.02.12 ground and bond according to specifications
  - E-14.02.13 verify accuracy of installation and compliance with electrical code
- 

**Sub-task****E-14.03 Installs and maintains excitation systems.****Key Competencies**

- E-14.03.01 adjust excitation systems to change generator output characteristics such as voltage and power factor
- E-14.03.02 perform installation and related procedures for excitation systems such as rotating and static
- E-14.03.03 perform operation of excitation system control using related interfaces
- E-14.03.04 apply theory and concepts associated with the operation of excitation systems

- E-14.03.05 perform maintenance, troubleshooting, repair and dismantling procedures for excitation systems and related components such as slip-rings, brush gear and commutators
  - E-14.03.06 conduct integrity checks
  - E-14.03.07 perform diagnostic tests on excitation systems such as step response and insulation tests
  - E-14.03.08 apply magnetism and AC/DC rotating machine theory
  - E-14.03.09 test and maintain high power rectifiers, silicon control rectifiers (SCRs), field rheostats and field breakers
  - E-14.03.10 ground and bond according to specifications
  - E-14.03.11 verify accuracy of installation and compliance with electrical code
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#### **Sub-task**

**E-14.04 Installs and maintains governor systems.**

#### **Key Competencies**

- E-14.04.01 adjust governor systems to change generator output characteristics such as speed and power
- E-14.04.02 perform installation and related procedures for governor systems such as mechanical, electrical, electronic governors
- E-14.04.03 perform operation of governor system control using related interfaces
- E-14.04.04 apply theory and concepts associated with the operation of governor systems
- E-14.04.05 perform maintenance, troubleshooting, repair and dismantling procedures for governor systems and related components such as permanent magnet generators (PMGs), gate limits, solenoids and selsyn drive transmitters
- E-14.04.06 conduct integrity checks
- E-14.04.07 perform diagnostic tests on governor systems such as speed no-load, speed droop and gate timing operation
- E-14.04.08 apply magnetism and AC/DC rotating machine theory
- E-14.04.09 ground and bond according to specifications
- E-14.04.10 verify accuracy of installation and compliance with electrical code

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**Task E-15****Installs and maintains motors.**

**Context** Power electricians must have the knowledge of high and low voltage motors and the controls that operate them.

**Required Knowledge**

- E-15.K1 types and classification of AC motors such as single phase, three phase, squirrel cage wound rotor, synchronous and induction
  - E-15.K2 types and classification of DC motors such as shunt, series and compound
  - E-15.K3 installation procedures for motors
  - E-15.K4 maintaining, troubleshooting, repairing and dismantling procedures
  - E-15.K5 protocols for conducting integrity checks
  - E-15.K6 auxiliary components associated with motors such as magnetic starters and overloads, frequency drives, interlock devices and soft starters
  - E-15.K7 test motors procedures and manufacturer's specifications
  - E-15.K8 code rules and jurisdictional regulations
  - E-15.K9 stop-start operating procedures
  - E-15.K10 magnetism and AC and DC rotating machine theory
- 

**Sub-task**

**E-15.01 Installs and maintains high voltage motors.**

**Key Competencies**

- E-15.01.01 perform installation and related procedures for high voltage motors and related starters
- E-15.01.02 apply magnetism and rotating machine theory and concepts
- E-15.01.03 perform maintenance, troubleshooting, repair and dismantling procedures
- E-15.01.04 perform diagnostic tests on high voltage motors such as insulation and winding resistance tests
- E-15.01.05 ground and bond according to specifications

- E-15.01.06 verify accuracy of installation and compliance with electrical code
  - E-15.01.07 interpret nameplate data such as full load amps, service factor, voltage, speed , type and class
- 

**Sub-task**

**E-15.02 Installs and maintains low voltage motors.**

**Key Competencies**

- E-15.02.01 perform installation and related procedures for low voltage motors and related starters
- E-15.02.02 apply magnetism and rotating machine theory and concepts
- E-15.02.03 perform maintenance, troubleshooting, repair and dismantling procedures
- E-15.02.04 perform diagnostic tests on low voltage motors such as insulation and winding resistance tests
- E-15.02.05 ground and bond according to specifications
- E-15.02.06 verify accuracy of installation and compliance with electrical code
- E-15.02.07 interpret nameplate data such as full load amps, service factor, voltage, speed , type and class

**Trends** Signalling and communication systems are trending towards digital technology. There is an increased use of wireless and networking communication protocols. Cyber security and related protocols are an increasing concern to meet industry standards.

