Electrician

Occupational Analysis Report

August 2011

Commission
de la construction
du Québec

The purpose of this report is to describe as accurately as possible the electrician trade as currently practiced in Québec's construction industry. It is a record of discussions held by a group of workers who met for the occasion after industry partners recommended them to the Commission de la construction du Québec (CCQ) for their expertise in the trade.

The occupational analysis is a first step in the definition of the competencies required for practicing the trade. This report becomes one of the reference and decision-making tools used by the CCQ for teaching and learning purposes.

The present report does not bind the CCQ in any way. It has no legal effect and is meant as a reflection of discussions held on the date of the analysis workshop.

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The masculine gender is used generically in this document to facilitate reading.

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APPROVAL

This occupational analysis report was read and approved by Commission de la construction du Québec decision-makers and the following persons on the dates mentioned below:

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December 12, 2011

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INTRODUCTION

In early 2009, the CCQ's Direction de la formation professionnelle launched a large-scale operation to review the occupational analyses[1] of all construction industry trades.

The CCQ undertook this operation for many reasons, particularly the following:

- the project to reform the construction workforce apprenticeship and management system, and the eventual design of qualitative apprenticeship booklets requiring a detailed description of each trade;
- the fact that most construction occupational analyses[2] had been conducted between 1987 and 1991 and had not been reviewed since;
- updates to vocational qualification examination question banks;
- implementation of Chapter 7 of the Agreement on Internal Trade (AIT) and of the Québec-France Understanding on the Mutual Recognition of Professional Qualifications.

These factors demonstrate the necessity of updating the occupational analyses in order to obtain a current and complete provincial profile of the various trades. The analysis of the electrician trade belongs to this context[3]. Its purpose is to describe the trade as currently practiced by journeymen in the construction industry. The present report was written in order to collate and organize the information gathered during the occupational analysis workshop held in Laval on April 29 and 30 and on May 1, 2010, and during a workshop held in Montreal on June 22, 2011. The purpose of that second workshop was to collect additional data on electricians' tasks and operations that could not be collected during the first workshop[4].

This analysis aims to draw a portrait of the trade and its working conditions, and to identify the skills and behaviours required. The report of the occupational analysis workshop is an accurate reflection of the consensus reached by a group of experienced electricians. A special effort was made to include in this report all the data collected during the workshop and the follow-up day, and to ensure that the data accurately depict the realities of the trade analysed.

1. The terms "profession" and "trade" are considered synonymous.
2. Called "work situation analyses" at the time.
3. This occupational analysis was conducted according to the Cadre de référence et instrumentation pour l'analyse d'une profession produced in 2007 by the ministère de l'Éducation, du Loisir et du Sport (Direction générale de la formation professionnelle et technique) and the Commission des partenaires du marché du travail, ministère de l'Emploi et de la Solidarité sociale.
4. The first workshop had not collected sufficient information on the installation of grounding networks, cathodic protection, and automation and control systems.

1. GENERAL CHARACTERISTICS OF THE TRADE

1.1 DEFINITION OF THE TRADE

According to the Regulation respecting the vocational training of workforce in the construction industry (Sched. A, section 21), the term “electrician” means:

> […] anyone who performs construction, overhaul, alteration, repair or maintenance work on an electrical installation for lighting, heating and motive power purposes, including, in every instance, the electrical wires, cables, conduits, accessories, appliances and apparatus that form part thereof, that are attached thereto or that are used to connect the installation to the public utility or municipal services network supplying it, such connection point being located on the wall of the building or structure nearest to the public utility line.
>
> “Electrician” also means anyone who performs installation, overhaul, alteration, repair and maintenance work on various security systems such as fire alarms, burglar alarms, access cards and video cameras[5].
>
> […]
>
> Performance of the work described above includes trade-related handling for the purposes of immediate and permanent installation.

According to the participants, this definition has shortcomings with regard to:

- structured cabling installation;
- home and building automation;
- work on very low voltage installations;
- various start and stop devices and procedures;
- pre-operational verifications prior to commissioning;
- in-plant troubleshooting and maintenance work;

5. The electrician trade includes the specialty of security systems installer. That specialty has already been the object of an occupational analysis by the CCQ. The description of that specialty has therefore been withdrawn from the definition herein of the electrician trade, and journeymen who only hold a security systems installer certification were not invited to participate in this occupational analysis.

- control equipment calibration;
- doing welding work.

The participants specified that the specialty of security systems installer is an integral part of the trade and should figure in the portrait of the trade.

1.2 JOB TITLES

The job title used for describing the practice of the trade in this occupational analysis is “electrician,” and there are no other job titles for designating persons practicing the trade.

Job titles not to be confused with that of electrician are:

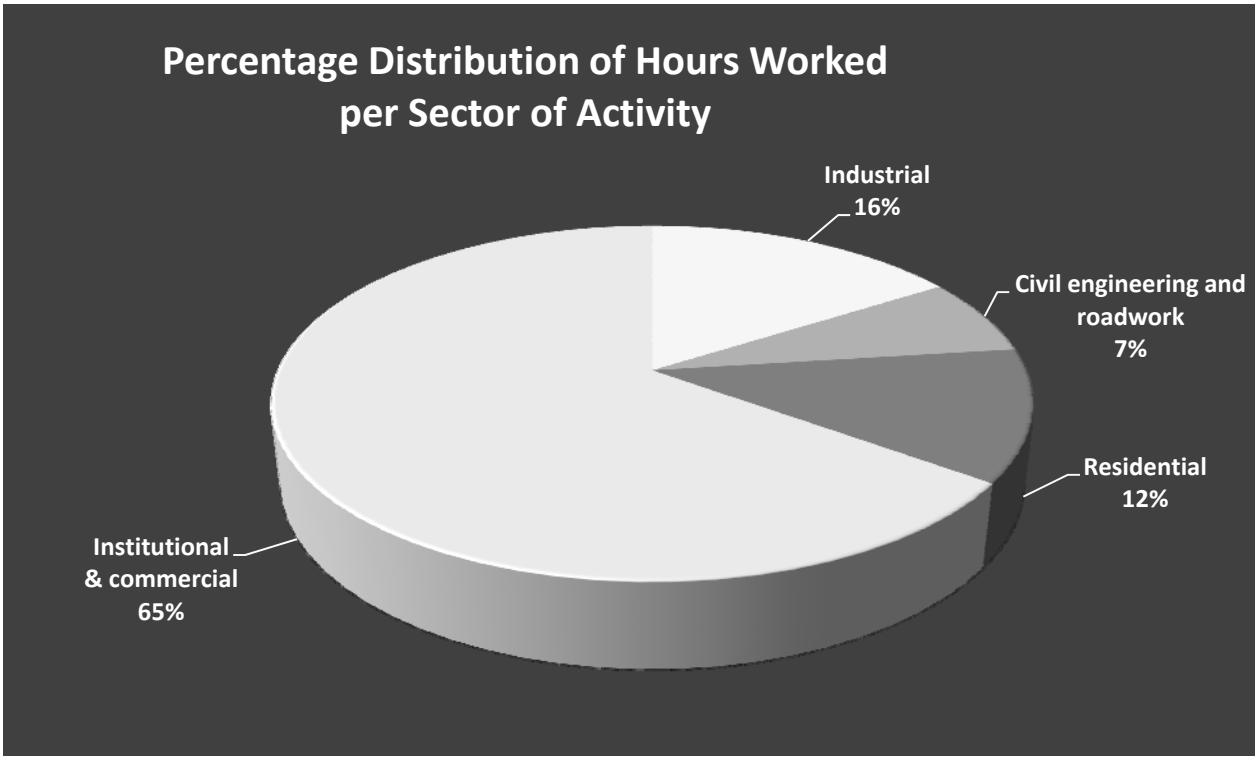
- instrumentation technician;
- electrodynamics technician.

1.3 SECTORS OF ACTIVITY

Electricians are active, to varying degrees, in the four sectors of the construction industry:

- civil engineering and roadwork;
- industrial;
- institutional and commercial;
- residential.

Below is the work distribution of electricians for the year 2008 per sector of activity[6]:



The electricians attending the workshop consider that this table corresponds well to their perception of areas where their trade is practiced. However, they emphasize that the percentage of the residential sector may be higher, given the tendency to under-declare the number of hours worked in this sector.

Asked about the sector of activity in which they work, five participants reported that they work mainly in the institutional and commercial sector; four reported working in the industrial sector; three in the civil engineering and roads sector; and one in the residential sector.

All the participants work in at least one other sector. Thus, six participants reported that they had also worked in the institutional and commercial sector; five in the civil engineering and roads sector; and two in the industrial sector.

6. Commission de la construction du Québec, *Carrières construction*, Québec City, 2009-2010 edition.

1.4 FIELD OF PRACTICE

The trade's field of practice is the construction industry. The Act respecting labour relations, vocational training and workforce management in the construction industry (R.S.Q., c. R-20) defines construction as follows:

> […] the foundation, erection, maintenance, renewal, repair, alteration and demolition work on buildings and civil engineering works carried out on the job site itself and vicinity including the previous preparatory work on the ground;
>
> In addition, the word "construction" includes the installation, repair and maintenance of machinery and equipment, work carried out in part on the job site itself and in part in the shop, moving of buildings, transportation of employees, dredging, turfing, cutting and pruning of trees and shrubs and laying out of golf courses, but solely in the cases determined by regulation.

1.5 LEGISLATION, REGULATIONS AND STANDARDS

The construction industry's electricians are subject to:

- the Act respecting labour relations, vocational training and workforce management in the construction industry (R.S.Q., c. R-20);
- the Regulation respecting the vocational training of workforce in the construction industry (R-20, r.6.2);
- the four sector-based collective agreements of the construction industry;
- the National Building Code (NBC);
- the Canadian Electrical Code;
- the Quebec Building Code, Chapter I, "Building" and Chapter V, "Electricity;"
- the Building Act, Chapter II, "Electricity" (R.S.Q., c. B-1.1);
- the Act Respecting Occupational Health and Safety (R.S.Q., c. S-2.1);
- the Safety Code for the construction industry (R.Q., c. S-2.1, r.6);
- municipal bylaws (for example, with regard to working times, sound levels, standards for overhead and underground electrical inputs, etc.).

In addition, the work of electricians must meet the requirements of several applicable standards:

- Hydro-Québec;
- The Underwriters' Laboratories of Canada (ULC standards);
- Canadian Standards Association (CSA standards);
- Occupational Health and Safety Assessment Series (OHSAS standards)
- International Organization for Standardization (ISO standards);
- customers' specific standards (particularly for the industrial sector and the civil engineering and roads sector).

1.6 WORKING CONDITIONS

The following data give an overview of the conditions and context of electricians' work, as commented by the participants in the occupational analysis workshop. To obtain up-to-date and complete information that has legal effect, it is necessary to refer to the four collective agreements of the construction industry sectors.

Salary

The average annual salary of a construction industry electrician was $45,222 for the year 2008. A journeyman's *hourly* wage varies somewhat according to the sector of activity. At April 4, 2009, the daily hourly wage was as follows[7]:

- Industrial. institutional and commercial: $32.54
- Civil engineering and roads: $32.52
- Light residential: $30.98
- Heavy residential: $32.50

7. The salary data are taken from the four 2007-2010 collective agreements of the construction industry (salary annexes) and from the following document, published by the Commission de la construction du Québec: *Faits saillants des conventions collectives sectorielles de l'industrie de la construction 2007-2010*.

Vacations and time off

Mandatory annual holidays of four weeks – two weeks in summer and two in winter at periods predetermined in collective agreements – are the general rule in the construction industry. To avoid penalizing employers and employees experiencing special constraints, the industry's four collective agreements allow certain possibilities for changing the vacation periods prescribed by the general rule.

To these vacation periods are added eight not worked statutory holidays, as well as a lump sum for sick leaves not otherwise paid.

Pension plan

Construction industry workers participate in a pension plan. They retain their eligibility for this pension plan throughout their career in construction, even if they change employer, trade or sector.

Insurance

The group insurance plan (medications, illness, disability, death) is fully paid by employers. Workers (and their families, as the case may be) are eligible as long as they remain active in the construction industry and work the required number of hours, whether or not they change employer.

Physical requirements

According to the participants, electricians need resistance and good physical strength. They also need dexterity when handling small components. Good vision is indispensable.

Work schedules

A 40-hour work week from Monday to Friday is the general rule in all construction industry sectors.

The daily limit is 8 hours a day, except in the light residential sector, where it can be 10 hours within a 40-hour week.

To avoid penalizing employers and employees experiencing special constraints, the industry's four collective agreements allow many possibilities for changing the schedule prescribed by the general rule: compressed schedule, schedule shift, make-up time in light residential construction, etc. These special schedules confer flexibility to the work schedules in effect in the construction industry.

According to the participants, certain electricians may work in the evening on major construction sites or renovation work, or they may work during the weekend during planned maintenance stoppages in plants. On certain construction sites, safety is a factor in determining work schedules.

Stress factors

The electrician trade has many stress factors. Electrocution and electrification hazards are real, particularly in the case of live-line work.

The consequences for customers and the public as a result of inadequate work execution are also stress factors. Electricians are accountable for accidents under the Criminal Code.

Finally here are other stress factors mentioned by the electricians attending the analysis:

- working under pressure and under tight deadlines;
- coordinating work with other trades;
- the absence of uniform lockout procedures;
- emergencies due to power failures;
- periods of unemployment.

1.7 WORK ORGANIZATION

Electricians work under the supervision of a team leader, foreman or project manager. The work is done in a team, most often in parallel.

1.8 JOB MARKET ENTRY CONDITIONS[8]

To obtain the competency certificate-apprentice in the trade, candidates must present to the CCQ the original version of an academic transcript or apprenticeship transcript attesting that they have passed a program of study recognized by the CCQ and giving access to the industry[9], notably the DEP in electricity, as well as a guarantee of employment from an employer registered with the CCQ for at least 150 hours within a period of not more than three consecutive months.

Although the construction industry favours graduates for access to the trade, labour shortages may at times make it necessary to admit candidates without a diploma. Thus, candidates without a diploma[10] are eligible to obtain a competency certificate-apprentice only during a labour shortage and must:

- Supply proof that they have the academic prerequisites for the program leading to a vocational studies diploma (DEP) in the trade referred to in the application or pledge, by signing a consent letter, to take the necessary training to obtain those prerequisites;
- Present a guarantee of employment registered during a labour-pool opening by an employer registered with the CCQ, for at least 150 hours over a period of at most three consecutive months.

The apprentice electrician must have completed four apprenticeship periods of 2,000 hours each (8,000 hours in total) in his trade, in order to be eligible for the provincial qualification examination that, successfully passed, leads to obtaining the competency certificate-journeyman for the trade. Credits are paid into the apprenticeship record book of an apprentice electrician who has obtained his diploma.

