Skills and Safety Matter:
Maintaining High Standards in the Electrical Trades is Essential for an Effective Ontario Apprenticeship Model

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Presented July 4, 2019

Electrical Contractors Association of Ontario (ECAO)

Ontario Electrical League (OEL)

International Brotherhood of Electrical Workers - Construction Council of Ontario (IBEW - CCO)

Christian Labour Association of Canada (CLAC)

ECAO
ELECTRICAL CONTRACTORS ASSOCIATION OF ONTARIO

ONTARIO ELECTRICAL LEAGUE

INTERNATIONAL BROTHERHOOD OF ELECTRICAL WORKERS

CLAC
better together

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Key Points

1. The Electrical Contractors Association of Ontario (ECAO) and the Ontario Electrical League (OEL) represent close to 1000 electrical contractors who, together, employ more than 30,000 electricians and apprentices. These contractors carry out the majority of electrical repair, installation and construction work in Ontario. Along with the International Brotherhood of Electrical Workers (IBEW) and CLAC (Christian Labour Association of Canada), we are committed to working with the government to ensure the success of apprenticeship reform and to work with them on ways to ensure Ontario maintains a skilled workforce for the future.

2. As the combined voice for the electrical industry in Ontario we believe the following are critical issues to consider:

    1) The Red Seal

    Ontario's apprenticeship reform needs to reflect our province's and our industry's historic commitment to the Red Seal. The Red Seal Endorsement is the gold standard for the trades. It ensures tradespersons will have their competency recognized everywhere in Canada

    2) Public and Worker Safety

    Apprenticeship reform must uphold public and worker safety in electrical work. Each trade has varying degrees of risk. However, we submit that the electrical trade is among the highest.

    3) Competency Standards

    Apprenticeship reform should maintain our province's high competency standards for performing electrical work. To build safe and effective infrastructure Ontario needs skilled trades professionals who will invest in training and ongoing education to perform complex work and adapt to evolving technology.

4) Support our Apprentices by Upholding the Value of a C of Q

To encourage individuals to pursue a career in one of the electrical trades we must enhance, not diminish, the value of a Certificate of Qualification (C of Q). Anyone considering a career in an electrical trade must feel confident they will be properly trained to do the work safely and effectively. Parents and school counsellors will also want that assurance before encouraging students to consider such a career path.

3. For these reasons, we seek assurances that Ontario's new apprenticeship system:

    1) **the Minister will not certify any electrical skill set unless that certification is also eligible for Red Seal Endorsement**;

    2) the Ministerial policy that will describe the activities of the electrical trades will **continue the existing scopes of practice** for those trades;

    3) ***all* of the activities in the policy describing the activities of the electrical trades will be restricted, with exceptions being made in the civil sector (*e.g.*, road construction)** – where there is a well-established practice that does not put worker or public safety at risk; and

    4) **any changes to the list of restricted activities will be made, if at all, only after extensive consultation with industry stakeholders.** These consultations should include: industry associations, unions, the Electrical Safety Authority, the Ontario Fire Marshal, the Canadian Standards Association (which develops the Canadian Electrical Code on which Ontario's Electrical Safety Code is based), the Health and Safety Branch of the Ministry of Labour, electrical utilities, and the colleges and training centres that deliver apprenticeship training to the electrical trades.

4. We understand the need for Ontario's apprenticeship system to be flexible and to be responsive to the needs of our economy. In the electrical trades, these goals must be achieved without weakening the Red Seal, public and worker safety or competency standards. We reiterate our willingness to work with the government on implementing its reform to Ontario's apprenticeship system so that it meets the goals of reform without risking the Red Seal, public and worker safety or competency standards.

Respectfully submitted

Electrical Contractors Association of Ontario (ECAO)
Ontario Electrical League (OEL)
International Brotherhood of Electrical Workers (IBEW)
CLAC

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Who We Are:

The contractors and workers represented by our organizations undertake, by far, the preponderant share of all electrical contracting projects – big and small – in Ontario.