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**Task F-16** **Installs and maintains protection systems.**

**Context** Power electricians must be able to install and maintain protection systems, which detect and isolate undesirable transient fault conditions within the electrical system. Fire detection and suppression equipment maintenance is performed by power electricians according to local authority having jurisdiction.

**Required Knowledge**

- F-16.K1 types and classification of protective relays such as electromechanical, electronic and digital, and their auxiliary components
  - F-16.K2 types and classification of fire detection equipment such as addressable, non-addressable and incipient , and their auxiliary components
  - F-16.K3 types and classification of fire suppression equipment such as water, inert gases and chemical agent, and their auxiliary components
  - F-16.K4 installation procedures for protection systems
  - F-16.K5 installation procedures for fire detection and suppression systems
  - F-16.K6 maintenance, troubleshooting and repairing procedures
  - F-16.K7 test equipment procedures and manufacturer’s specifications
  - F-16.K8 code rules and jurisdictional regulations
  - F-16.K9 AC theory, protection system design and relay nomenclature
-



**Sub-task****F-16.01            Installs and maintains protective relay systems.****Key Competencies**

- F-16.01.01        install protective relays based on engineered drawings and manufacturer's specifications
  - F-16.01.02        determine operating and maintenance procedures for protective relay schemes
  - F-16.01.03        perform diagnostic testing with equipment such as single-phase and three-phase power supply, relay testing software and related computer interface
  - F-16.01.04        perform test analysis and compare to manufacturer's specifications
  - F-16.01.05        interpret and install protective relay database and settings
  - F-16.01.06        apply technical knowledge such as AC and DC theory
  - F-16.01.07        determine and perform required maintenance of protective relays
  - F-16.01.08        perform functional testing of protective relay schemes
- 

**Sub-task****F-16.02            Installs and maintains fire-detection and suppression equipment.****Key Competencies**

- F-16.02.01        install fire detection and suppression equipment based on engineered drawings and manufacturer's specifications
- F-16.02.02        determine operating and maintenance procedures for fire detection and suppression equipment
- F-16.02.03        perform diagnostic and functional testing with specialized software and tools
- F-16.02.04        perform test analysis and compare to manufacturer's specifications
- F-16.02.05        verify accuracy of installation and compliance with electrical code
- F-16.02.06        verify operating and maintenance procedures for auxiliary equipment such as fire pump controls, flapper valves, compressed air systems and pilot valves

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**Task F-17****Installs and maintains control systems.**

**Context** Control systems are used to change the operational status of equipment from various locations within the transmission and generation systems. Instrumentation equipment is used to provide feedback or measurable data to a control system or visual display.

**Required Knowledge**

F-17.K1	types and classification of control systems such as electromechanical relay and microprocessor-based PLCs, HMIs, and their auxiliary components
F-17.K2	types and classification of instrumentation equipment and their auxiliary components
F-17.K3	types and classification of AC and DC motor controls and their auxiliary components
F-17.K4	installation procedures for control systems and instrumentation equipment
F-17.K5	maintenance, troubleshooting and repairing procedures
F-17.K6	test equipment procedures and manufacturer's specifications
F-17.K7	code rules and jurisdictional regulations
F-17.K8	AC and DC theory, control system design and relay nomenclature
F-17.K9	shielding, grounding and isolation applications

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**Sub-task**

**F-17.01 Installs and maintains relay and microprocessor-based (PLCs) control and monitoring systems.**

**Key Competencies**

F-17.01.01	install relay and microprocessor-based (PLCs) control and monitoring systems based on engineered drawings and manufacturer's specifications
F-17.01.02	determine operating and maintenance procedures for relay and PLC control and monitoring systems
F-17.01.03	access PLC programming for use of monitoring of process controls, including logic changes, upload/download, troubleshoot and file management
F-17.01.04	apply communication protocols

- F-17.01.05 perform functional testing of relay and PLC control and monitoring systems
- F-17.01.06 develop and modify controlled programs within a PLC using basic software architecture and programming languages such as ladder diagram, function block diagram and structured text
- 