8. Other conditions than those listed above may apply. For a complete list of conditions for entering the trade, see the Act respecting labour relations, vocational training and workforce management in the construction industry (R.S.Q., c. R-20). You can also consult the CCQ's website: http://www.ccq.org/E_CertificatsCompetence.aspx?sc_lang=en&profil=DevenirTravailleur
9. Several vocational and college programs of study in electricity and electrical engineering give access to the industry for this trade. See the list of those programs in Annex 3.
10. All the participants in the analysis held a diploma in electricity, and several had taken retraining programs and customized training.

The participants also mentioned that there existed a qualification certificate issued by Emploi-Québec and pertaining to non-construction work, i.e., outside the scope of the Act respecting labour relations, vocational training and workforce management in the construction industry[11] (R.S.Q., c. R-20).

Finally, certain qualities are sought by employers hiring new electricians. The following list presents the main qualities, in the order they were mentioned and not in order of importance:

- mobility;
- versatility or experience in a specific field;
- punctuality;
- performance;
- working quickly, particularly in the residential sector.

1.9 PLACE OF WOMEN IN THE TRADE

Section 126.0.1 of the Act respecting labour relations, vocational training and workforce management in the construction industry pertains to women's access to the construction industry: "The Commission, after consultation with the Commission des droits de la personne et des droits de la jeunesse, shall develop measures to favour the access of women to and their maintenance and greater representation on the labour market in the construction industry."

According to the CCQ, 140 practiced the electrician trade in 2008 (out of a total of 14,272 electricians, i.e., a proportion of almost 1%)[12].

In the view of the electricians in attendance, the low presence of women could be explained by the trade's substantial physical requirements and by the persistence of some prejudice.

11. No participant held this certificate at the time of the occupational analysis.
12. Commission de la construction du Québec, *Carrières construction*, Québec City, 2009-2010 edition.

1.10 CAREER PROSPECTS

With experience, electricians can become team leaders, foremen, job-site stewards, project managers or superintendents.

They can also become master electricians and be members of the Corporation des maîtres électriciens du Québec (CMEQ). That corporation groups all electrical contractors across the province[13].

Electricians can have access to other careers, such as:

- inspector for the Régie du bâtiment du Québec or for the CCQ;
- appraiser;
- instrumentation technician;
- teacher;
- union representative;
- prevention officer.

1.11 DEVELOPMENT OF THE TRADE

The trade is undergoing major changes, with the arrival of wind turbines and solar collectors, improving electronic products (particularly control and operating devices), new earthquake-resistant installations, more frequent use of structured cabling, the development of various network communication protocols, the implementation of home and building automation, etc.

Moreover, the participants emphasized that more and more devices are equipped with one or more plugs to connect them directly, that many systems are delivered prewired, and that certain devices can now self-calibrate. The work is thereby changed, because electricians install less connectors and pass less wires than previously. Their intervention is therefore shortened.

These technological changes oblige electricians to continually keep their knowledge up-to-date.

13. Source: https://www.cmeq.org/accueil/affichage.asp?B=618.

1.12 IMPACT OF ENVIRONMENTAL STANDARDS ON THE PRACTICE OF THE TRADE

According to the participants, energy-efficiency policies, the growth of recycling activities with LEED sites, the tightening of environmental standards and the increase in the number of qualifications could lead to an increased workload in coming years.

2. WORK DESCRIPTION

2.1 TASKS AND OPERATIONS

List of tasks

The following list presents the main tasks performed by electricians. The order in which the tasks are presented does not necessarily reflect their importance in the trade.

Task 1 Install high-voltage distribution and bypass systems

Task 2 Install low-voltage distribution systems

Task 3 Install residential distribution, bypass and home automation systems

Task 4 Install lighting systems

Task 5 Install heating, air conditioning and ventilation systems

Task 6 Put in place and connect motive forces

Task 7 Install emergency power systems

Task 8 Install alarm and monitoring systems

Task 9 Install telephone and intercom systems

Task 10 Install automation and control systems for industrial and building equipment

Task 11 Install cathodic protection systems

Task 12 Maintain, repair and troubleshoot electrical and structured cabling systems

For the purposes of the present report, the definition of voltage is that of the Quebec Construction Code, Chapter V, “Electricity”:

High voltage: voltage higher than 750 V

Low voltage: voltage higher than 30 V and at most 750 V

Very low voltage: voltage not exceeding 30 V

The table of electricians’ tasks and operations is presented in the following pages.

Table 2.1 Tasks and Operations

TASKS	OPERATIONS									
1. INSTALL HIGH-VOLTAGE DISTRIBUTION AND BYPASS SYSTEMS	1.1	Interpret plans and specifications	1.2	Prepare the work	1.3	Build a grounding network	1.4	Install pipes, cabletroughs and raceways	1.5	Prepare the electrical distribution room	1.6	Install three-phase transformers
	1.7	Install power factor correction capacitors	1.8	Pull high-voltage and control cables	1.9	Install control and operating devices	1.10	Make connections	1.11	Make pre-start-up verifications	1.12	Activate the distribution and bypass system
	1.13	Demobilize the construction site	1.14	Write reports								
2. INSTALL LOW-VOLTAGE DISTRIBUTION SYSTEMS	2.1	Interpret plans and specifications	2.2	Prepare the work	2.3	Build a grounding network	2.4	Install pipes, cabletroughs and raceways	2.5	Prepare the electrical distribution room	2.6	Install single-phase and three-phase transformers
	2.7	Install power factor correction capacitors	2.8	Make pre-start-up verifications	2.9	Activate the distribution system	2.10	Clean the workplace or demobilize the construction site	2.11	Write reports		
3. INSTALL RESIDENTIAL DISTRIBUTION, BYPASS AND HOME AUTOMATION SYSTEMS	3.1	Interpret plans and specifications and find out the customer's load requirements	3.2	Install the meter socket	3.3	Install the electrical mast or the conduit	3.4	Install the electrical panel	3.5	Pass the wires	3.6	Connect the wires
	3.7	Do the grounding	3.8	Install outlet boxes	3.9	Pass the cables	3.10	Make the connections	3.11	Do the finishing work	3.12	Clean the workplace
	3.13	Write reports										

TASKS	OPERATIONS									
4. INSTALL LIGHTING SYSTEMS	4.1	Interpret plans and specifications	4.2	Prepare the work	4.3	Install pipes, cabletroughs and raceways	4.4	Install lighting supply and distribution panels	4.5	Install control and operating panels	4.6	Install control switches or systems
	4.7	Install lighting fixtures	4.8	Make connections	4.9	Check the lighting system's operation	4.10	Activate the lighting system	4.11	Clean the workplace or demobilize the construction site	4.12	Write reports
5. INSTALL HEATING, AIR CONDITIONING AND VENTILATION SYSTEMS	5.1	Interpret plans and specifications	5.2	Prepare the work	5.3	Install pipes, cabletroughs and raceways and pass cables	5.4	Install heating supply and distribution panels	5.5	Install control and operating panels	5.6	Install heating, air conditioning and ventilation units
	5.7	Install control and operating devices	5.8	Make connections	5.9	Make pre-start-up verifications	5.10	Activate the heating, air conditioning and ventilation system	5.11	Clean the premises or demobilize the construction site	5.12	Write reports
6. PUT IN PLACE AND CONNECT MOTIVE FORCES	6.1	Interpret plans and specifications	6.2	Prepare the work	6.3	Build a grounding network	6.4	Put motive force devices in place	6.5	Install pipes, cabletroughs and raceways	6.6	Install the control system for motive force devices (MCC)
	6.7	Install control and operating panels	6.8	Install control and operating devices	6.9	Pull the conductors or cables	6.10	Make connections	6.11	Take measurements	6.12	Make pre-start-up verifications
	6.13	Activate motive force devices	6.14	Clean the workplace or demobilize the construction site	6.15	Write reports						

TASKS	OPERATIONS									
7. INSTALL EMERGENCY POWER SYSTEMS	7.1	Interpret plans and specifications	7.2	Prepare the work	7.3	Prepare the electrical distribution room for generators and batteries	7.4	Install pipes, cabletroughs and raceways	7.5	Build a grounding network	7.6	Install generators
	7.7	Install batteries	7.8	Pull the cables	7.9	Check the continuity	7.10	Install control and operating devices	7.11	Make connections	7.12	Make pre-start-up verifications
	7.13	Participate in the activation of the emergency power system	7.14	Clean the workplace or demobilize the construction site	7.15	Write reports						
8. INSTALL ALARM AND MONITORING SYSTEMS	8.1	Interpret plans and specifications	8.2	Prepare the work	8.3	Install pipes and cabletroughs	8.4	Do the grounding	8.5	Install structured cabling	8.6	Install surveillance cameras
	8.7	Install a fire alarm system	8.8	Install an intrusion alarm system	8.9	Install an access control system	8.10	Make connections	8.11	Check the operation of systems	8.12	Activate the systems
	8.13	Clean the workplace or demobilize the construction site	8.14	Write reports								
9. INSTALL TELEPHONE AND INTERCOM SYSTEMS	9.1	Interpret plans and specifications	9.2	Prepare the work	9.3	Install conduits and cabletroughs	9.4	Build a grounding network	9.5	Install structured cabling	9.6	Install the telephone and intercom equipment
	9.7	Make connections to the main housing	9.8	Check the operation of systems	9.9	Activate the telephone and intercom systems	9.10	Clean the workplace	9.11	Write reports		

TASKS	OPERATIONS											
10. INSTALL AUTOMATION AND CONTROL SYSTEMS FOR INDUSTRIAL AND BUILDING EQUIPMENT	10.1	Interpret plans and specifications	10.2	Prepare the work	10.3	Install pipes and cabletroughs	10.4	Do the grounding	10.5	Install structured cabling	10.6	Install control and operating devices
	10.7	Install control and operating panels	10.8	Make connections	10.9	Make pre-start-up verifications	10.10	Activate the system	10.11	Clean the workplace or demobilize the construction site	10.12	Write reports
11. INSTALL CATHODIC PROTECTION SYSTEMS	11.1	Interpret plans and specifications	11.2	Prepare the work	11.3	Do the grounding	11.4	Install the cathodic protection box	11.5	Install pipes or cabletroughs	11.6	Install the terminal box
	11.7	Install conduits and cabling between the cathodic protection box and the terminal box	11.8	Install conduits between the terminal box and the ends of the conduit or instrumentation to be protected	11.9	Install pads at the ends of the conduit or instrumentation to be protected	11.10	Activate the system	11.11	Clean the workplace or demobilize the construction site	11.12	Write reports
12. MAINTAIN, REPAIR AND TROUBLESHOOT ELECTRICAL AND STRUCTURED CABLING SYSTEMS	12.1	Answer a service call, if applicable	12.2	Make a diagnosis	12.3	Prepare the work	12.4	Do preventive maintenance	12.5	Replace devices	12.6	Replace panels and mechanisms
	12.7	Replace cables and conductors	12.8	Make pre-start-up verifications	12.9	Help reactivate the electrical system or the structured cabling system	12.10	Clean the workplace or demobilize the construction site	12.11	Write reports		

2.2 OPERATIONS, SUB-OPERATIONS AND CLARIFICATIONS

In the following pages are presented the sub-operations related to some of the operations, as well as a few clarifications made by the participants.

Table 2.2 Sub-Operations and Operation Clarifications

TASK 1 INSTALL HIGH-VOLTAGE DISTRIBUTION AND BYPASS SYSTEMS

Operations	Sub-Operations	Clarifications
1.1 Interpret plans and specifications	1.1.1 Check whether there are addendas or whether modifications have been made 1.1.2 Check whether there is ongoing work done by other trades 1.1.3 Check the loads	
1.2 Prepare the work	1.2.1 Draw the list and order the equipment 1.2.2 Check the equipment 1.2.3 Handle equipment 1.2.4 Check the tools 1.2.5 Put in place site shacks and containers 1.2.6 Take part in site meetings and the daily news 1.2.7 Install a temporary power supply	
1.3 Build a grounding network	1.3.1 Install a ground grid or ground plates 1.3.2 Push the grounding rod in 1.3.3 Install inert lightning rods 1.3.4 Pull the grounding cables 1.3.5 Make aluminothermic welds (Cadweld welds) 1.3.6 Install compression lugs 1.3.7 Bolt or make tightening torques 1.3.8 Take measurements 1.3.9 Install one or more busbars	
1.4 Install pipes, cabletroughs and raceways	1.4.1 Cut pipes, cabletroughs and raceways 1.4.2 Bend the pipes 1.4.3 Put pipes, cabletroughs and raceways in place	
1.5 Prepare the electrical distribution room	1.5.1 Drill the concrete 1.5.2 Handle rigging and handling equipment 1.5.3 Install: - cabinets or cubicles - the power supply and bypass cabinet - the changeover system - the control panels - other panels 1.5.4 Drill holes in the panels 1.5.5 Weld 1.5.6 Prepare the battery room	

TASK 1 INSTALL HIGH-VOLTAGE DISTRIBUTION AND BYPASS SYSTEMS

Operations	Sub-Operations	Clarifications
1.6 Install three-phase transformers	1.6.1 Handle and rigging and handling equipment 1.6.2 Do the grounding 1.6.3 Put in place and fasten the transformers	
1.7 Install power factor correction capacitors	1.7.1 Handle and rigging and handling equipment 1.7.2 Do the grounding 1.7.3 Put in place and fasten the power factor correction capacitors	
1.8 Pull high-voltage and control cables	1.8.1 Use the megohmmetre to measure cable resistance 1.8.2 Install the winch and pulley 1.8.3 Pass the cables 1.8.4 Proceed to the termination 1.8.5 Identify the cables 1.8.6 Perform an insulation test 1.8.7 Perform high-voltage tests 1.8.8 Spread sand or have it spread	
1.9 Install control and operating devices	1.9.1 Install control and operating devices 1.9.2 Check resistance 1.9.3 Install safety devices	
1.10 Make connections	1.10.1 Identify the cables 1.10.2 Proceed to the termination 1.10.3 Do the grounding 1.10.4 Make aluminothermic welds (Cadweld welds) 1.10.5 Install a busbar	
1.11 Make pre-start-up verifications	1.11.1 Install fuses 1.11.2 Measure: - resistance - voltage - electric current intensity 1.11.3 Energize 1.11.4 Lockout 1.11.5 Calibrate the circuit breakers	
1.12 Activate the distribution and bypass system		
1.13 Demobilize the construction site	1.13.1 Pack up tools and equipment 1.13.2 Make an inventory of tools and equipment	
1.14 Write reports		