- The Electrical Contractors Association of Ontario (ECAO) represents over 500 unionized electrical contractors in Ontario. ECAO's members employ more than 17,000 skilled tradespersons and apprentices in the electrical trades.
- The Ontario Electrical League (OEL) represents over 400 union and non-union electrical contractors in Ontario. The member companies of the OEL employ more than 12,000 skilled electricians and apprentices.
- The International Brotherhood of Electrical Workers – Construction Council of Ontario (IBEW-CCO) represents close to 19,000 men and women in the electrical trades, including 3,500 apprentices.
- CLAC represents 1,355 men and women in the electrical trades in Ontario, including 441 apprentices employed by over 60 contractors.

Our Concerns:

We have four key concerns that we ask the government to take into account when implementing apprenticeship reform.

First: we are concerned that issuing certificates for stand-alone electrical skill sets that are not also eligible for Red Seal Endorsement will undermine the Red Seal Program;

Second: we are concerned that loosening the restricted activities in the electrical trades will put public and worker safety at risk;

Third: we are concerned that certifying portions of the electrical trade as stand-alone skill sets will undermine Ontario's high standards of competency in the electrical industry; and

Fourth: we are concerned that migrating work from apprentices to less qualified or untrained workers will diminish the

employment opportunities for apprentices and reduce the perceived value of a Certificate of Qualification in the electrical trades.

What We Seek:

We want to ensure that the reforms to the apprenticeship and trade system achieve their objectives while, at the same time, ensuring a continuation of the high levels of safety, quality and efficiency that characterize our industry.

The *Modernizing the Skilled Trades and Apprenticeship Act* makes two significant changes:

First: the new legislation replaces the existing scope of practice for a trade (per Reg. 275/11 of the *Ontario College of Trades and Apprenticeship Act*) with a policy issued by the Minister that will describe the activities of the trade;

Second: the new legislation provides that certain activities of a trade can be restricted.

To ensure continued high levels of competency, safety, quality and efficiency we seek assurances from the government that:

a) Ontario will not certify any electrical skill set unless that certification is also eligible for Red Seal Endorsement;

b) the Ministerial policies describing the activities of the two construction-related electrical trades[1] will mirror the current scopes of practice that are set out in Reg. 275/11 of the *Ontario College of Trades and Apprenticeship Act.* These scopes of practice reflect the National Occupational Analysis for the electrical trade. They appropriately and succinctly describe the competencies that industry believes an electrician needs to have;

c) for the construction-related electrical trades, *all* of the activities set out in the Ministerial policy describing their activities will continue to be restricted. This will be a continuation of the current practice. We recognize, however, the need for exceptions to reflect well-established practice in the civil sector (e.g., road construction); and

d) in light of the importance of public and worker safety, changes to the list of restricted practices will be considered, if at all, *only* after extensive consultations with all stakeholders, including:
    - industry associations,

[1] The two construction-related electrical trades are:
- Electrician – Construction and Maintenance (309A), and
- Electrician – Domestic and Rural (309C)

The Electrician – Domestic and Rural (309C) has a more limited scope of practice than Electrician – Construction and Maintenance (309A).

- unions,
- the Electrical Safety Authority,
- the Ontario Fire Marshal,
- the Canadian Standards Association,
- the Health and Safety Branch of the Ministry of Labour,
- the Canadian Electrical Contractors Association,
- electrical utilities, and
- the colleges and training centres that deliver apprenticeship training to the electrical trades.

We understand the need for Ontario's apprenticeship system to be flexible and to be responsive to the needs of Ontario's economy. We will work with the government to develop strategies that will increase flexibility and responsiveness in the electrical trades within a context of protecting the Red Seal, ensuring public and worker safety, and maintaining high competency standards.

We also understand that in some areas of civil construction (*e.g.*, road work), there are well-established practices that have developed where some electrical work is carried out by persons who are not fully-trained electricians. We are not seeking to disrupt these well-established practices. We are, however, strongly of the view that in utility work and building construction and repair (both residential and non-residential), there should be no weakening of Red Seal competency standards or restricted activities policy.

In the sections below we will expand on the concerns that have prompted this submission.

1. It is Essential that Ontario Uphold the Red Seal

The Red Seal Endorsement is the 'gold standard' for the trades. It ensures that Ontario-trained tradespersons will have their competency recognized everywhere in Canada. This has been an important objective of every Ontario government.