### **Sub-task**

#### **F-17.02 Installs and maintains instrumentation equipment.**

##### **Key Competencies**

- F-17.02.01 select and install instrumentation equipment based on engineered drawings and manufacturer's specifications
- F-17.02.02 determine operating and maintenance procedures for instrumentation equipment
- F-17.02.03 troubleshoot transducers, panel instruments, and associated wiring and hardware
- F-17.02.04 apply communication and interpret data transmission protocols
- F-17.02.05 perform functional testing and calibration of instrumentation transducers such as voltage, current, speed, temperature and pressure
- F-17.02.06 verify accuracy of installation
- 

### **Sub-task**

#### **F-17.03 Installs and maintains AC and DC motor controls.**

##### **Key Competencies**

- F-17.03.01 determine installation requirements for AC and DC motor controls such as size, capacity type and location
- F-17.03.02 interpret nameplate data such as full load amps, service factor, voltage, speed, type and class
- F-17.03.03 select and install motor controls such as starters, speed controllers, push button stations and dynamic brakes
- F-17.03.04 apply technical knowledge such as AC and DC theory
- F-17.03.05 ground and bond according to specifications
- F-17.03.06 determine operating and maintenance procedures for motor controls

- F-17.03.07 verify accuracy of installation and compliance with electrical code
- F-17.03.08 troubleshoot and repair motor controls

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**Task F-18****Installs and maintains monitoring systems.**

**Context** Monitoring systems can be independent or part of a control system and they include building security and annunciation (monitoring) systems. Power electricians must be able to test and calibrate them.

**Required Knowledge**

- F-18.K1 types and classification of building security systems such as card key access, FOB access and video surveillance
- F-18.K2 types and classification of annunciation systems such as sequence of events annunciators (SEAs), sequence of events recorders (SERs), transient fault recorders (TFRs) and station annunciators
- F-18.K3 installation procedures for monitoring systems
- F-18.K4 maintenance, troubleshooting and repairing procedures
- F-18.K5 code rules and jurisdictional regulations
- F-18.K6 shielding, grounding and isolation applications

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**Sub-task****F-18.01 Installs and maintains building security systems.****Key Competencies**

- F-18.01.01 install building security equipment based on engineered drawings and manufacturer's specifications
- F-18.01.02 determine operating procedures for building security equipment
- F-18.01.03 verify accuracy of installation and compliance with electrical code
- F-18.01.04 perform functional testing and calibration of building security equipment, including commissioning procedures
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**Sub-task**

**F-18.02            Installs and maintains annunciation (monitoring) systems.**

**Key Competencies**

- F-18.02.01        install annunciation equipment based on engineered drawings and manufacturer's specifications
- F-18.02.02        determine operating and maintenance procedures for annunciation equipment
- F-18.02.03        verify accuracy of installation and compliance with electrical code
- F-18.02.04        perform functional testing and calibration of annunciation equipment, including commissioning procedures

## **APPENDICES**

**Standard Tools**

adjustable wrench	linesman pliers
awl	measuring tape
cable cutter	micrometer
calipers	needle nose pliers
camera	nut drivers
caulking gun	pipe benders
centre punch	pipe cutters
chalk line	pipe threader
cold chisel	pipe wrench
combination square	reamers (EMT and rigid)
combination wrench set	screwdrivers – Robertson, Philips, torx, flat, tamper-proof
crimping pliers	side/diagonal cutters
crowbar	slip joint pliers
drift punch set	snap ring pliers
drill bits	socket set
feeler gauge	speed wrench
files	tap and die set
fish tape	tin snips
flashlight	tool belt
fuse puller	tool nose bag
hack saw	trouble light
hammers	vise
hex key set	water pump pliers
keyhole saw	wire mike
knives	wire strippers
knockout cutter	wood chisel
level	

**Access Equipment**

articulated boom lift	lift table
boom lifts	scaffolds (rolling, mechanical, stationary, ladder jack)
bucket truck	scissor lift
ladders (extension, fixed, step)	

## Personal Protective Equipment and Safety Equipment

arc flash equipment	high-visibility clothing
arc rated clothing	high voltage rubber gloves
barricades	knee pads
confined space equipment	life line
ear plugs and muffs	lock-out/tag-out kit
eye wash facilities	portable light
face shield	pylons
fall arrest equipment	respirator
fall restraint device	rope grab
fibreglass reinforced plastic (FRP) tools	safety boots
fire blanket	safety glasses
fire extinguisher	safety harness
first aid equipment	safety vest
fume and toxic gas detector	signage
gloves	spill response equipment
goggles	ventilation equipment
grounding cables	warning tape
hard hat	work positioning belt