TASK 2 INSTALL LOW-VOLTAGE DISTRIBUTION SYSTEMS

Operations	Sub-Operations	Clarifications
2.1 Interpret plans and specifications	2.1.1 Check whether there are addendas or whether modifications have been made 2.1.2 Check whether there is ongoing work done by other trades 2.1.3 Check the loads	
2.2 Prepare the work	2.2.1 Make sure tools and safety equipment are in good condition 2.2.2 Draw the list and order the equipment 2.2.3 Check the equipment 2.2.4 Install a temporary power supply	
2.3 Build a grounding network	2.3.1 Pass the cable 2.3.2 Push the grounding rod in 2.3.3 Install inert lighting rods 2.3.4 Connect the cable to the water inlet 2.3.5 Make aluminothermic welds (Cadweld welds) 2.3.6 Install compression lugs 2.3.7 Bolt or make tightening torques 2.3.8 Take measurements 2.3.9 Install one or more busbars	
2.4 Install pipes, cabletroughs and raceways	2.4.1 Drill the concrete 2.4.2 Install pipes in the formwork 2.4.3 Install pipes and cabletroughs to the wall and ceiling	
2.5 Prepare the electrical distribution room	2.5.1 Handle the equipment 2.5.2 Prepare anchors 2.5.3 Assemble and fasten panels to the wall 2.5.4 Insert conduits in the panels 2.5.5 Pass the conductors 2.5.6 Check the conductor insulation 2.5.7 Connect the conductors 2.5.8 Clean the premises	
2.6 Install single-phase and three-phase transformers	2.6.1 Inspect the transformers 2.6.2 Prepare anchors 2.6.3 Place and fasten the transformers 2.6.4 Insert conduits in the transformers 2.6.5 Pass the conductors 2.6.6 Check the conductor insulation 2.6.7 Connect the conductors 2.6.8 Complete the grounding connection	
2.7 Install power factor correction capacitors	2.7.1 Prepare anchors 2.7.2 Place and fasten capacitors 2.7.3 Insert conduits in the capacitors 2.7.4 Pass the conductors 2.7.5 Check the conductor insulation 2.7.6 Connect the capacitors	

TASK 2 INSTALL LOW-VOLTAGE DISTRIBUTION SYSTEMS

Operations	Sub-Operations	Clarifications
2.8 Make pre-start-up verifications	2.8.1 Install fuses 2.8.2 Measure: - resistance - voltage - electric current intensity 2.8.3 Switch on 2.8.4 Lockout 2.8.5 Calibrate the circuit breakers	
2.9 Activate the distribution system	2.9.1 Notify personnel of the activation	
2.10 Clean the workplace or demobilize the construction site	2.10.1 Clean the premises or 2.10.2 Pack up tools and equipment 2.10.3 Make an inventory of tools and equipment	
2.11 Write reports		

TASK 3 INSTALL RESIDENTIAL DISTRIBUTION, BYPASS AND HOME AUTOMATION SYSTEMS

This task is performed in three steps.

Operations	Sub-Operations	Clarifications
3.1 Interpret plans and specifications and find out the customer's load requirements	3.1.1 Check whether there are addendas or whether modifications have been made 3.1.2 Check whether there is ongoing work done by other trades 3.1.3 Make a list of the equipment 3.1.4 Check the loads	First step: distribution.
3.2 Install the meter socket		
3.3 Install the electrical mast or the conduit		
3.4 Install the electrical panel		
3.5 Pass the wires		
3.6 Connect the wires	3.6.1 Connect the wires: - in the panel - at the meter socket - on the roof	
3.7 Do the grounding[14]	3.7.1 Pass the grounding wire 3.7.2 Connect the grounding wire to the water inlet or grounding rods	

14. The Direction de l'application des conventions collectives has issued a notice to the effect that operations 3.7, 9.4, 10.4 and 11.3 are performed exclusively by electricians if the grounding network is connected to a building's electrical system. Otherwise, those sub-operations are shared with other trades.

TASK 3 INSTALL RESIDENTIAL DISTRIBUTION, BYPASS AND HOME AUTOMATION SYSTEMS

Operations	Sub-Operations	Clarifications
3.8 Install outlet boxes	3.8.1 Choose the type of box 3.8.2 Mark the location 3.8.3 Drill holes 3.8.4 Fasten the boxes	Second step: bypass.
3.9 Pass the cables	3.9.1 Pass cables or structured cabling[15]: - for power - coaxial - of the computer network - audio - for home automation - of the doorbell	
3.10 Make the connections	3.10.1 Insert wires in the boxes 3.10.2 Make the connections	Outdoor connections may also be involved (heat pump and air conditioner, for example).
3.11 Do the finishing work	3.11.1 Install: - switches - outlets - lighting fixtures - baseboard units (or connect to the electric furnace or the radiant system) - telephone outlets - cable outlets - network outlets - the doorbell	Third step: the finishing.
3.12 Clean the workplace		
3.13 Write reports	3.13.1 Fill out the time sheet 3.13.2 Note the information on the equipment installed	

TASK 4 INSTALL LIGHTING SYSTEMS

Operations	Sub-Operations	Clarifications
4.1 Interpret plans and specifications	4.1.1 Check whether there are addendas or whether modifications have been made 4.1.2 Check whether there is ongoing work done by other trades 4.1.3 Check the loads	The lighting may be indoors or outdoors (street or parking lot, for example).

15. The Direction de l'application des conventions collectives has issued a notice to the effect that, for home automation, the electrician is responsible for electric heating systems. Hot water heating (pipefitter), ventilation (tinsmith) and air conditioning (refrigeration mechanic) systems are the responsibility of the trade involved in installing them. In those three cases, the electrician is responsible by default for sub-operations.

TASK 4 INSTALL LIGHTING SYSTEMS

Operations	Sub-Operations	Clarifications
4.2 Prepare the work	4.2.1 Take brightness measurements, if applicable 4.2.2 Calculate the lighting level required for each room, if applicable 4.2.3 Adapt the lighting plan, if applicable: - lighting level - type of lighting 4.2.4 Make a list of the equipment 4.2.5 Check the equipment 4.2.6 Choose the tools 4.2.7 Prepare a permit application 4.2.8 Apply safety measures	
4.3 Install pipes, cabletroughs and raceways	4.3.1 Proceed to the excavation or request it 4.3.2 Install a socket 4.3.3 Assemble lighting fixtures 4.3.4 Bend the pipes, if applicable 4.3.5 Install the following devices: - earthquake resistant - anti-explosion - anti-dust - etc. 4.3.6 Install structured cabling	
4.4 Install lighting supply and distribution panels		
4.5 Install control and operating panels		
4.6 Install control switches or systems		
4.7 Install lighting fixtures	4.7.1 Install: - contact switches - transformers - relays	
4.8 Make connections		
4.9 Check the lighting system's operation	4.9.1 Take measurements of: - resistance - voltage	
4.10 Activate the lighting system		
4.11 Clean the workplace or demobilize the construction site	4.11.1 Clean the premises or 4.11.2 Pack up tools and equipment 4.11.3 Make an inventory of tools and equipment	
4.12 Write reports	4.12.1 Fill out the time sheet 4.12.2 Note the information on the equipment installed	

TASK 5 INSTALL HEATING, AIR CONDITIONING AND VENTILATION SYSTEMS

Operations	Sub-Operations	Clarifications
5.1 Interpret plans and specifications	5.1.1 Check whether there are addendas or whether modifications have been made 5.1.2 Check whether there is ongoing work done by other trades 5.1.3 Check the loads	
5.2 Prepare the work	5.2.1 Calculate the heating needs of each room, if applicable 5.2.2 Adapt the heating plan, if applicable 5.2.3 Establish the list of materials 5.2.4 Draw the list and order the equipment 5.2.5 Check the equipment 5.2.6 Handle equipment 5.2.7 Install site shacks and containers 5.2.8 Take part in site meetings and the daily news 5.2.9 Install a temporary power supply	
5.3 Install pipes, cabletroughs and raceways and pass cables	5.3.1 Cut pipes and cabletroughs 5.3.2 Bend the pipes 5.3.3 Put pipes and cabletroughs in place 5.3.4 Pull the cables	By passing cables at the same time as pipes and cabletroughs, equipment losses are reduced.
5.4 Install heating supply and distribution panels	5.4.1 Handle the equipment 5.4.2 Drill the panels 5.4.3 Put the panels in place 5.4.4 Fasten the panels	
5.5 Install control and operating panels	5.5.1 Handle the equipment 5.5.2 Drill the panels 5.5.3 Put the panels in place 5.5.4 Fasten the panels	
5.6 Install heating, air conditioning and ventilation units[16]	5.6.1 Handle the units 5.6.2 Put the units in place 5.6.3 Fasten the units	
5.7 Install control and operating devices	5.7.1 Handle the units 5.7.2 Put the units in place 5.7.3 Fasten the units	
5.8 Make connections	5.8.1 Connect the wires: - at very low voltage and current (4 to 20 mA) - at low voltage - of communication cables	
5.9 Make pre-operational verifications	5.9.1 Use the megohmmetre to measure cable resistance 5.9.2 Turn the units on 5.9.3 Check ventilation system rotation	

16. The Direction de l'application des conventions collectives has issued a notice to the effect that, for home automation, the electrician is responsible for electric heating systems. Hot water heating (pipefitter), ventilation (tinsmith) and air conditioning (refrigeration mechanic) systems are the responsibility of the trade involved in installing them. In those three cases, the electrician is responsible by default for sub-operations.

TASK 5 INSTALL HEATING, AIR CONDITIONING AND VENTILATION SYSTEMS

Operations	Sub-Operations	Clarifications
5.10 Activate the heating, air conditioning and ventilation system		
5.11 Clean the premises or demobilize the construction site	5.11.1 Clean the premises or 5.11.2 Pack up tools and equipment 5.11.3 Make an inventory of tools and equipment	
5.12 Write reports		

TASK 6 PUT IN PLACE AND CONNECT MOTIVE FORCES

This task applies to all motive force devices, including wind turbines. To install the latter, the sequence of operations is different.

Operations	Sub-Operations	Clarifications
6.1 Interpret plans and specifications	6.1.1 Check whether there are addendas or whether modifications have been made 6.1.2 Check whether there is ongoing work done by other trades 6.1.3 Check the loads	
6.2 Prepare the work	6.2.1 Prepare a permit application 6.2.2 Make a list of the equipment 6.2.3 Choose the necessary tools 6.2.4 Apply safety measures	
6.3 Build a grounding network	6.3.1 Install a ground grid or ground plates 6.3.2 Push the grounding rod in 6.3.3 Install inert lighting rods 6.3.4 Pull the grounding cables 6.3.5 Make aluminothermic welds (Cadweld welds) 6.3.6 Install compression lugs 6.3.7 Bolt or make tightening torques 6.3.8 Take measurements	
6.4 Put motive force devices in place	6.4.1 Check the equipment 6.4.2 Handle the units 6.4.3 Interpret the device's rating plate information 6.4.4 Position or help position: - motors - pumps - generators - compressors - conveyors - elevators - servomotors	
6.5 Install pipes, cabletroughs and raceways	6.5.1 Prepare supports and anchors 6.5.2 Bend and thread the pipes 6.5.3 Install flexible pipes	

TASK 6 PUT IN PLACE AND CONNECT MOTIVE FORCES

Operations	Sub-Operations	Clarifications
6.6 Install the control system for motive force devices (MCC)	6.6.1 Fasten the panels 6.6.2 Drill the panels 6.6.3 Do the grounding	MCC: motor control centre.
6.7 Install control and operating panels	6.7.1 Fasten the panels 6.7.2 Drill the panels 6.7.3 Do the grounding	
6.8 Install control and operating devices	6.8.1 Install: - a speed controller - an isolating switch - probes - sensors - positioning switches - level indicators - gas detectors - etc.	
6.9 Pull the conductors or cables	6.9.1 Pull the conductors 6.9.2 Pull the control and communication cables 6.9.3 Identify the conductors and cables	
6.10 Make connections	6.10.1 Connect wires: - at high voltage - at low voltage - at very low voltage and current (4 to 20 mA) - of communication cables	
6.11 Take measurements	6.11.1 Use the megohmmetre to measure cable resistance 6.11.2 Check phase-to-phase continuity 6.11.3 Check phase-ground continuity	
6.12 Make pre-operational verifications	6.12.1 Take voltage and intensity measurements of the electric current (with no mechanical load") 6.12.2 Check the direction of rotation 6.12.3 Calibrate the circuit breakers 6.12.4 Calibrate the overload relays 6.12.5 Calibrate the limit switches 6.12.6 Calibrate the level indicators 6.12.7 Configure the speed controller 6.12.8 Program a programmable logic controller (PLC)	
6.13 Activate motive force devices	6.13.1 Check the operation of the process 6.13.2 Take electric current intensity measurements (with electric charge)	
6.14 Clean the workplace or demobilize the construction site	6.14.1 Clean the premises or 6.14.2 Pack up tools and equipment 6.14.3 Make an inventory of tools and equipment	
6.15 Write reports	6.15.1 Fill out the time sheet 6.15.2 Note the information on the equipment installed	

TASK 7 INSTALL EMERGENCY POWER SYSTEMS

Operations	Sub-Operations	Clarifications
7.1 Interpret plans and specifications	7.1.1 Check whether there are addendas or whether modifications have been made 7.1.2 Check whether there is ongoing work done by other trades 7.1.3 Check the loads	
7.2 Prepare the work	7.2.1 Obtain the tools 7.2.2 Make a list of the equipment 7.2.3 Check the equipment 7.2.4 Handle devices 7.2.5 Install a temporary power supply	
7.3 Prepare the electrical distribution room for generators and batteries	7.3.1 Prepare anchors 7.3.2 Fasten a plywood sheet 7.3.3 Install the panels	
7.4 Install pipes, cabletroughs and raceways	7.4.1 Drill the structure, if applicable 7.4.2 Fasten the anchors 7.4.3 Install the support 7.4.4 Install the pull box	
7.5 Build a grounding network	7.5.1 Install a ground grid or ground plates 7.5.2 Push the grounding rod in 7.5.3 Install inert lighting rods 7.5.4 Pull the grounding cables 7.5.5 Make aluminothermic welds (Cadweld welds) 7.5.6 Install compression lugs 7.5.7 Bolt or make tightening torques 7.5.8 Take measurements 7.5.9 Install one or more busbars	Network size depends on the power system's power.
7.6 Install generators	7.6.1 Handle the generators 7.6.2 Put the generators in place 7.6.3 Fixer les generators 7.6.4 Install the changeover switches	
7.7 Install batteries	7.7.1 Assemble and fasten supports 7.7.2 Install batteries 7.7.3 Make battery interconnections 7.7.4 Check the batteries 7.7.5 Install chargers 7.7.6 Install the UPS	UPS: uninterruptible power supply.
7.8 Pull the cables	7.8.1 Install the winch and pulley 7.8.2 Prepare the cabling for pulling 7.8.3 Pass the cables	
7.9 Check the continuity		
7.10 Install control and operating devices	7.10.1 Make interconnections between related systems	
7.11 Make connections	7.11.1 Connect cables with the equipment	