The Red Seal Plan was first developed in Ontario by the Ontario Electrical League (OEL) as a symbol of reliability. The Red Seal decal was posted on switch boxes in homes to signify that residential wiring met minimum standards. The plan then went national. By 1930, roughly one million Red Seal homes were built in Toronto, Winnipeg, and Vancouver. Over the years, the Red Seal was adopted by other Canadian jurisdictions, the United States and international locations such as Australia through licensing agreements with the OEL. The term "Red Seal" has since been adopted for the national program that sets common standards for the skilled trades across Canada. When the Red Seal appears on trade certificate, it means that the tradesperson has demonstrated the competency required to meet the national standard.

Ontario would seriously undermine the Red Seal Program if it issued certifications for electrical skill sets that were not also eligible for Red Seal Endorsement. Moreover, doing so would run counter to the *Ontario Labour Mobility Act*. The *Ontario Labour Mobility Act* came into force in December,

2009. The purpose of this legislation is to implement the labour mobility provisions of the Federal-Provincial *Agreement on Internal Trade*. The *Act* explicitly reaffirms Ontario's commitment to the Red Seal program. More importantly, sec. 12(1)(c) states that Ontario will *not* establish occupational certifications that are inconsistent with the Red Seal program. Sec. 12(1) reads as follows [with emphasis added]:

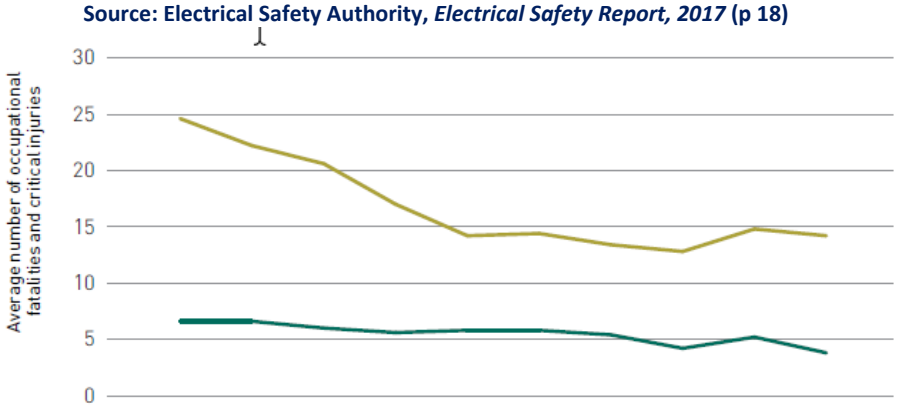
> 12 (1) Every Ontario regulatory authority shall, to the extent possible and where practical,
>
> (a) ensure that the process it follows in establishing or amending occupational standards for the occupations for which it is authorized to grant an authorizing certificate is conducive to labour mobility within Canada;
>
> (b) take steps to reconcile differences between the occupational standards it has established for an occupation and occupational standards in effect with respect to the same occupation in the other provinces and territories of Canada that are parties to the Canadian Free Trade Agreement; and
>
> (c) ensure that the occupational standards it establishes for each occupation for which it is authorized to grant an authorizing certificate are consistent with such common interprovincial or international occupational standards as may have been developed for that occupation, including occupational standards developed under the Interprovincial Standards Red Seal Program. 2009, c. 24, s. 12 (1); 2017, c. 34, Sched. 32, s. 2.

In light of the importance of upholding the Red Seal Program and the commitments made in the Ontario Labour Mobility Act, we believe it would be a serious misstep if Ontario were to issue certificates for electrical skill sets if those certificates were not eligible for Red Seal Endorsement.

2. Public and Worker Safety are Paramount

Ontario has made significant progress in improving electrical safety for the general public and for workers. Figure No. 1 shows that there has been a significant decline in fatalities and critical injuries from electrical incidents both for persons working in the electrical trade and for other workers.