## Power Tools and Equipment

band saws	jig saw
battery/rechargeable drill	magnetic drill
bench grinder	nibbler
chop saw	power cable feeders
circular saw	power drill
cordless tools	power pipe bender
core drill	power pipe cutters
drill press	power pipe threader
grinder	power puller
heat gun	power reel lift
hammer drill	PVC bender
hole saw kit	reciprocating saw
hydraulic bender	sump pump
hydraulic crimper	vacuum



## Specialty Tools and Equipment

AC/DC power supplies	picks
bearing puller	pneumatic hoist
chain falls	portable generator
come-along	powder-actuated tools
communication devices (cell phones and VHF radio)	reel jacks
computer/laptop	rope
creepers and crawlers	shackles
extension cords	shovels
gasket cutter	sledgehammer
ground rod puller	slings
inverters	spud wrench
knock-out punch	soldering apparatus
laser level	strain relief grips
manual hoist	thermite (thermal) welding
	torque wrench

## Measuring Equipment

AC/DC ammeter	megohmmeter (insulation tester)
AC/DC voltmeter	micro-ohmmeter
atmospheric tester	motor rotation meter
battery analyser	multimeter
breaker analyzer	ohmmeter
cable locator	oil dielectric tester
capacitance bridge tester	oscilloscope
clip-on ammeter	phase rotation meter
density monitor tester	potential indicator
dew point tester	power quality analyser
event/data recorder	ratiometer
fast gas relay tester	recloser control analyser
fault locator	recording meter (watts, volts and amps)
frequency meter	resistance load box
ground fault tester	tachometer
ground megohmmeter	temperature calibrator
ground resistivity tester	thermographic imaging camera
hi-pot tester (dielectric tester)	thermometer (infra red and electronic)
high-current test set	transducer
inductive voltage detector	transformer ohmmeter
insulation resistance meter	ultrasonic testing equipment
LAN meter (cable analyser)	variable autotransformer (variac)
light meter	

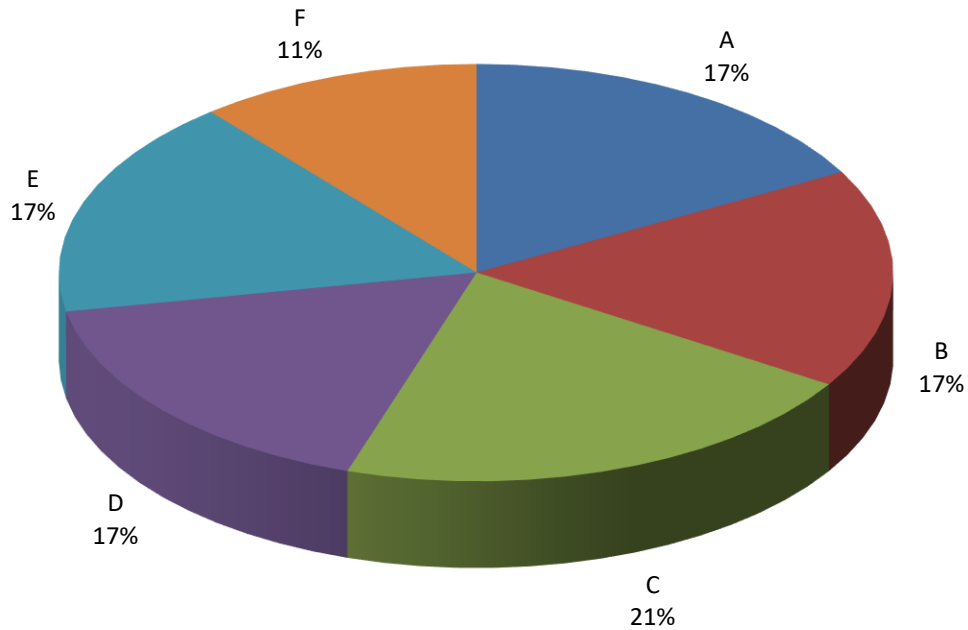
<b>bonding</b>	a low impedance path obtained by permanently joining all non-current carrying metal parts to assure electrical continuity and having the capacity to conduct safely any current likely to be imposed on it
<b>cathodic protection</b>	technique to control the corrosion of a metal surface by making that surface the cathode of an electrochemical cell
<b>commissioning</b>	the process of assuring that all components of a power utility system are designed, installed, tested, operated, and maintained according to the operational requirements
<b>converter</b>	a piece of equipment that changes electrical energy between AC and DC
<b>extra low voltage</b>	any voltage up to and including 30 volts
<b>generator</b>	a device that converts mechanical energy to electrical energy for use in an external circuit
<b>grounding</b>	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
<b>high voltage</b>	any voltage exceeding 750 volts
<b>lock-out/ tag-out</b>	a safety procedure necessary to shutoff and disable equipment thereby preventing the release of hazardous energy while employees perform servicing and maintenance
<b>low voltage</b>	any voltage exceeding 30 volts but not exceeding 750 volts
<b>transformer</b>	an electrical device that transfers electrical energy between two or more circuits through electromagnetic induction