TASK 7 INSTALL EMERGENCY POWER SYSTEMS

Operations	Sub-Operations	Clarifications
7.12 Make pre-operational verifications	7.12.1 Check the cabling 7.12.2 Check the voltage 7.12.3 Check power supply system components	
7.13 Participate in the activation of the emergency power system		This operation may be performed in collaboration, for example with plumbers, instrumentation technicians, building mechanics, industrial mechanics, etc.
7.14 Clean the workplace or demobilize the construction site	7.14.1 Clean the premises or 7.14.2 Pack up tools and equipment 7.14.3 Make an inventory of tools and equipment	
7.15 Write reports		

TASK 8 INSTALL ALARM AND MONITORING SYSTEMS

Operations	Sub-Operations	Clarifications
8.1 Interpret plans and specifications	8.1.1 Check whether there are addendas or whether modifications have been made 8.1.2 Check whether there is ongoing work done by other trades	
8.2 Prepare the work	8.2.1 Obtain the tools 8.2.2 Make a list of the equipment 8.2.3 Check the equipment 8.2.4 Handle the units	
8.3 Install pipes and cabletroughs	8.3.1 Drill the structure, if applicable 8.3.2 Fasten the anchors 8.3.3 Install the support 8.3.4 Install the pull box	
8.4 Do the grounding	8.4.1 Connect pipes or cabletroughs to the grounding 8.4.2 Install a busbar 8.4.3 Make additional connections requested by the customer	
8.5 Install structured cabling	8.5.1 Prepare the cabling for pulling 8.5.2 Pass the cables	
8.6 Install surveillance cameras	8.6.1 Prepare anchors 8.6.2 Fasten the cameras	

TASK 8 INSTALL ALARM AND MONITORING SYSTEMS

Operations	Sub-Operations	Clarifications
8.7 Install a fire alarm system	8.7.1 Install the control panel 8.7.2 Install: - the manual station - the bell or siren - call panels - detectors 8.7.3 Interconnect related systems to the control panel: - fire pump - elevator - automatic door - ventilation - telephony - call panel	
8.8 Install an intrusion alarm system	8.8.1 Install the power supply system 8.8.2 Install the components requested by the customer	
8.9 Install an access control system	8.9.1 Install the power supply system 8.9.2 Install the components requested by the customer	
8.10 Make connections		
8.11 Check the operation of systems	8.11.1 Turn the systems on 8.11.2 Check the components	
8.12 Activate the systems		
8.13 Clean the workplace or demobilize the construction site		
8.14 Write reports		

TASK 9 INSTALL TELEPHONE AND INTERCOM SYSTEMS

Operations	Sub-Operations	Clarifications
9.1 Interpret plans and specifications	9.1.1 Check whether there are addendas or whether modifications have been made 9.1.2 Check whether there is ongoing work done by other trades	
9.2 Prepare the work	9.2.1 Obtain the tools 9.2.2 Make a list of the equipment 9.2.3 Check the equipment 9.2.4 Handle the devices	

TASK 9 INSTALL TELEPHONE AND INTERCOM SYSTEMS

Operations	Sub-Operations	Clarifications
9.3 Install conduits and cabletroughs	9.3.1 Prepare anchors 9.3.2 Fasten a plywood sheet 9.3.3 Install BIX connectors 9.3.4 Drill the structure, if applicable 9.3.5 Fasten the anchors 9.3.6 Install the support 9.3.7 Install the pull box	
9.4 Build a grounding network[17]	9.4.1 Install a ground grid or ground plates 9.4.2 Push the grounding rod in 9.4.3 Install inert lighting rods 9.4.4 Pull the grounding cables 9.4.5 Make aluminothermic welds (Cadweld welds) 9.4.6 Install compression lugs 9.4.7 Bolt or make tightening torques 9.4.8 Take measurements 9.4.9 Install one or more busbars and the insulator	
9.5 Install structured cabling	9.5.1 Prepare the cabling for pulling 9.5.2 Pass the cables	
9.6 Install the telephone and intercom equipment	9.6.1 Install the speaker box 9.6.2 Install telephone outlets 9.6.3 Install the main housing	
9.7 Make connections to the main housing		
9.8 Check the operation of systems	9.8.1 Check the cabling 9.8.2 Check components by zone	
9.9 Activate the telephone and intercom systems		
9.10 Clean the workplace		
9.11 Write reports		

TASK 10 INSTALL AUTOMATION AND CONTROL SYSTEMS FOR INDUSTRIAL AND BUILDING EQUIPMENT

Operations	Sub-Operations	Clarifications
10.1 Interpret plans and specifications	10.1.1 Check whether there are addendas or whether modifications have been made 10.1.2 Check whether there is ongoing work done by other trades	
10.2 Prepare the work	10.2.1 Obtain the tools 10.2.2 Make a list of the equipment 10.2.3 Check the equipment 10.2.4 Handle the units	

17. The Direction de l'application des conventions collectives has issued a notice to the effect that sub-operations 3.7, 9.4, 10.4 and 11.3 are performed exclusively by electricians if the grounding network is connected to a building's electrical system. Otherwise, those sub-operations are shared with other trades.

TASK 10 INSTALL AUTOMATION AND CONTROL SYSTEMS FOR INDUSTRIAL AND BUILDING EQUIPMENT

Operations	Sub-Operations	Clarifications
10.3 Install pipes and cabletroughs	10.3.1 Drill the structure, if applicable 10.3.2 Fasten the anchors 10.3.3 Installer supports 10.3.4 Installer pull boxes	
10.4 Do the grounding[18]	10.4.1 Connect pipes or cabletroughs to the grounding	
10.5 Install structured cabling	10.5.1 Prepare the cabling for pulling 10.5.2 Pass the cables	
10.6 Install control and operating devices	10.6.1 Handle the units 10.6.2 Precalibrate the devices 10.6.3 Install control and operating devices	
10.7 Install control and operating panels	10.7.1 Handle the equipment 10.7.2 Drill the panels 10.7.3 Put the panels in place 10.7.4 Fasten the panels	
10.8 Make connections	10.8.1 Connect the wires at very low voltage and current (4 to 20 mA)	
10.9 Make pre-operational verifications	10.9.1 Measure the resistance of devices 10.9.2 Turn the units on 10.9.3 Make the final calibration 10.9.4 Measure the intensity and voltage 10.9.5 Use a computer to force the device output 10.9.6 Make necessary corrections	
10.10 Activate the system	10.10.1 Validate that the programming is operating correctly 10.10.2 Correct the line of code, if applicable	
10.11 Clean the workplace or demobilize the construction site		
10.12 Write reports	10.12.1 Fill out the device validation sheet	

TASK 11 INSTALL CATHODIC PROTECTION SYSTEMS

Operations	Sub-Operations	Clarifications
11.1 Interpret plans and specifications	11.1.1 Check loads and voltage	
11.2 Prepare the work	11.2.1 Obtain the tools 11.2.2 Draw the list and order the equipment 11.2.3 Check the equipment	

18. The Direction de l'application des conventions collectives has issued a notice to the effect that sub-operations 3.7, 9.4, 10.4 and 11.3 are performed exclusively by electricians if the grounding network is connected to a building's electrical system. Otherwise, those sub-operations are shared with other trades.

TASK 11 INSTALL CATHODIC PROTECTION SYSTEMS

Operations	Sub-Operations	Clarifications
11.3 Do the grounding[19]		
11.4 Install the cathodic protection box	11.4.1 Put the box in place 11.4.2 Anchor the box	
11.5 Install pipes or cabletroughs		
11.6 Install the terminal box	11.6.1 Install the support 11.6.2 Fasten the box with nuts or 11.6.3 Anchor the box	
11.7 Install conduits and cabling between the cathodic protection box and the terminal box		
11.8 Install conduits between the terminal box and the ends of the conduit or instrumentation to be protected	11.8.1 Pass the conductors 11.8.2 Make the connections in the terminal box	
11.9 Install pads at the ends of the conduit or instrumentation to be protected	11.9.1 Put the pads in place 11.9.2 Connect the wiring	
11.10 Activate the system	11.10.1 Check the voltage	
11.11 Clean the workplace or demobilize the construction site		
11.12 Write reports		

TASK 12 MAINTAIN, REPAIR AND TROUBLESHOOT ELECTRICAL AND STRUCTURED CABLING SYSTEMS

Operations	Sub-Operations	Clarifications
12.1 Answer a service call, if applicable		This operation is applicable only in case of failure.
12.2 Make a diagnosis	12.2.1 Obtain information from personnel 12.2.2 Take measurements 12.2.3 Check hot spots 12.2.4 Check the direction of rotation of motive force devices 12.2.5 Etc.	

19. The Direction de l'application des conventions collectives has issued a notice to the effect that sub-operations 3.7, 9.4, 10.4 and 11.3 are performed exclusively by electricians if the grounding network is connected to a building's electrical system. Otherwise, those sub-operations are shared with other trades.

TASK 12 MAINTAIN, REPAIR AND TROUBLESHOOT ELECTRICAL AND STRUCTURED CABLING SYSTEMS

Operations	Sub-Operations	Clarifications
12.3 Prepare the work	12.3.1 Make a list of the equipment 12.3.2 Obtain the tools 12.3.3 Acquire the required devices 12.3.4 Participate in plant stoppages 12.3.5 Lockout 12.3.6 Etc.	
12.4 Do preventive maintenance	12.4.1 Tighten screws 12.4.2 Clean terminals 12.4.3 Clean components 12.4.4 Etc.	
12.5 Replace devices	12.5.1 Remove the defective device 12.5.2 Install the new device	
12.6 Replace panels and mechanisms	12.6.1 Remove defective panels and mechanisms 12.6.2 Installer new panels and mechanisms	
12.7 Replace cables and conductors	12.7.1 Remove defective cables and conductors 12.7.2 Install new cables and conductors	
12.8 Make pre-start-up verifications	12.8.1 Check the direction of rotation of motive force devices 12.8.2 Take measurements	
12.9 Help reactivate the electrical system or the structured cabling system	12.9.1 Make necessary verifications 12.9.2 Take measurements	
12.10 Clean the workplace or demobilize the construction site		
12.11 Write reports	12.11.1 Fill out the time sheet 12.11.2 Note the information about the: - customer - type of maintenance - type of repairs - work time	

2.3 ACHIEVEMENT CONDITIONS AND PERFORMANCE CRITERIA

2.3.1 Achievement Conditions

Data on achievement conditions were collected for the electrician trade as a whole. The data pertain to aspects such as work areas, level of collaboration, work instructions, reference documents consulted, material resources used, and health and safety hazards.

Annex 1 is a list of tools and equipment used for each task.

Table 2.3 Achievement Conditions

TASK 1 INSTALL HIGH-VOLTAGE DISTRIBUTION AND BYPASS SYSTEMS

Workplaces On the construction site, outdoors and indoors. In the industrial, institutional and commercial, heavy residential, civil engineering and roads sectors.
Level of collaboration In a team.[20] Under the supervision of the foreman, project manager or team leader.
Instructions and references Based on plans, specifications and contractor instructions. According to the Canadian Electrical Code, the Quebec Building Code, Chapter I, "Building," and Chapter V, "Electricity," Hydro-Québec standards and, if applicable, ISO, OHSAS and customer standards.
Material Resources Pipes, cabletroughs and raceways, panels, high-voltage cables, grids, grounding plates and rods, inert lightning rods, connectors, busbars, termination kits, control cables, three-phase transformers, power factor correction capacitors, control and operating devices, protective devices, circuit-breakers, crosshead fasteners, insulating tape, lubricants, galvanizing products, antioxidant greases, bolts, locknuts, etc.
Health and safety hazards In a context involving hazards: • of electrocution and electrification; • related to electric arcs; • of silicosis; • of falls; • of cuts; • of burns; • of fractures; • related to noise.

20. The participants also mentioned that they collaborated with the job-site steward. However, under section 86 of the Act respecting labour relations, vocational training and workforce management in the construction industry (R.S.Q., c. R-20), a job-site steward is responsible for investigating disputes regarding the application of the collective agreement and discuss them with the employer. In that sense, the Direction de la formation professionnelle is of the view that the concept of job-site steward applies only to personnel management and is not relevant to the present document.

TASK 2 INSTALL LOW-VOLTAGE DISTRIBUTION SYSTEMS

Workplaces

On the construction site, outdoors and indoors.

In the industrial, institutional and commercial, residential (rarely for light residential), civil engineering and roads sectors.

Level of collaboration

In a team.

Under the supervision of the foreman, project manager or team leader.

Instructions and references

Based on plans and specifications and contractor instructions.

According to the Canadian Electrical Code, the Quebec Building Code, Chapter I, “Building,” and Chapter V, “Electricity,” Hydro-Québec standards and, if applicable, ISO, OHSAS and customer standards.

Material resources

Pipes, cabletroughs and raceways, panels, cables, grounding rods, inert lightning rods, connectors, busbars, supports, control cables, single-phase and three-phase transformers, circuit-breakers, plywood, screws, fuses, crosshead fasteners, insulating tape, bolts, locknuts, etc.

Health and safety hazards

In a context involving hazards:

- of electrocution and electrification;
- of silicosis;
- of cuts;
- of fractures;
- of falls.

TASK 3 INSTALL RESIDENTIAL DISTRIBUTION, BYPASS AND HOME AUTOMATION SYSTEMS

Workplaces

On the construction site, outdoors and indoors.

In the residential sector.

Level of collaboration

Alone and in a team.

Under the supervision of the foreman or project manager.

Instructions and references

Based on plans, specifications, customer requests and contractor instructions.

According to the Canadian Electrical Code, the Quebec Building Code, Chapter I, “Building,” and Chapter V, “Electricity,” and Hydro-Québec standards.

Material resources

Meter sockets, electrical masts or conduits, electrical panels, cables, structured cabling, outlet boxes, baseboard units, lighting fixtures, switches, electrical outlets, telephone outlets, insulating tape, insulated connections, etc.

Health and safety hazards

In a context involving hazards:

- of electrocution;
- of electrification;
- of silicosis;
- of falls;
- of cuts.

TASK 4 INSTALL LIGHTING SYSTEMS

Workplaces

On the construction site, outdoors and indoors.

In the industrial, institutional and commercial, residential, civil engineering and roadwork sectors.

Level of collaboration

Alone and in a team.

Under the supervision of the foreman, project manager or team leader.

Instructions and references

Based on plans, specifications and contractor instructions.

According to the Canadian Electrical Code, the Quebec Building Code, Chapter I, “Building,” and Chapter V, “Electricity,” Hydro-Québec standards and, if applicable, ISO, OHSAS and customer standards.

Material resources

Pipes, cabletroughs, cables, lighting power supply and distribution panels, control and operating panels, control cables, switches, control systems, lighting fixtures, protective devices, contact switches, transformers, relays, crosshead fasteners, insulating tape, etc.