Figure No. 1
Five-Year Rolling Average of Electrical-Related Occupational Fatalities and Critical Injuries in Ontario, 2004-2017
Source: Electrical Safety Authority, *Electrical Safety Report, 2017* (p 18)



Five-year rolling average	2004-2008	2005-2009	2006-2010	2007-2011	2008-2012	2009-2013	2010-2014	2011-2015	2012-2016	2013-2017
Occupational safety overall	25	22	21	17	14	14	13	13	15	14
Electrical trade	6.6	6.6	6.0	5.6	5.8	5.8	5.4	4.2	5.2	3.8

Of particular note in the *Electrical Safety Report* for 2017 is the finding by the Electrical Safety Authority that improper installation procedure or lack of hazard assessment was the cause of 50% of the electricity-related fatalities and critical injuries. (See *Electrical Safety Report, 2017*, p 22).

It also important to note that more than three-quarters of electricity-related work fatalities were experienced by workers who were *not* trained as electricians or powerline workers. (See *Electrical Safety Report, 2017*, p 24). This finding is consistent with a study on the risk of harm in electrical contracting which found that "one of the most prominent risks of harm mentioned by participants (72 written comments) was the risk of harm 'caused by workers who are unskilled, uninformed, untrained, uneducated, non-expert and un-certified'…"[2]

Ontario's Construction Projects Regulation to the *Occupational Health and Safety Act* (Reg. 213/91) is one of the foundations of Ontario's success in reducing workplace injuries and fatalities in the construction industry. Sec. 182 of the Construction Projects regulation requires electrical work to be performed by a qualified electrician or a registered apprentice, except under limited circumstances. Sec. 182 reads as follows:

> 182. (1) No worker shall connect, maintain or modify electrical equipment or installations unless,
>
> (a) the worker holds a certificate of qualification issued under the *Ontario College of Trades and Apprenticeship Act, 2009*, that is not suspended, in the trade of,
>
> (i) electrician — construction and maintenance, or

[2] Gavin Howe, "Risk of Harm: What Risk of harm Means to the Experts", study commissioned by the Electrical Contractors Association of Ontario / International Brotherhood of Electrical Workers / Ontario Pipe Trades Council

(ii) electrician — domestic and rural, if the worker is performing work that is limited to the scope of practice for that trade; or

(b) the worker is otherwise permitted to connect, maintain or modify electrical equipment or installations under the *Ontario College of Trades and Apprenticeship Act, 2009* or the *Technical Standards and Safety Act, 2000*. O. Reg. 627/05, s. 4; O. Reg. 88/13, s. 2.

(2) A worker who does not meet the requirements of clause (1) (a) or (b) may insert an attachment plug cap on the cord of electrical equipment or an electrical tool into, or remove it from, a convenience receptacle. O. Reg. 627/05, s. 4.

It is also important to note that, according to the Electrical Safety Authority, 9% of fires causing structural loss, where electricity was the ignition source, were caused by faulty wiring. (See *Electrical Safety Report, 2017*, p 49).

Permitting unqualified persons to perform electrical work that is now restricted would run counter to the Construction Projects regulation of the *Occupational Health and Safety Act* and would weaken adherence to Ontario's Electrical Safety Code. Narrowing the list of restricted practices would risk reversing the progress that Ontario has made in reducing electricity-related fatalities, critical injuries and fires.

3. Changes to Restricted Practices Should be Made Only After Extensive Stakeholder Consultation

It is always open to the Minister to revise the policy on restricted activities at some later date. However, the starting point when implementing apprenticeship reform should be continuation of the current restrictions on performing electrical work. If changes are to be made to the restricted activities, these changes should be made, if at all, *only* after broad consultations with:

- industry associations (ECAO and OEL),
- unions (IBEW and CLAC),
- the Canadian Standards Association (which develops the Canadian Electrical Code),
- the Electrical Safety Authority (which develops and administers Ontario's Electrical Safety Code),
- the Ontario Fire Marshal,
- the Health and Safety Branch of the Ministry of Labour (which administers the Construction Projects regulation of the *Occupational Health and Safety Act*),
- the Canadian Electrical Contractors Association,
- electrical utilities, and
- the colleges and training centres that deliver apprenticeship training to the electrical trades.