<b>AC</b>	alternating current
<b>ACR</b>	automatic circuit recloser
<b>ANSI</b>	American National Standards Institute
<b>ARC</b>	arc-rated clothing
<b>DC</b>	direct current
<b>DVM</b>	digital multi-meters
<b>FRP</b>	fibreglass reinforced plastic
<b>HMI</b>	human machine interface
<b>HVAC</b>	heating, ventilation and air conditioning
<b>HVDC</b>	high voltage direct current
<b>IEEE</b>	Institute of Electrical and Electronics Engineers
<b>LED</b>	light emitting diode
<b>PLC</b>	programmable logic controller
<b>PMG</b>	permanent magnet generator
<b>PPE</b>	personal protective equipment
<b>SVC</b>	static VAR compensators
<b>TPG</b>	temporary protective ground
<b>UCMS</b>	unit control monitoring system

**APPENDIX D****MAJOR WORK ACTIVITY AND TASK WEIGHTING**

<b>MWA A</b>	<b>COMMON OCCUPATIONAL SKILLS</b>	<b>17%</b>
Task A-1	Performs safety-related functions.	23%
Task A-2	Uses and maintains tools and equipment.	20%
Task A-3	Organizes work and handles materials.	13%
Task A-4	Uses communication and mentoring techniques.	14%
Task A-5	Applies knowledge and technical skills.	30%
<b>MWA B</b>	<b>POWER UTILITY SYSTEMS</b>	<b>17%</b>
Task B-6	Analyses system requirements.	40%
Task B-7	Performs energy control.	60%
<b>MWA C</b>	<b>HIGH VOLTAGE EQUIPMENT</b>	<b>21%</b>
Task C-8	Installs and maintains interruptive high voltage equipment.	38%
Task C-9	Installs and maintains reactive high voltage equipment.	38%
Task C-10	Installs and maintains other high voltage equipment.	24%
<b>MWA D</b>	<b>LOW VOLTAGE EQUIPMENT</b>	<b>17%</b>
Task D-11	Installs and maintains low voltage distribution equipment.	43%
Task D-12	Installs and maintains other low voltage equipment.	36%
Task D-13	Installs and maintains building systems equipment.	21%
<b>MWA E</b>	<b>ROTATING MACHINES</b>	<b>17%</b>
Task E-14	Installs and maintains generators and synchronous condensers.	60%
Task E-15	Installs and maintains motors.	40%

<b>MWA F</b>	<b>SIGNALLING AND COMMUNICATION SYSTEMS</b>	<b>11%</b>
Task F-16	Installs and maintains protection systems.	42%
Task F-17	Installs and maintains control systems.	39%
Task F-18	Installs and maintains monitoring systems.	19%



**TITLES OF MAJOR WORK ACTIVITIES**

MWA A	Common Occupational Skills	MWA D	Low Voltage Equipment
MWA B	Power Utility Systems	MWA E	Rotating Machines
MWA C	High Voltage Equipment	MWA F	Signalling and Communication Systems

\*Average percentage of the total number of questions on a provincial examination, assigned to assess each major work activity of the occupational standard, as derived from the collective input from workers within the occupation. Provincial certification examinations typically have from 100 to 150 multiple-choice questions.