Health and safety hazards

In a context involving hazards:

- of electrocution;
- of electrification;
- of silicosis;
- of falls;
- related to noise.

TASK 5 INSTALL HEATING, AIR CONDITIONING AND VENTILATION SYSTEMS

Workplaces

On the construction site, outdoors and indoors.

In the industrial, institutional and commercial, heavy residential, civil engineering and roadwork sectors.

Level of collaboration

In a team.

Under the supervision of the foreman, project manager or team leader.

Instructions and references

Based on plans and specifications, customer specifications and contractor instructions.

According to the Canadian Electrical Code, the Quebec Building Code, Chapter I, “Building,” and Chapter V, “Electricity,” Hydro-Québec standards and, if applicable, ISO, OHSAS and customer standards.

Material resources

Pipes, cabletroughs, cables, heating supply and distribution panels, control and operating panels, control cables, heating, air conditioning and ventilation units, control and operating devices, threadbars, bolts, etc.

Health and safety hazards

In a context involving hazards:

- of electrocution;
- of electrification;
- of silicosis;
- of falls;
- of cuts;
- of burns;
- of fractures;
- related to noise.

TASK 6 PUT IN PLACE AND CONNECT MOTIVE FORCES

Workplaces

On the construction site, outdoors and indoors.

In the residential, institutional and commercial, residential, civil engineering and roadwork sectors.

Level of collaboration

Alone and in a team.

Under the supervision of the foreman, project manager or team leader.

Instructions and references

Based on plans and specifications and contractor instructions.

According to the Canadian Electrical Code, the Quebec Building Code, Chapter I, “Building,” and Chapter V, “Electricity,” Hydro-Québec standards and, if applicable, ISO, OHSAS and customer standards.

Material resources

Pipes, cabletroughs, cables, control cables, control systems for motive force devices, motive force devices, control and operating panels, control and operating devices, grids, grounding plates and rods, inert lightning rods, connectors, crosshead fasteners, insulating tape, insulated connections, etc.

Health and safety hazards

In a context involving hazards:

- of electrocution;
- of electrification;
- of silicosis;
- of falls;
- of backache.

TASK 7 INSTALL EMERGENCY POWER SYSTEMS

Workplaces

On the construction site, outdoors and indoors.

In the industrial, institutional and commercial, residential (more rarely), civil engineering and roadwork sectors.

Level of collaboration

Alone and in a team.

Under the supervision of the foreman, project manager or team leader.

Instructions and references

Based on plans and specifications and contractor instructions.

According to the Canadian Electrical Code, the Quebec Building Code, Chapter I, “Building,” and Chapter V, “Electricity,” Hydro-Québec standards and, if applicable, ISO, OHSAS, customer and municipal standards.

Material resources

Pipes, cabletroughs, cables, control cables, generators, batteries, control and operating devices, grids, grounding plates and rods, inert lightning rods, busbars, insulating tape, crosshead fasteners, insulated connections, hardware components, etc.

Health and safety hazards

In a context involving hazards:

- of electrocution;
- of electrification;
- of silicosis;
- of falls;
- of cuts;
- of intoxication;
- of burns;
- of various bodily injuries;
- related to noise.

TASK 8 INSTALL ALARM AND MONITORING SYSTEMS

Workplaces

On the construction site, outdoors and indoors.

In the industrial, institutional and commercial, heavy residential, civil engineering and roadwork sectors.

Level of collaboration

In a team.

In collaboration with the system technician during activation.

Under the supervision of the foreman, project manager or team leader.

Instructions and references

Based on plans and specifications and contractor instructions.

According to the Canadian Electrical Code, the Quebec Building Code, Chapter I, “Building,” and Chapter V, “Electricity,” Hydro-Québec standards, manufacturer manuals and, if applicable, ULC, ISO, OHSAS, customer and municipal standards.

Material resources

Pipes, cabletroughs, cables, structured cabling, surveillance cameras, fire alarm systems, intrusion alarm systems, access control systems, insulating tape, crosshead fasteners, insulated connections, hardware components, etc.

Health and safety hazards

In a context involving hazards:

- of electrocution;
- of electrification;
- of silicosis;
- of falls;
- of cuts;
- of intoxication;
- of burns;
- of various bodily injuries;
- related to noise.

TASK 9 INSTALL TELEPHONE AND INTERCOM SYSTEMS

Workplaces

On the construction site, outdoors and indoors.

In the industrial, institutional and commercial, residential, civil engineering and roadwork sectors.

Level of collaboration

Alone and in a team.

Under the supervision of the foreman, project manager or team leader.

Instructions and references

Based on plans and specifications and contractor instructions.

According to the National Building Code, the Canadian Electrical Code, the Quebec Building Code, Chapter I, “Building,” and Chapter V, “Electricity,” Hydro-Québec standards, structured-cable pulling standards, and the router manual.

Material resources

Pipes, cabletroughs, cables, structured cabling, telephone and intercom equipment, grids, grounding plates and rods, inert lightning rods, busbars, insulators, insulating tape, Velcro tape, etc.

Health and safety hazards

In a context involving hazards:

- of electrification;
- of falls;
- of silicosis;
- of cuts;
- of bodily injuries;
- related to noise.

TASK 10 INSTALL AUTOMATION AND CONTROL SYSTEMS FOR INDUSTRIAL AND BUILDING EQUIPMENT

Workplaces

On the construction site, outdoors and indoors.

In the industrial, institutional and commercial, heavy residential, civil engineering and roadwork sectors.

Level of collaboration

In a team.

In collaboration with the system technician during activation.

Under the supervision of the foreman, project manager or team leader.

Instructions and references

Based on plans and specifications and contractor instructions.

According to the National Building Code, the Canadian Electrical Code, the Quebec Building Code, Chapter I, “Building,” and Chapter V, “Electricity,” Hydro-Québec standards, manufacturer manuals and, if applicable, ULC, ISO, OHSAS, customer and municipal standards.

Material resources

Pipes, cabletroughs, cables, structured cabling, direct digital control (DDC*)* device*,* programmable logic controller (PLC), distributed control system (DCS), insulating tape, crosshead fasteners, insulated connections, hardware components, etc.

Health and safety hazards

In a context involving hazards:

- of electrocution;
- of electrification;
- of silicosis;
- of falls;
- of cuts;
- of intoxication;
- of burns;
- related to noise.

TASK 11 INSTALL CATHODIC PROTECTION SYSTEMS

Workplaces

On the construction site, outdoors and indoors.

In the industrial and the civil engineering and roadwork sectors.

Level of collaboration

Alone and in a team.

Under the supervision of the foreman, project manager or team leader.

Instructions and references

Based on plans and specifications and contractor instructions.

According to the National Building Code, the Canadian Electrical Code, the Quebec Building Code, Chapter I, “Building,” and Chapter V, “Electricity,” and, if applicable, ULC, ISO, OHSAS and customer standards.

Material resources

PVC conduits, cabletroughs, cables, cathodic protection box, terminal box, connectors, crosshead fasteners, insulating tape, insulated connections, etc.

Health and safety hazards

In a context involving hazards:

- of electrocution;
- of electrification;
- of backache;
- falls.

TASK 12 MAINTAIN, REPAIR AND TROUBLESHOOT ELECTRICAL AND STRUCTURED CABLING SYSTEMS

Workplaces On the construction site, outdoors and indoors. In the industrial, institutional and commercial, residential, civil engineering and roadwork sectors.
Level of collaboration Alone and in a team. In collaboration with the customer, the process operator and maintenance personnel. Under the supervision of the foreman, project manager or team leader.
Instructions and references Based on plans and specifications and contractor instructions. According to the Canadian Electrical Code, the Quebec Building Code, Chapter I, “Building,” and Chapter V, “Electricity,” Hydro-Québec standards, in-house standards, ISO standards (if applicable), OHSAS standards, the National Building Code, maintenance procedures, manufacturer manuals and other standards.
Material resources Depending on the nature of the intervention.
Health and safety hazards Depending on the nature of the intervention. Generally, this task is more hazardous than others.

2.3.2 Performance Criteria

Performance criteria were gathered for each task. They are used for assessing whether the tasks were performed satisfactorily. The criteria pertain to aspects such as the quantity and quality of work done, the observance of a work procedure, the attitudes adopted, etc.

To draw the list of criteria related to each task, the participants worked in teams. The teams’ results were then collected and presented in full session.

Table 2.4 Performance Criteria

TASK 1 INSTALL HIGH-VOLTAGE DISTRIBUTION AND BYPASS SYSTEMS	
Performance Criteria	
Appropriate choice of conductors	Complete and rigorous pre-operational verifications
Correct ground installation	Observance of codes and standards in effect
Correct installation of cables and piping systems	Observance of lockout procedures
Appropriate conductor connections	Observance of plans and specifications
Appropriate use of tools and measuring instruments	Observance of occupational health and safety rules
TASK 2 INSTALL LOW-VOLTAGE DISTRIBUTION SYSTEMS	
Performance Criteria	
Appropriate choice of conductors	Adequate panel occupancy by conduits
Correct ground installation	Observance of codes and standards in effect
Correct installation of cables and piping systems	Observance of lockout procedures
Appropriate conductor connections	Observance of plans and specifications
Appropriate use of tools and measuring instruments	Observance of occupational health and safety rules
Complete and rigorous pre-operational verifications	
TASK 3 INSTALL RESIDENTIAL DISTRIBUTION, BYPASS AND HOME AUTOMATION SYSTEMS	
Performance Criteria	
Appropriate choice of conductors	Good knowledge of home automation systems
Correct ground installation	Aesthetic finishing
Correct installation of cables and piping systems	Observance of codes and standards in effect
Appropriate conductor connections	Observance of plans and specifications
Appropriate use of tools and measuring instruments	Observance of occupational health and safety rules
Complete and rigorous pre-operational verifications	

TASK 4 INSTALL LIGHTING SYSTEMS	
Performance Criteria	
Appropriate choice of conductors	Aligned and aesthetic lighting outlets
Correct ground installation	Installation performed by qualified and competent personnel
Correct installation of cables and piping systems	Correct device operation
Appropriate conductor connections	Observance of codes and standards in effect
Appropriate use of tools and measuring instruments	Observance of lockout procedures
Complete and rigorous pre-operational verifications	Observance of plans and specifications
Aesthetic installation	Observance of occupational health and safety rules
Observance of municipal by-laws	

TASK 5 INSTALL HEATING, AIR CONDITIONING AND VENTILATION SYSTEMS	
Performance Criteria	
Appropriate choice of conductors	Correct device operation
Correct ground installation	Observance of codes and standards in effect
Correct installation of cables and piping systems	Observance of lockout procedures
Appropriate conductor connections	Observance of customer specifications
Appropriate use of tools and measuring instruments	Observance of plans and specifications
Complete and rigorous pre-operational verifications	Observance of occupational health and safety rules
Observance of municipal by-laws	

TASK 6 PUT IN PLACE AND CONNECT MOTIVE FORCES	
Performance Criteria	
Correct interpretation of the rating plate	Observance of startup procedures
Appropriate choice of conductors	Observance of codes and standards in effect
Correct ground installation	Observance of lockout procedures
Correct installation of cables and piping systems	Observance of customer specifications
Appropriate conductor connections	Observance of plans and specifications
Appropriate use of tools and measuring instruments	Observance of occupational health and safety rules
Complete and rigorous pre-operational verifications	
Correct device operation	

TASK 7 INSTALL EMERGENCY POWER SYSTEMS	
Performance Criteria	
Appropriate choice of conductors	Reliable emergency system
Correct ground installation	Observance of lockout procedures
Correct installation of cables and piping systems	Observance of municipal by-laws
Appropriate conductor connections	Observance of codes and standards in effect
Appropriate use of tools and measuring instruments	Observance of plans and specifications
Complete and rigorous pre-operational verifications	Observance of occupational health and safety rules

TASK 8 INSTALL ALARM AND MONITORING SYSTEMS	
Performance Criteria	
Appropriate choice of cables	Reliable systems
Correct ground installation	Observance of gas emission standards
Correct installation of cables and piping systems	Observance of municipal by-laws
Appropriate cable connections	Observance of codes and standards in effect
Appropriate use of tools and measuring instruments	Observance of lockout procedures
Complete and rigorous pre-operational verifications	Observance of occupational health and safety rules
Observance of plans and specifications	

TASK 9 INSTALL TELEPHONE AND INTERCOM SYSTEMS	
Performance Criteria	
Appropriate choice of cables	Observance of structured cable pulling standards
Correct ground installation	Observance of codes and standards in effect
Correct installation of cables and piping systems	Observance of plans and specifications
Appropriate cable connections	Observance of codes and standards in effect
Appropriate use of tools and measuring instruments	Observance of occupational health and safety rules
Complete and rigorous pre-operational verifications	

TASK 10	INSTALL AUTOMATION AND CONTROL SYSTEMS FOR INDUSTRIAL AND BUILDING EQUIPMENT	
Performance Criteria		
Appropriate choice of cables		Observance of gas emission standards
Correct ground installation		Observance of municipal by-laws
Correct installation of cables and piping systems		Observance of codes and standards in effect
Appropriate cable connections		Observance of plans and specifications
Appropriate use of tools and measuring instruments		Observance of lockout procedures
Complete and rigorous pre-operational verifications		Observance of startup procedures
System reliability		Observance of occupational health and safety rules

TASK 11	INSTALL CATHODIC PROTECTION SYSTEMS	
Performance Criteria		
Correct interpretation of the rating plate		Observance of lockout procedures
Appropriate choice of conductors		Observance of customer specifications
Correct ground installation		Observance of plans and specifications
Correct installation of cables and piping systems		Observance of codes and standards in effect
Appropriate conductor connections		Observance of startup procedures
Appropriate use of tools and measuring instruments		Observance of occupational health and safety rules
Correct system operation		

TASK 12	MAINTAIN, REPAIR AND TROUBLESHOOT ELECTRICAL AND STRUCTURED CABLING SYSTEMS	
Performance Criteria		
Appropriate choice of conductors		Complete and rigorous pre-operational verifications
Correct ground installation		Observance of lockout procedures
Correct installation of cables and piping systems		Observance of customer specifications
Appropriate conductor connections		Observance of plans and specifications
Appropriate use of tools and measuring instruments		Observance of codes and standards in effect
Correct diagnosis		Observance of occupational health and safety rules
Maintenance, repairs and troubleshooting done by qualified and competent personnel		

2.4 FUNCTIONS

Functions:

- are a natural and concrete set of interrelated tasks;
- may be defined by work outcomes or a procedure.

For the electrician trade, the participants, after examining the tasks in terms of the definition of “function”, consider that all the tasks are different and that none can be grouped by affinities.

3. QUANTITATIVE DATA ON TASKS

The data presented in the tables below are average results among participants in the workshop.

3.1 WORK TIME

Work time, expressed in percentages, represents the average time allocated to each task by each expert, on an **annual** basis[21].