4. Training in Electrical Theory is Essential to Safe and Correct Performance of Electrical Work

To make sense of the *Ontario Electrical Safety Code*, an individual must first understand basic electrical concepts. These include:

- Basic electrical concepts and their measurement:
  - voltage
  - current flow
  - amperage
  - wattage
  - resistance
  - impedance
  - conductivity
  - power factor (both single and three-phase)
- Basic laws of physics as they apply to electricity:
  - Ohm's Law (V=IR)
  - Kirchoff's Voltage Law (voltage drop principle)
  - Kirchoff's Current Law (circuit analysis)
  - Power Formula (P=IE) (compute the amount of energy transferred or converted per unit of time)
- The design and purpose of basic electrical components and devices:
  - conductors
  - overload and over-current devices
  - diodes and other solid-state devices
  - panels
  - switch boxes
  - fuses
  - circuit breakers
- principles of bonding and grounding (including resistance),
- circuit theory, including series, parallel and three-wire circuits,
- how to read and interpret electrical drawings and specifications,
- use of testing equipment:
  - voltmeter
  - ohmmeter
  - ammeter
  - insulation
  - multi-meter
- how to read manufacturer's specifications,
- principles of electrical safety, including tag-out procedures *per* CSA's Z460-18 "Control of Hazardous Energy - Lockout and Other Methods" and CSA's Z462-18 "Workplace Electrical safety"

An individual who cannot solve equations using basic algebra will be unable to apply the most basic principles of electrical theory and will therefore be unable to correctly install, troubleshoot or repair electrical components or electrical distribution systems. To correctly read and apply electrical blueprints or drawings, an individual must be able to apply both metric and imperial scales (*e.g.,* 1: 50; 1/8": 1.0').

The current curriculum standard for an Electrician – Construction and Maintenance requires 840 hours of in-school training. An indication of the importance of electrical theory is that 66% of these hours (553 hours or 14 weeks) is focused on electrical theory.

The emphasis on training in electrical theory reflects the clear understanding among all informed stakeholders that knowledge of electrical theory is essential if electrical work is to be performed safely and in compliance with the *Ontario Electrical Safety Code*.

Appendix A consists of a detailed review of the scope of practice for Electrician – Construction and Maintenance and notes both the theory requirements to perform those activities safely and correctly and the safety and efficiency consequences of incorrect performance. An important conclusion from this detailed analysis is that the need for knowledge of basic electrical theory underpins *every* activity in the scope of practice for the electrical trade.

5. We Need to Support Our Apprentices by Protecting the Value of a C of Q

The prevailing practice in the electrical contracting industry is to assign basic electrical tasks to apprentices who are supervised by qualified journeypersons. As apprentices progress through their training, the complexity of those tasks can increase. This practice supports the apprenticeship system. It is also economically efficient because it allows basic tasks to be performed by junior staff.

Last year the government replaced the former ratio rules with a standard 1:1 ratio across all trades that have ratios prescribed by regulation. In the electrical trade the effect of this change was to replace the former modified 3:1 ratio with a 1:1 ratio of journeypersons to apprentices. The 1:1 ratio rule will allow a significant increase in the number of apprentices.

Even setting aside safety concerns, as a result of the ratio change, there is now no *economic* reason to loosen the restricted activities policy to allow some types of electrical work to be performed by lower paid workers with lesser or no formal qualifications. Indeed, to do so could actually lead to an 'electrical helper' taking the job that would otherwise have supported a new apprentice.

A major goal of apprenticeship reform is to increase the attraction of the trades as a career choice. Allowing untrained or partially-trained workers to perform electrical work will reduce the perceived value of a C of Q in the electrical trades. This, in turn, will diminish the attraction of the electrical trades as a career choice.

We cannot support our apprentices by migrating their work to untrained or partially-trained workers. Even without considering the implications for safety, such a policy would undermine the goals of apprenticeship reform.

6. Conclusion

Four concerns prompted this submission:

1) the need to uphold the Red Seal,

2) the need to safeguard public and worker safety,

3) the need to maintain high competency standards, and

4) the need to support our apprentices and protect the value of a C of Q in the electrical trades.

We are not raising these concerns to impede apprenticeship reform. On the contrary, we want apprenticeship reform to succeed and we will work with the government to ensure its success. Nor are we seeking to reverse well-established practices in civil construction (*e.g*., roads) where certain components of electrical work are sometimes performed by non-electricians. However, in the utility sector, the power sector and in the construction of buildings (both residential and non-residential), it is important to put safety first and to ensure that there is no watering down of competency standards or the current safety standards.