# APPENDIX F

# TASK PROFILE CHART – Power Electrician

MWA	TASKS	SUB-TASKS			
<b>A – COMMON OCCUPATIONAL SKILLS</b>	<b>A-1 Performs safety-related functions.</b>	A-1.01 Uses personal protective equipment (PPE) and safety equipment.	A-1.02 Maintains safe work environment.	A-1.03 Performs lock-out and tagging procedures.	A-1.04 Installs and maintains temporary protective grounds (TPGs).
	<b>A-2 Uses and maintains tools and equipment.</b>	A-2.01 Maintains tools and equipment.	A-2.02 Uses access equipment.	A-2.03 Uses rigging, hoisting and lifting equipment.	A-2.04 Uses technical instruments and testers.
	<b>A-3 Organizes work and handles materials.</b>	A-3.01 Organizes work and uses documentation and reference materials.	A-3.02 Finalizes required documentation.	A-3.03 Fills and recovers insulating gas-filled equipment.	A-3.04 Fills and recovers insulating oil-filled equipment.
	<b>A-4 Uses communication and mentoring techniques.</b>	A-4.01 Uses communication techniques.	A-4.02 Uses mentoring techniques.		
	<b>A-5 Applies knowledge and technical skills.</b>	A-5.01 Interprets plans, drawings and specifications.	A-5.02 Analyses and troubleshoots problems.	A-5.03 Uses computers and software.	A-5.04 Plans project tasks and procedures.
<b>B – POWER UTILITY SYSTEMS</b>	<b>B-6 Analyses system requirements.</b>	B-6.01 Determines operating procedures.	B-6.02 Performs loading calculations.		
	<b>B-7 Performs energy control.</b>	B-7.01 Performs high voltage switching.	B-7.02 Performs low voltage switching.	B-7.03 Controls mechanical systems.	

MWA	TASKS	SUB-TASKS				
<b>C – HIGH VOLTAGE EQUIPMENT</b>	<b>C-8 Installs and maintains interruptive high voltage equipment.</b>	C-8.01 Installs and maintains automatic circuit reclosers (ACRs).	C-8.02 Installs and maintains breakers.	C-8.03 Installs and maintains disconnects.		
	<b>C-9 Installs and maintains reactive high voltage equipment.</b>	C-9.01 Installs and maintains transformers and reactors.	C-9.02 Installs and maintains regulating and capacitive equipment.	C-9.03 Installs and maintains instrument transformers.		
	<b>C-10 Installs and maintains other high voltage equipment.</b>	C-10.01 Installs and maintains grounding systems.	C-10.02 Installs and maintains buswork.	C-10.03 Installs and maintains lightning and surge arrestors.	C-10.04 Installs and maintains static VAR compensators (SVCs).	
		C-10.05 Installs and maintains high voltage direct current (HVDC) equipment.				
<b>D – LOW VOLTAGE EQUIPMENT</b>	<b>D-11 Installs and maintains low voltage distribution equipment.</b>	D-11.01 Installs and maintains transformers.	D-11.02 Installs and maintains breakers.	D-11.03 Installs and maintains buswork and load centers.		
	<b>D-12 Installs and maintains other low voltage equipment.</b>	D-12.01 Installs and maintains metering systems.	D-12.02 Installs and maintains battery banks and chargers, and power supplies.	D-12.03 Installs and maintains cathodic protection systems.		
	<b>D-13 Installs and maintains building systems equipment.</b>	D-13.01 Installs and maintains heating, ventilation and air conditioning (HVAC) systems.	D-13.02 Installs and maintains lighting systems.			
<b>E – ROTATING MACHINES</b>	<b>E-14 Installs and maintains generators and synchronous condensers.</b>	E-14.01 Installs and maintains high voltage generators and synchronous condensers.	E-14.02 Installs and maintains low voltage generators.	E-14.03 Installs and maintains excitation systems.	E-14.04 Installs and maintains governor systems.	



MWA	TASKS	SUB-TASKS		
	<b>E-15 Installs and maintains motors.</b>	E-15.01 Installs and maintains high voltage motors.	E-15.02 Installs and maintains low voltage motors.	
<b>F – SIGNALLING AND COMMUNICATION SYSTEMS</b>	<b>F-16 Installs and maintains protection systems.</b>	F-16.01 Installs and maintains protective relay systems.	F-16.02 Installs and maintains fire-detection and suppression equipment.	
	<b>F-17 Installs and maintains control systems.</b>	F-17.01 Installs and maintains relay and microprocessor-based (PLC) control and monitoring systems.	F-17.02 Installs and maintains instrumentation equipment.	F-17.03 Installs and maintains AC and DC motor controls.
	<b>F-18 Installs and maintains monitoring systems.</b>	F-18.01 Installs and maintains building security systems.	F-18.02 Installs and maintains annunciation (monitoring) systems.	