Table 3.1 Work Time Allocated to Tasks

Task		Work Time
1	Install high-voltage distribution and bypass systems	15.9%
2	Install low-voltage distribution systems	14.4%
3	Install residential distribution, bypass and home automation systems	2.5%
4	Install lighting systems	24.8%
5	Install heating, air conditioning and ventilation systems	9.5%
6	Put in place and connect motive forces	9.8%
7	Install emergency power systems	6.9%
8	Install alarm and monitoring systems	2.7%
9	Install telephone and intercom systems	1.5%
12	Maintain, repair and troubleshoot electrical and structured cabling systems	12.0%

21 Tasks 10 and 11, produced by the occupational analysis supplement, were not assessed.

3.2 IMPORTANCE AND DIFFICULTY OF TASKS

The **importance** of a task is estimated according to the more or less harmful consequences of performing a task poorly or not at all. The importance is assessed according to the following scale:

1. Not important at all: Poor execution of the task has no consequences on the overall quality of the product or service.

2. Not very important: Poor execution of the task could have minimal consequences on the overall quality of the product or service.

3. Important: Poor execution of the task could have major consequences on the overall quality of the product or service.

4. Very important: Poor execution of the task could have very major consequences on the overall quality of the product or service.

A task's **difficulty** is assessed according to the following scale:

1. Very easy: The task involves little risk of error; it requires no notable mental or physical effort and is less difficult than average.

2. Easy: The task involves a few risks of error; it requires minimal mental or physical effort and is of average difficulty.

3. Difficult: The task involves many risks of error; it requires a major mental or physical effort and is more difficult than average.

4. Very difficult: The task involves a very high risk of error; it requires a very major mental or physical effort and is among the most difficult in the trade.

The data presented in the table below are the average results for the electricians who participated in the workshop [22].

Table 3.2 Importance and Difficulty of Tasks

Task	Importance	Difficulty
1 Install high-voltage distribution and bypass systems	4.0	2.9
2 Install low-voltage distribution systems	4.0	2.8
3 Install residential distribution, bypass and home automation systems	3.9	2.4
4 Install lighting systems	3.9	1.9
5 Install heating, air conditioning and ventilation systems	3.9	2.1
6 Put in place and connect motive forces	4.0	2.7
7 Install emergency power systems	4.0	2.5
8 Install alarm and monitoring systems	4.0	2.3
9 Install telephone and intercom systems	4.0	2.2
12 Maintain, repair and troubleshoot electrical and structured cabling systems	4.0	3.3

22 Tasks 10 and 11, produced by the occupational analysis supplement, were not assessed.

4. KNOWLEDGE, SKILLS AND ATTITUDES

The occupational analysis enabled us to specify some of the knowledge, skills and attitudes necessary for performing the tasks. Those qualities are transferable, i.e., applicable to a variety of tasks and situations.

The following pages present the knowledge, skills and attitudes that, according to the participants, are considered essential for performing the tasks of the electrician trade.

4.1 KNOWLEDGE

Mathematics

Using the four basic math operations, calculating radiuses, using the Pythagorean Theorem, solving algebra problems with one unknown (Ohm's law), calculating angles and using trigonometry concepts are necessary in practicing the trade, particularly in the following operations:

- interpreting plans and specifications;
- preparing the work;
- installing pipes, cabletroughs or raceways;
- writing reports.

Electricians use vector calculus to correct the power factor and for certain pre-operational verifications.

Computer use

Electricians use computers to obtain information on products and devices and to write reports.

They also use computers for certain pre-operational verifications and to program programmable logic controllers, access cards or speed regulators.

Computer use is essential in everything related to structured cabling installations and in the task of installing automated and control systems for industrial and building equipment.

Plans and Diagrams

The trade requires good knowledge in the interpretation of plans and diagrams, since electricians use such reference documents to perform all their tasks and operations.

The plans and diagrams consulted are varied: electrical, lighting, heating, architecture, ventilation, air conditioning, single-line, process diagrams, ladder diagrams, etc.

In addition, electricians must update plans and diagrams (as-built drawings).

Electricity

Knowledge of voltage, intensity, power, resistance, insulation, conductivity, and types of measurement units is, of course, essential to the practice of the trade. In addition, the electrician has to understand the operation of alternating and direct currents, know how to use Ohm's law and Kirchhoff's current law, interpret the various measurement units, and be able to use instruments to obtain data.

Electrical knowledge is useful in all tasks, but particularly necessary in operations such as taking measurements, pre-operational verifications, load calculations, and diagnosing the causes of an operating problem.

Welding

Electricians do aluminothermic welding, aluminium welding (four positions) and tin welding, essentially to make connections.

Some electricians can weld on steel by using flux-cored arc welding (FCAW) and shielded metal arc welding (SMAW). Such welding is usually done to assemble or build supports for electric devices. For this type of work, electricians need to hold a recognized and valid card[23].

23. One person present at the analysis had this type of card.

Instrumentation and control

It is useful to understand the operation of the various control and operating devices, notably that of a PID control loop (proportional-integral-derivative controller), triacs and thyristors, and to interpret stable state control diagrams and scale plans, in order to perform the task of installing automated and control systems for industrial and building equipment, as well as in troubleshooting operations and pre-operational verifications.

Knowledge of instrumentation and control is particularly important for persons working in the industrial sector.

Electronics

Understanding the operation of certain electronic components such as diodes, thyristors, capacitors, etc. enables an electrician to check the device's operation and adjust it, make pre-operational verifications, and replace electronic cards on control and operating devices.

Home automation and telephony

This knowledge is useful for tasks 3, 8, 9 and 12, i.e., "Install residential distribution, bypass and home automation systems," "Install alarm and monitoring systems," "Install telephone and intercom systems" and "Maintain, repair and troubleshoot electrical and structured cabling systems."

In addition, knowledge of structured cabling types, radiofrequency systems, infrared systems and network characteristics is important for practicing the trade.

Laws and regulations

Referring to the list of laws and regulations mentioned in Section 1.5, the electricians attending the workshop specified that this knowledge is essential for understanding the nature of the work to do and for performing their tasks correctly.

4.2 SKILLS

Skills are types of know-how. They are divided into three categories: cognitive, motor and perceptual.

4.2.1 Cognitive skills

Problem-solving and decision-making

This skill is useful for:

- interpreting plans and specifications;
- pre-operational verifications;
- activation operations;
- maintaining, repairing and troubleshooting electric systems and structured cabling.

Planning activities

This skill is important for all tasks and operations. It is particularly useful for maintaining, repairing and troubleshooting electric systems and structured cabling, because those tasks often require more-complex planning.

4.2.2 Motor skills

Motor skills involve gestures and movements. The main motor skills that electricians need are the following:

- dexterity, for all connection operations on small components (tasks 8 and 9, notably) and the calibration of certain devices;
- movement coordination, for example for working from a height, pulling cables and making certain high-voltage connections;
- physical strength, i.e., the ability for a few moments to lift, carry, push and pull loads at times exceeding 25 kg, particularly for working with large calibre cables and for bending and connecting pipes.

4.2.3 Perceptual skills

Perceptual skills are sensory skills enabling a person to perceive by his senses what is happening in his environment. The main perceptual skills that electricians need are the following:

- sight, to distinguish the colours of cables, estimate height, and read information printed in small characters on certain components;
- hearing, to perceive operating problems (particularly with motive force devices) and protect against occupational health and safety hazards;
- smell, to detect gas leaks, perceive odours of overheating or burning, and protect against occupational health and safety hazards;
- touch, to distinguish cable gauges and apply a tightening sequence.

4.3 ATTITUDES

Attitudes are ways of acting, reacting and relating with others or with one's environment. They involve personal skills. The main attitudes that electricians need are the following:

Personal attitudes

Perseverance, attention to detail, resourcefulness and patience are personal attitudes useful in the trade, particularly for troubleshooting an operating problem.

Interpersonal attitudes

Respect for others, diplomacy and flexibility are important attitudes to be developed by electricians, given that they work in a team and have to relate with customers.

Professional ethics

Confidentiality is required for all work involving alarm and emergency systems, and for all work performed in certain institutions (police, hospitals, etc.) or in industrial settings (industrial secrets on certain processes, for example).

In addition, given the dangers posed by an unsafe electric installation, electricians must be highly ethical.

Preventive attitudes and behaviours in matters of health and safety

These attitudes and behaviours are demonstrated by:

- wearing personal protection and safety equipment according to the nature of work to be done;
- checking the good operation of tools and choosing the appropriate tools to perform a task;
- working while the power is off;
- observing lockout procedures;
- the ability to avail oneself of the right of refusal in a dangerous situation.

5. TRAINING SUGGESTIONS

The electricians attending the occupational analysis workshop made suggestions on initial training and the training of journeymen.

With regard to initial training, several participants made the following suggestions:

- Reduce the number of admissions to the vocational program of study in electricity, because in the last few years a substantial influx of apprentices in the job market has been observed, as well as more numerous and longer unemployment periods.
- Organize tours of construction sites to show young people the realities of the trade.
- Favour learning activities with practical aspects.
- Incorporate lockout procedures in training contents to a greater extent (the participants also expressed the hope that a provincial lockout method would be developed).
- Emphasize welding.

One participant asked that the vocational program of study include training periods in the workplace.

As for the training of journeymen, the participants asked that the CCQ offer more training courses in the regions.

Annexes

Annex 1
Tools and Equipment

For each task of the electrician trade, and on the basis of a list submitted to them[24], the participants determined the tools and equipment they use: standard tools, personal protective equipment (PPE) and safety equipment, scaffolding and access equipment, power tools and equipment, specialty tools and equipment, measuring equipment.

Table A.1 Tools and Equipment

TASK 1 INSTALL HIGH-VOLTAGE DISTRIBUTION AND BYPASS SYSTEMS	
Standard Tools	
Reamers	File
Fuse puller	Hammers
Portable light	Drill bits
Crowbar	Torpedo level
Pipe bender	Non-metallic and non-conductive folding rule
Cold chisel	Slip joint pliers
Adjustable wrench	Needle nose pliers
Pipe wrench	Side/diagonal cutters
Chalk line	Wire strippers
Pipe cutters	Crimping pliers
Cable cutter	Lineman pliers
Knives	Punch
Combination square	Tool holder
Electric threader	Non-metallic and non-conductive measuring tape
Screwdriver set	Fish tape
Step drill	Hack saw
Hex key set	Compass saw
Combination square	Tool bucket
Socket set	Pipe threader
Tap and die set	Nut drivers
Flashlight	

24. This list is based on the 2008 Canadian Red Seal occupational analysis *Electrician (Construction)*.

TASK 1 INSTALL HIGH-VOLTAGE DISTRIBUTION AND BYPASS SYSTEMS	
Personal Protective Equipment (PPE) and Safety Equipment	
Breathing apparatus	Face shield
Pylons	Ventilation equipment
Portable light	Fire extinguisher
Barricades	Gloves
Safety boots	Insulated gloves
Ear plugs and muffs	Knee pads
Life line	Safety vest
Hard hat	Safety harness
Safety belt	Lanyard (retractable and soft pack)
Coveralls (fire retardant)	Safety glasses
Life line	Signage
Rope grab	Warning tape
Fall arresters	Arc visor
Eye wash facilities	
Scaffolding and Access Equipment	
Lift truck	Telescopic lift truck
Scaffolds	Boom lift
Ladders step	Lift
Telescopic hoist	
Power Tools and Equipment	
Core drill	Battery/rechargeable drill
Vacuum	Drill press
Tugger	Magnetic drill
Power pipe bender	Power drill
PVC bender	Heat gun
Hydraulic bender	Reciprocating saw
Power pipe cutters	Circular saw
Power reel lift	Jig saw
Hole saw kit	Band saws
Hammer drill	Hydraulic crimper
Grinder	Power pipe cutters
Bench grinder	Power puller

TASK 1 INSTALL HIGH-VOLTAGE DISTRIBUTION AND BYPASS SYSTEMS	
Specialty Tools and Equipment	
Spud wrench	Sledgehammer
Torque wrench	Mechanical hoist
Rope	Chain falls
Communication devices (intrinsically safe, cell phones and 2-way radio)	Wire rack
Slings	Shovels
Knock-out punch	Hot stick
Thermal welder	Extension cords
Soldering apparatus	Manual hoist
Portable generator	Reel jacks
Shackles	
Measuring Equipment	
Ammeter	Megohmmeter
Hi-pot tester (dielectric tester)	Ground Megohmmetre
Jumper	Multimeter
Cable locator	Ohmmeter
Inductive voltage detector	Clamp ammeter
Phase rotation meter	Voltage tester
Recording meter (watts, volts and amps)	Voltmeter
TASK 2 INSTALL LOW-VOLTAGE DISTRIBUTION SYSTEMS	
Standard Tools	
Reamers	Tap and die set
Fuse puller	Screwdriver set
Portable light	Flashlight
Crowbar	File
Tool holder	Hammers
Pipe bender	Drill bits
Tin snips	Torpedo level
Cold chisel	Awl
Adjustable wrench	Needle nose pliers
Pipe wrench	Side/diagonal cutters
Chalk line	Wire strippers
Pipe cutters	Crimping pliers
Cable cutter	Lineman pliers
Knives	Punch

TASK 2 INSTALL LOW-VOLTAGE DISTRIBUTION SYSTEMS	
Standard Tools	
Combination square	Measuring tape
Electric threader	Fish tape
Step drill	Hack saw
Hex key set	Compass saw
Combination wrench set	Tool bucket
Socket set	Nut drivers
Personal Protective Equipment (PPE) and Safety Equipment	
Breathing apparatus	Face shield
Pylons	Ventilation equipment
Portable light	Fire extinguisher
Barricades	Gloves
Safety boots	Insulated gloves
Ear plugs and muffs	Knee pads
Life line	Safety vest
Hard hat	Safety harness
Safety belt	Eye wash facilities
Coveralls (fire retardant)	Lanyard (retractable and soft pack)
Life line	Safety glasses
Rope grab	Signage
Fall arresters	Warning tape
Scaffolding and Access Equipment	
Lift truck	Telescopic lift truck
Scaffolds	Boom lift
Ladders (step)	Lift
Telescopic hoist	
Power Tools and Equipment	
Vacuum	Grinder
Tugger	Battery/rechargeable drill
Power pipe bender	Heat gun
PVC bender	Reciprocating saw
Hydraulic bender	Jig saw
Hole saw kit	Band saws
Hammer drill	Power puller