For these reasons, we seek assurances that:

a) Ontario will not certify any electrical skill set unless that certification is also eligible for Red Seal Endorsement;

b) the Ministerial policies describing the activities of the two construction-related electrical trades will mirror the current scopes of practice that reflect the National Occupational Analysis for the electrical trade and also the electrical industry's input

c) for the construction-related electrical trades, *all* of the activities set out in the Ministerial policies describing their activities will continue to be restricted.

d) in light of the importance of public and worker safety, changes to the list of restricted practices will be considered, if at all, *only* after extensive consultations with all stakeholders,

Respectfully submitted,

Electrical Contractors Association of Ontario (ECAO)

Ontario Electrical League (OEL)

International Brotherhood of Electrical Workers Construction Council of Ontario (IBEW CCO)

CLAC

Appendix A

Detail Comparison of Scope of Practice Activities for 'Electrician – Construction and Maintenance'
With Theory Requirements to Perform Those Activities Correctly and Consequences of Incorrect Performance

	Activities in Current Scope of Practice	Required Knowledge of Electrical Theory to Perform Activities	Consequences of Incorrect Performance of Activities From Lack of Theoretical Knowledge
1.	Laying out, assembling, installing, repairing, maintaining, connecting or testing electrical fixtures, apparatus, control equipment and wiring for systems of alarm, communication, light, heat or power in buildings or other structures.	• Understand the amount of heat generated by resistance/impedance of current. • Understand the impact of torque at any termination on resistance and heat generation. • Apply Ohm's Law, Power Formula, circuit theory and Kirchoff's Voltage Law. (This is especially important over longer distances and/or multiple terminations and devices). • Know how to select and use testing equipment: voltmeter, ammeter, multi-meter and continuity tester. In a 3-phase circuit, must use an oscilloscope. • To repair a faulty system, must understand a system's electrical equipment and their functions. • For fire alarms, must understand the physics and redundancy of different types of alarms and the installation requirements for the different types of fire devices as required by the Underwriter Laboratory of Canada (ULC) Standards, National Building Code of Canada (NBC), manufacturer's specifications, OESC. • Understand the symbols and abbreviations used in electrical drawings and specifications. • Understand manufacturer's specifications when changing electrical equipment, such as heating devices, starters, controllers, overload and overcurrent devices. • Understand how selection of fuses and circuit breakers affect system operation, such as fault current detection, coordination. • Know where to check the Ontario Electrical Safety Code for direction. • Know the prescribed minimum safety procedures under the Construction Projects regulation to the *Occupational Health and Safety Act*.	• Incorrect selection of overload or overcurrent devices could cause circuit overloading**,** damage to electrical equipment, and risk of fire. • Integrity of insulation can be degraded by excess heat in the conductor and at the termination. This creates a risk of shorts and system failure. • Integrity of insulation can be degraded by fluctuations of the magnetic field. Similar risk of shorts and system failure. • Devices, fixtures, *etc*. will not function efficiently (or at all) if the circuit is overloaded or does not supply the specified voltage required by the electrical equipment. • Malfunctioning of fire alarm systems is especially dangerous as it will affect the detection, signalling, and operation of building systems. • Greater risk of electrocution when working with 240 or higher voltages. • Using an incorrect component will cause a device to function inefficiently or burn out. • Code violations that are not identified by an ESA inspector will pose a continuing risk.