TASK 2 INSTALL LOW-VOLTAGE DISTRIBUTION SYSTEMS	
Specialty Tools and Equipment	
Torque wrench	Sledgehammer
Rope	Mechanical hoist
Communication devices (intrinsically safe, cell phones and 2-way radio)	Chain falls
Slings	Wire rack
Knock-out punch	Shovels
Thermal welder	Extension cords
Portable generator	Manual hoist
Shackles	Reel jacks
Measuring Equipment	
Ammeter	Megohmmeter
Insulation resistance meter	Multimeter
Jumper	Ohmmeter
Phase rotation meter	Clamp ammeter
Recording meter (watts, volts and amps)	Voltage tester
TASK 3 INSTALL RESIDENTIAL DISTRIBUTION, BYPASS AND HOME AUTOMATION SYSTEMS	
Standard Tools	
Reamers	Flashlight
Crowbar	File
Tool holder	Hammers
Pipe bender	Drill bits
Tin snips	Torpedo level
Wood chisel	Awl
Cold chisel	Slip joint pliers
Adjustable wrench	Needle nose pliers
Pipe wrench	Side/diagonal cutters
Chalk line	Wire strippers
Pipe cutters	Crimping pliers
Cable cutter	Lineman pliers
Knives	Punch
Combination square	Measuring tape
Step drill	Fish tape
Hex key set	Hack saw
Combination wrench set	Compass saw
Socket set	Tool bucket
Screwdriver set	Nut drivers

TASK 3 INSTALL RESIDENTIAL DISTRIBUTION, BYPASS AND HOME AUTOMATION SYSTEMS	
Personal Protective Equipment (PPE) and Safety Equipment	
Portable light	Fire extinguisher
Safety boots	Gloves
Ear plugs and muffs	Knee pads
Hard hat	Safety harness
Safety belt	Safety glasses
Face shield	
Scaffolding and Access Equipment	
Scaffolds	Boom lift
Ladders (step)	Lift
Telescopic hoist	
Power Tools and Equipment	
PVC bender	Reciprocating saw
Hammer drill	
Specialty Tools and Equipment	
Shovels	Extension cords
Measuring Equipment	
Ammeter	Megohmmeter
Cable locator	Clamp ammeter
Recording meter (watts, volts and amps)	
TASK 4 INSTALL LIGHTING SYSTEMS	
Standard Tools	
Reamers	Flashlight
Fuse puller	Screwdriver set
Portable light	File
Tool holder	Hammers
Pipe bender	Drill bits
Tin snips	Torpedo level
Adjustable wrench	Slip joint pliers
Chalk line	Needle nose pliers
Pipe cutters	Wire strippers
Cable cutter	Crimping pliers
Knives	Lineman pliers

TASK 4 INSTALL LIGHTING SYSTEMS	
Standard Tools	
Combination square	Measuring tape
Electric threader	Fish tape
Step drill	Hack saw
Hex key set	Compass saw
Combination wrench set	Pipe threader
Socket set	Nut drivers
Tap and die set	
Personal Protective Equipment (PPE) and Safety Equipment	
Breathing apparatus	Fire extinguisher
Barricades	Gloves
Safety boots	Insulated gloves
Ear plugs and muffs	Knee pads
Life line	Safety vest
Hard hat	Safety harness
Safety belt	Safety glasses
Life line	Signage
Rope grab	Grounding strap
Fall arresters	Warning tape
Face shield	Lock-out kit
Ventilation equipment	
Scaffolding and Access Equipment	
Lift truck	Telescopic lift truck
Scaffolds	Boom lift
Ladders (step)	Lift
Telescopic hoist	
Power Tools and Equipment	
Taper reamer	Grinder
Vacuum	Battery/rechargeable drill
Tugger	Heat gun
Power pipe bender	Reciprocating saw
PVC bender	Jig saw
Hydraulic bender	Band saws
Power pipe cutters	Hydraulic crimper
Power reel lift	Power puller
Hole saw kit	

TASK 4 INSTALL LIGHTING SYSTEMS	
Specialty Tools and Equipment	
Torque wrench	Mechanical hoist
Rope	Chain falls
Communication devices (intrinsically safe, cell phones and 2-way radio)	Wire rack
Slings	Shovels
Knock-out punch	Hot stick
Thermal welder	Picks
Portable generator	Extension cords
Shackles	Creepers and crawlers
Sledgehammer	Reel jacks
Powder-actuated tools	
Measuring Equipment	
Ammeter	Megohmmeter
Jumper	Ground Megohmmetre
Cable locator	Multimeter
Inductive voltage detector	Ohmmeter
Fault locator	Clamp ammeter
Luxmeter	Voltage tester
TASK 5 INSTALL HEATING, AIR CONDITIONING AND VENTILATION SYSTEMS	
Standard Tools	
Reamers	Screwdriver set
Fuse puller	Flashlight
Portable light	File
Crowbar	Hammers
Tool holder	Drill bits
Pipe bender	Torpedo level
Tin snips	Slip joint pliers
Adjustable wrench	Side/diagonal cutters
Pipe wrench	Wire strippers
Chalk line	Punch
Cable cutter	Lineman pliers
Knives	Measuring tape
Step drill	Fish tape
Hex key set	Hack saw
Combination wrench set	Compass saw
Socket set	Nut drivers

TASK 5 INSTALL HEATING, AIR CONDITIONING AND VENTILATION SYSTEMS	
Personal Protective Equipment (PPE) and Safety Equipment	
Breathing apparatus	Fall arresters
Pylons	Eye wash facilities
Portable light	Face shield
Barricades	Fire extinguisher
Safety boots	Gloves
Ear plugs and muffs	Knee pads
Life line	Safety harness
Hard hat	Lanyard (retractable and soft pack)
Safety belt	Safety glasses
Coveralls (fire retardant)	Signage
Life line	Warning tape
Rope grab	Arc visor
Scaffolding and Access Equipment	
Lift truck	Telescopic lift truck
Scaffolds	Boom lift
Ladders (step)	Lift
Telescopic hoist	
Power Tools and Equipment	
Taper reamer	Hammer drill
Vacuum	Grinder
Power pipe bender	Battery/rechargeable drill
Hydraulic bender	Reciprocating saw
Hole saw kit	Band saws
Specialty Tools and Equipment	
Spud wrench	Knock-out punch
Rope	Portable generator
Communication devices (intrinsically safe, cell phones and 2-way radio)	Shackles
Slings	Extension cords
Measuring Equipment	
Ammeter	Ohmmeter
LAN meter (cable analyser)	Clamp ammeter
Insulation resistance meter	Voltage tester
Multimeter	Voltmeter

TASK 6 PUT IN PLACE AND CONNECT MOTIVE FORCES	
Standard Tools	
Reamers	File
Fuse puller	Hammers
Portable light	Drill bits
Pipe bender	Torpedo level
Tin snips	Needle nose pliers
Cold chisel	Side/diagonal cutters
Adjustable wrench	Wire strippers
Pipe cutters	Crimping pliers
Cable cutter	Lineman pliers
Knives	Tool holder
Step drill	Measuring tape
Hex key set	Fish tape
Combination wrench set	Hack saw
Socket set	Pipe threader
Screwdriver set	Nut drivers
Personal Protective Equipment (PPE) and Safety Equipment	
Portable light	Fire extinguisher
Safety boots	Gloves
Ear plugs and muffs	Knee pads
Hard hat	Safety vest
Life line	Safety harness
Rope grab	Safety glasses
Fume and toxic gas detector	Signage
Fall arresters	Grounding strap
Ventilation equipment	Arc visor
Scaffolding and Access Equipment	
Lift truck	Telescopic lift truck
Scaffolds	Boom lift
Ladders (step)	Lift
Telescopic hoist	

TASK 6 PUT IN PLACE AND CONNECT MOTIVE FORCES	
Power Tools and Equipment	
Taper reamer	Bench grinder
Vacuum	Battery/rechargeable drill
Power pipe bender	Drill press
Hydraulic bender	Power drill
Power pipe cutters	Heat gun
Power reel lift	Band saws
Hole saw kit	Power pipe cutters
Hammer drill	Power puller
Grinder	
Specialty Tools and Equipment	
Spud wrench	Grip hoist
Torque wrench	Chain falls
Slings	Wire rack
Knock-out punch	Shovels
Soldering apparatus	Hot stick
Portable generator	Extension cords
Shackles	Creepers and crawlers
Sledgehammer	Manual hoist
Powder-actuated tools	Reel jacks
Measuring Equipment	
Ammeter	Ground Megohmmetre
Cable locator	Multimeter
Light meter	Ohmmeter
Phase rotation meter	Clamp ammeter
Motor rotation meter	Voltage tester
Recording meter (watts, volts and amps)	Voltmeter
Fault locator	Wattmeter
Megohmmeter	
TASK 7 INSTALL EMERGENCY POWER SYSTEMS	
Standard Tools	
Reamers	Flashlight
Fuse puller	File
Portable light	Hammers
Crowbar	Drill bits
Pipe bender	Torpedo level

TASK 7 INSTALL EMERGENCY POWER SYSTEMS	
Standard Tools	
Tin snips	Awl
Cold chisel	Slip joint pliers
Adjustable wrench	Needle nose pliers
Pipe wrench	Side/diagonal cutters
Chalk line	Wire strippers
Pipe cutters	Crimping pliers
Cable cutter	Lineman pliers
Knives	Punch
Combination square	Tool holder
Electric threader	Measuring tape
Step drill	Fish tape
Hex key set	Hack saw
Combination wrench set	Compass saw
Socket set	Tool bucket
Tap and die set	Pipe threader
Screwdriver set	Nut drivers
Personal Protective Equipment (PPE) and Safety Equipment	
Breathing apparatus	Face shield
Self-contained breathing apparatus	Ventilation equipment
Pylons	Confined space equipment
Portable light	Fire extinguisher
Barricades	Gloves
Safety boots	Insulated gloves
Ear plugs and muffs	Knee pads
Life line	Safety harness
Hard hat	Lanyard (retractable and soft pack)
Safety belt	Safety glasses
Coveralls (fire retardant)	Signage
Life line	Grounding strap
Rope grab	Warning tape
Fume and toxic gas detector	Lock-out kit
Fall arresters	Arc visor
Eye wash facilities	

TASK 7 INSTALL EMERGENCY POWER SYSTEMS	
Scaffolding and Access Equipment	
Lift truck	Telescopic lift truck
Scaffolds	Boom lift
Ladders (step)	Lift
Telescopic hoist	
Power Tools and Equipment	
Vacuum	Drill press
Tugger	Magnetic drill
Power pipe bender	Power drill
PVC bender	Heat gun
Hydraulic bender	Reciprocating saw
Power pipe cutters	Circular saw
Power reel lift	Jig saw
Hole saw kit	Band saws
Hammer drill	Hydraulic crimper
Grinder	Power pipe cutters
Bench grinder	Power puller
Battery/rechargeable drill	
Specialty Tools and Equipment	
Spud wrench	Powder-actuated tools
Torque wrench	Grip hoist
Rope	Mechanical hoist
Communication devices (intrinsically safe, cell phones and 2-way radio)	Chain falls
Slings	Wire rack
Knock-out punch	Shovels
Thermal welder	Hot stick
Soldering apparatus	Extension cords
Portable generator	Strain relief grip
Shackles	Creepers and crawlers
Sledgehammer	Manual hoist
Inverter	Reel jacks

TASK 7 INSTALL EMERGENCY POWER SYSTEMS	
Measuring Equipment	
Ammeter	Fault locator
LAN meter (cable analyser)	Megohmmeter
Insulation resistance meter	Ground Megohmmetre
Jumper	Multimeter
Cable locator	Ohmmeter
Inductive voltage detector	Clamp ammeter
Light meter	Tachometer
Phase rotation meter	Voltage tester
Motor rotation meter	Voltmeter
Recording meter (watts, volts and amps)	Wattmeter
TASK 8 INSTALL ALARM AND MONITORING SYSTEMS	
Standard Tools	
Reamers	Hammers
Portable light	Drill bits
Pipe bender	Torpedo level
Tin snips	Awl
Cold chisel	Slip joint pliers
Chalk line	Needle nose pliers
Pipe cutters	Side/diagonal cutters
Cable cutter	Wire strippers
Knives	Crimping pliers
Combination square	Lineman pliers
Step drill	Punch
Electric threader	Tool holder
Hex key set	Measuring tape
Combination wrench set	Fish tape
Socket set	Hack saw
Tap and die set	Compass saw
Screwdriver set	Tool bucket
Flashlight	Nut drivers
File	

TASK 8 INSTALL ALARM AND MONITORING SYSTEMS	
Personal Protective Equipment (PPE) and Safety Equipment	
Breathing apparatus	Fall arresters
Self-contained breathing apparatus	Eye wash facilities
Pylons	Face shield
Portable light	Ventilation equipment
Barricades	Confined space equipment
Safety boots	Fire extinguisher
Ear plugs and muffs	Gloves
Life line	Insulated gloves
Hard hat	Knee pads
Safety belt	Safety harness
Coveralls (fire retardant)	Lanyard (retractable and soft pack)
Life line	Safety glasses
Rope grab	Signage
Fume and toxic gas detector	Grounding strap
Scaffolding and Access Equipment	
Lift truck	Telescopic lift truck
Scaffolds	Boom lift
Ladders (step)	Lift
Telescopic hoist	
Power Tools and Equipment	
Taper reamer	Battery/rechargeable drill
Vacuum	Drill press
PVC bender	Magnetic drill
Power pipe cutters	Heat gun
Hole saw kit	Reciprocating saw
Hammer drill	Circular saw
Grinder	Jig saw
Bench grinder	Band saws
Specialty Tools and Equipment	
Communication devices (intrinsically safe, cell phones and 2-way radio)	Powder-actuated tools
Knock-out punch	Wire rack
Soldering apparatus	Extension cords
Portable generator	Reel jacks

TASK 8 INSTALL ALARM AND MONITORING SYSTEMS	
Measuring Equipment	
Ammeter	Ohmmeter
Jumper	Clamp ammeter
Cable locator	Voltage tester
Motor rotation meter	Voltmeter
Recording meter (watts, volts and amps)	
TASK 9 INSTALL TELEPHONE AND INTERCOM SYSTEMS	
Standard Tools	
Reamers	Torpedo level
Portable light	Awl
Pipe bender	Slip joint pliers
Tin snips	Needle nose pliers
Cold chisel	Side/diagonal cutters
Chalk line	Wire strippers
Pipe cutters	Crimping pliers
Knives	Lineman pliers
Step drill	Punch
Hex key set	Tool holder
Combination wrench set	Measuring tape
Socket set	Fish tape
Tap and die set	Hack saw
Screwdriver set	Compass saw
Flashlight	Tool bucket
File	Pipe threader
Hammers	Nut drivers
Drill bits	
Personal Protective Equipment (PPE) and Safety Equipment	
Breathing apparatus	Face shield
Self-contained breathing apparatus	Ventilation equipment
Pylons	Confined space equipment
Portable light	Fire extinguisher
Barricades	Gloves
Safety boots	Insulated gloves
Ear plugs and muffs	Knee pads
Life line	Safety vest

TASK 9 INSTALL TELEPHONE AND INTERCOM SYSTEMS	
Personal Protective Equipment (PPE) and Safety Equipment	
Hard hat	Safety harness
Safety belt	Lanyard (retractable and soft pack)
Coveralls (fire retardant)	Safety glasses
Life line	Signage
Rope grab	Grounding strap
Fire blanket	Warning tape
Fume and toxic gas detector	Lock-out kit
Fall arresters	First aid equipment
Eye wash facilities	
Scaffolding and Access Equipment	
Lift truck	Telescopic lift truck
Scaffolds	Boom lift
Ladders (step)	Lift
Telescopic hoist	
Power Tools and Equipment	
Taper reamer	Drill press
Vacuum	Magnetic drill
Power pipe bender	Power drill
Hole saw kit	Reciprocating saw
Hammer drill	Circular saw
Grinder	Jig saw
Bench grinder	Band saws
Battery/rechargeable drill	
Specialty Tools and Equipment	
Rope	Soldering apparatus
Communication devices (intrinsically safe, cell phones and 2-way radio)	Portable generator
Knock-out punch	Extension cords
Measuring Equipment	
LAN meter (cable analyser)	Ohmmeter
Insulation resistance meter	Voltage tester
Jumper	Voltmeter
Fault locator	Wattmeter
Multimeter	

TASK 10 INSTALL AUTOMATION AND CONTROL SYSTEMS FOR INDUSTRIAL AND BUILDING EQUIPMENT	
Standard Tools	
Reamers	Hammers
Portable light	Drill bits
Pipe bender	Torpedo level
Tin snips	Awl
Cold chisel	Slip joint pliers
Chalk line	Needle nose pliers
Pipe cutters	Side/diagonal cutters
Cable cutter	Wire strippers
Knives	Crimping pliers
Combination square	Lineman pliers
Step drill	Punch
Electric threader	Tool holder
Hex key set	Measuring tape
Combination wrench set	Fish tape
Socket set	Hack saw
Tap and die set	Compass saw
Screwdriver set	Tool bucket
Flashlight	Nut drivers
File	
Personal Protective Equipment (PPE) and Safety Equipment	
Breathing apparatus	Fall arresters
Self-contained breathing apparatus	Eye wash facilities
Pylons	Face shield
Portable light	Ventilation equipment
Barricades	Confined space equipment
Safety boots	Fire extinguisher
Ear plugs and muffs	Gloves
Life line	Knee pads
Hard hat	Safety harness
Safety belt	Lanyard (retractable and soft pack)
Coveralls (fire retardant)	Safety glasses
Life line	Signage
Rope grab	Grounding strap
Fume and toxic gas detector	

TASK 10 INSTALL AUTOMATION AND CONTROL SYSTEMS FOR INDUSTRIAL AND BUILDING EQUIPMENT	
Scaffolding and Access Equipment	
Lift truck	Telescopic lift truck
Scaffolds	Boom lift
Ladders (step)	Lift
Telescopic hoist	
Power Tools and Equipment	
Taper reamer	Battery/rechargeable drill
Vacuum	Drill press
PVC bender	Magnetic drill
Power pipe cutters	Heat gun
Hole saw kit	Reciprocating saw
Hammer drill	Circular saw
Grinder	Jig saw
Bench grinder	Band saws
Specialty Tools and Equipment	
Communication devices (intrinsically safe, cell phones and 2-way radio)	Computer
Knock-out punch	Wire rack
Soldering apparatus	Extension cords
Portable generator	Reel jacks
Powder-actuated tools	
Measuring Equipment	
Ammeter	Ohmmeter
Jumper	Clamp ammeter
Cable locator	Voltage tester
Recording meter (watts, volts and amps)	Voltmeter

TASK 11 INSTALL CATHODIC PROTECTION SYSTEMS	
Standard Tools	
Reamers	Torpedo level
Adjustable wrench	Needle nose pliers
Pipe cutters	Side/diagonal cutters
Cable cutter	Wire strippers
Knives	Crimping pliers
Step drill	Lineman pliers
Hex key set	Tool holder
Combination wrench set	Measuring tape
Socket set	Fish tape
Screwdriver set	Hack saw
File	Pipe threader
Hammers	Nut drivers
Drill bits	
Personal Protective Equipment (PPE) and Safety Equipment	
Safety boots	Safety vest
Ear plugs and muffs	Safety harness
Hard hat	Safety glasses
Fume and toxic gas detector	Signage
Fire extinguisher	Grounding strap
Gloves	
Knee pads	
Power Tools and Equipment	
Taper reamer	Power drill
Vacuum	Band saws
Power pipe cutters	Power pipe cutters
Hammer drill	Power puller
Battery/rechargeable drill	
Specialty Tools and Equipment	
Spud wrench	Slings
Torque wrench	Extension cords
Measuring Equipment	
Ground Megohmmetre	Ohmmeter
Multimeter	Voltage tester

TASK 12 MAINTAIN, REPAIR AND TROUBLESHOOT ELECTRICAL AND STRUCTURED CABLING SYSTEMS	
Standard Tools	
Depending on the nature of the intervention.	
Personal Protective Equipment (PPE) and Safety Equipment	
Portable light	Fire extinguisher
Safety boots	Gloves
Ear plugs and muffs	Insulated gloves
Life line	Knee pads
Hard hat	Safety vest
Safety belt	Safety harness
Coveralls (fire retardant)	Lanyard (retractable and soft pack)
Life line	Safety glasses
Rope grab	Signage
Fall arresters	
Face shield	
Scaffolding and Access Equipment	
Depending on the nature of the intervention.	
Power Tools and Equipment	
Depending on the nature of the intervention.	
Specialty Tools and Equipment	
Depending on the nature of the intervention.	
Measuring Equipment	
Depending on the nature of the intervention.	

Annex 2

Grid of Occupational Health and Safety Elements

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Table A.2 Description of Hazards

No.	Hazards	Effects on Health and Safety	Means of Prevention
1	**Same-level fall hazards** • Poor housekeeping (clutter, rubbish, debris, holes, etc.) • Slippery surfaces (rain, ice, snow, residues, dust, oil, etc.) • Risk of tripping over extension cords, pipes, materials, etc. • Risk of spraining an ankle or foot in a hole	• Collisions • Contusions • Bruises • Fractures • Sprains	• Clean the workplace (pick up debris). • Level the ground. • Apply abrasives to make the surface less slippery. • Absorb oils, recover water. • Hang cluttering objects at 2.1 m or protect the walk area. • Close the holes (fasten plating).
2	**Fall-from-height hazards**		• Assess the risk of falling from several levels in the work environment and check the availability of means of protection (see 2*e*).
	2 a) • Using a stepladder	• Collisions • Contusions • Bruises • Fractures • Sprains • Internal injuries • Physical and psychological after-effects • Paralysis • Death	2 a) • Use a **class 1 stepladder with a rated capacity of 250 lb**. • Keep the spreaders fully open. • Install the stepladder on a firm level surface. • Choose the stepladder according to the height to be reached.

No.	Hazards	Effects on Health and Safety	Means of Prevention
	2 b) • Using a ladder		2 b) • Use a **class 1** ladder. • Position and maintain a slope of 1/4 to 1/3 from the height of the bearing point. • Use only for work of short duration (less than one hour). • Do not stand on the last two rungs to reach a point that is not close. • Climb up and down a ladder while: - always having three support points; - holding the bars and not the side rails; - remaining between the side rails; - not holding anything in the hands; - facing the ladder.
	2 c) • Using a small mobile scaffold (Baker)		2 c) • Apply stability principles. • Never exceed three times the smallest support base. • Always use the wheel locking mechanism. • Climb down a mobile scaffold to move it.
	2 d) • Using a metal frame scaffold or a tubular scaffold		2 d) • Stabilize the scaffold by: - using stabilizers on the ground; - tying it to the building; - using guys; - place the two side rails side by side and fasten them by wind bracing. • When there is a risk of falling more than 3 m: - install a railing system of the type developed by the Association des entrepreneurs en maçonnerie du Québec (AEMQ); or - wear a shock-absorbing harness, with an anchor that has a breaking strength of 18 kN; or - be attached to a vertical lifeline meeting with Safety Code specifications. • Check the bearing capacity of the ground. • install beds and jack screws if the ground is sloped. • For each scaffolding section, install vertical locks. • Use safe means of access. • Install anchors to the structure at intervals not exceeding 3 times the minimum scaffold width.

No.	Hazards	Effects on Health and Safety	Means of Prevention
	2 e) • Using an aerial automotive work platform 2 f) • Using tower or platform scaffolding (Fraco or other)		• Make sure to use planks carrying the NLGA seal of approval: - the floor is wide enough (minimum 470 mm); - the distance between the structure and the floor is less than 350 mm. 2 e) • Took the training required by safety standards. • Wear an energy-absorbing harness for the jib boom platform. • Delimit the work area to avoid the risk of collision. • Keep the feet on the platform floor. • Climb up and down facing the equipment, with 3 support points. • Keep the platform access and floor clean. 2 f) • Comply with standards, capacities and an installation plan provided by an engineer.
3	**Ergonomic hazards** • Posture constraints / statis • Repeated movements • Handling • Difficulty of the task • Vibrations (hand-arm system) • Weight of stones and concrete blocks	• Musculoskeletal lesions • Sprains • Hernias • Fatigue • Discomfort • Pain • Tendinitis	• Rotate tasks if possible. • Favour the purchase of tools limiting vibrations to a minimum. • Use handling equipment. • Know handling techniques.

No.	Hazards	Effects on Health and Safety	Means of Prevention
4	**Chemical hazards – gases and fumes** • Using propane, gasoline, etc. • Production of carbon monoxide by motors • Aluminothermic welding (Cadweld) and other processes (MIG, TIG) • Using chemicals (flux, glue, adhesive resin, sealing material, etc.)	• Body intoxication (with carbon monoxide, notably) • Burns	• Took WHMIS training. • Keep at workplaces the specification sheets of hazardous products. • Ensure mechanical or natural ventilation. • Use a welding fume vacuum system. • Measure the percentage of oxygen and the level of carbon monoxide to ensure that ventilation is effective. • Wear respiratory protection. • Wear appropriate personal protective equipment (gloves, coveralls). • Wear safety glasses or a visor. • Use a tile saw or a dust vacuum system. • Use tools equipped with a vacuum system including a HEPA filter. • Have appropriate emergency equipment (eye-wash station, fire extinguisher, etc.). • For welding, refer to manufacturer instructions.
5	**Chemical hazards – dust** • Silica dust • Asbestos dust • Sanding with a grinder	• Corrosive burns • Respiratory illnesses • Skin problems (dermatosis)	• Took WHMIS training. • Keep at workplaces the specification sheets of hazardous products. • Wear respiratory protection equipped with appropriate filters for the contaminants. • Wear appropriate personal protective equipment (gloves, coveralls, safety glasses or visor). • Use a tile saw with a dust vacuum system. • Use tools equipped with a vacuum system including a HEPA filter. • Have appropriate emergency equipment (eye-wash station, fire extinguisher, etc.).

No.	Hazards	Effects on Health and Safety	Means of Prevention
6	**Electrical hazards** • Contact with overhead electric lines • Electric tools • Contact with electric wires or outlets • Arc flash	• Electrification • Fibrillations • Burns • Amputation • Paralysis • Electrocution • Death	• Maintain the minimum distances of approach prescribed by the Safety Code for the construction industry. • Establish a working agreement with the operating company. • Use tools featuring double insulation or grounding. • Use measuring devices with a safety rating appropriate for electrical installation. • Use extension cords in good condition and ground protection. • Perform the electrical shutdown, lockout and identification of components. • Took the compulsory training for working near electric lines. • Assess and determine the hazard level of arc flashes. • Took training in live-line work and protective clothing according to the hazard level.
7	**Noise hazards** • Hand, electric, gasoline, etc. tools • Handling scaffolds • Ambient noise of equipment in operation	• Hearing loss (occupational deafness)	• Choose the least noisy equipment possible. • Do required preventive maintenance. • Wear ear plugs or shells.
8	**Mechanical hazards** • Moving parts • Broken blade, drill bit or tool • Hazard of being caught or cornered by machinery in operation	• Contusions • Fractures • Crushing • Amputation • Cuts • Burns	• Have a regulatory grid regarding protection from machines. • Perform required preventive maintenance. • Collect information and take training in the use of new tools. • Follow the electrical shutdown or lockout procedure.

No.	Hazards	Effects on Health and Safety	Means of Prevention
9	**Environmental hazards** • Extreme temperature (cold or hot) • Confined space	• Discomfort due to cold • Hypothermia • Chilblains • Heatstroke • Intoxication, asphyxia	• Comply with health and safety rules. • Ensure adequate ventilation of work areas. • Do preventive maintenance of gas equipment. • Take training in the hazards of carbon monoxide and nitrogen dioxide. • Adopt the work method and the procedure required for work in confined spaces.
10	**Stress-related hazards** • Quality of the finish • Application time • Application productivity • Reaction of mixes • Related hazardous activities (hoisting with a crane, live-line work, machinery in operation, unusually hazardous environment, etc.)	• Health problems • Hypertension • Eczema	• Plan the work. • Limit work done under pressure. • Be trained and qualified in work methods specific to the hazards involved.
11	**Fire hazards**	• Smoke • Coughing • Irritation • Intoxication • Burns	• Have a fire extinguisher.

Annex 3

List of Diplomas Giving Access to the Electrician Trade of the Construction Industry

Vocational Diplomas (DEPs)	
Title	**Codes**
Construction Electrician	732-500
Construction Electrician	782-500
Construction Electricity	1930
Construction Electricity	EAA-057
Électricien de construction ou Électricité de construction	232-500
Électricien de construction ou Électricité de construction	282-500
Électricité	5295
Électricité d'entretien	EAA-008
Électricité de construction	EAA-007
Électricité de construction	1344
Électricité de construction	1430
Electricity	5795
Installation et entretien de systèmes de sécurité	5184
Installation et entretien de systèmes de sécurité	5242
Installation et entretien de systèmes de sécurité	5296
Maintenance Electricity	EAA-058
Réparation et dépannage de systèmes de sécurité	1352

College Diplomas	
Title	**Codes**
Électrodynamique	243.01
Électronique	243.03
Électronique - option télécommunications	243.93
Électronique - option audiovisuel	243.95
Électronique - option ordinateurs	243.94
Électronique industrielle option instrumentation et automatisation	243.87
Électronique industrielle	243.21
Électronique industrielle option électrodynamique	243.86
Industrial Electronics	243.06
Instrumentation et contrôle	243.02
Technologie de conception électronique	243.16
Technologie de l'électronique industrielle	243.06
Technologie de systèmes ordinés	247.01
Technologie de systèmes ordinés	243.15
Technologie physique	244.01
Technologie physique	243.14
Technologie de l'électronique	243.11
Technologie de l'électronique industrielle	243.C0