2.	Planning proposed installations from blueprints, sketches or specifications and installing panel boards, switch boxes, pull boxes and other related electrical devices.	• Understand the symbols and abbreviations used in electrical drawings and specifications. • Know how to determine and correctly apply scaling. • Know where to check the Ontario Electrical Safety Code for direction. Particularly important that electrical installations (both new and changes to existing) must be *per* Code. • Apply Ohm's Law, Power Formula, circuit theory and Kirchoff's Voltage Law. (This is especially important over longer distances and/or multiple terminations and devices)	• Incorrect reading of drawings or specifications or incorrect application of scaling will lead to an installation that may be unsafe, will perform sub-optimally or will have to be removed and replaced. • Failure to plan and install in conformity with the Ontario Electrical Safety Code will pose a safety threat. If identified by an inspector, the work will need to be re-done. • Overloading or undersupplying of circuits as a result failure to correctly apply Ohm's Law or Kirchoff's Voltage Law will result in either a safety hazard, sub-optimal operation of the installation or shorting out of the system.
3.	Measuring, cutting, threading, bending, assembling and installing conduits and other types of electrical conductor enclosures that connect panels, boxes, outlets and other related electrical devices.	• Know how to consult the Ontario Electrical Safety Code for direction for different environments and conditions of use. • The Code specifies how many threads are to be engaged, the minimum and maximum length of threads and the type of threads allowed. • Know how to calculate impact of bends (both the number of bends and the degrees of the bends) in each run so that the pulling tension needed for the insertion of the conductors or cables does not exceed the conductor's rating. • Understand the importance of proper clearances to prevent overheating, deterioration of insulation and electrical noise as per Institute of Electrical and Electronics Engineers (IEEE) standards. • Know the prescribed minimum safety procedures under the Construction Projects regulation to the *Occupational Health and Safety Act*. • Understand how expansion and contraction from environmental conditions affect performance of conduit. • Understand how excess tension adversely affects the installation of conduit. • know how to calculate the pulling tension (sidewall bearing pressure) required for the installation of the conductor/cable.	• Incorrect number of threads engaged poses a safety threat to the flows of fault current and environment (such as hazardous and wet locations). • Failure to factor in the expansion and contraction from environmental conditions can result in a loss of integrity in the conduit and a safety risk. • Excess tension due the conduit run can cause failure of the conductor and/or the conductor's insulation. • Failure to abide by the minimum requirements of the Construction Projects regulation poses a safety risk to people and property.

4.	Installing brackets, hangers or equipment for supporting electrical equipment.	• Understand the theory of grounding and bonding. Correct grounding and bonding including bonding and grounding of electrical support structures are a key requirement of the Code as this protects persons and property from electric shock and system failure. • Understanding how to minimize/eliminate sheath currents when using ferrous (magnetic) electrical support materials. • Understand the conductivity of different materials. • Know how to consult the Ontario Electrical Safety Code and equipment standards for direction.	• Correct grounding and bonding are an electrical system's ultimate safety fall-back. If a system is properly grounded and bonded, there is limited risk of serious injury to persons or damage to property. Conversely, incorrect grounding and bonding poses the risk of catastrophic consequences to persons or property if there is a system failure. • Failure to address sheath currents could cause dangerous cable/conductor overheating.
5.	Installing in or drawing electrical conductors through conductor enclosures.	• Understand tensile pull and be able to do relevant calculations to preserve integrity of conductors/cable • Understand the impact of bends and observe maximum bend ratios. • Know how to factor in ambient temperature to allow for contraction and expansion of conductor and raceway. • Understand how magnetic induction causes conductor heating. • Understand how to correctly configure single conductors in parallel to minimise overheating. • Apply Ohm's Law and Kirchoff's Voltage Law when adding to an existing raceway.	• Improperly installed raceway is an important cause of electrical systems failing to perform efficiently or safely. • If a building is sealed after raceway has been incorrectly installed, the subsequent re-work costs will be high.
6.	Preparing conductors for splicing of electrical connections, securing conductor connections by soldering, or other mechanical means and reinsulating and protecting conductor connections.	• Understand the thermal limitation of conductors and termination points • Understand the torqueing and crimping requirements at termination points. • Understand the significance of the following: correctly sizing the termination device (lug); material of the termination device (lug) in relation to conductor material, stranding, torque, and manufacturer's specifications. • Understand the conductivity and corrosion factors of different metals. Understand the need to match termination material and conductor. • Understand the limit on the number of conductors on a single termination. • Understand how to minimize/eliminate sheath currents using insulating and non-ferrous materials.	• Incorrect splicing and terminations are serious fire and safety hazards. • Incorrect selection of conductors also poses serious fire and safety hazards.

		• Understand the distinct installation and safety issues with aluminum wiring. • Ability to read and understand manufacturer's specifications for terminating and splicing. • Know how to consult the Ontario Electrical Safety Code for direction.	
7.	Testing electrical equipment for proper function.	• Know the properties and use of the various types of testing equipment and how to select and use correct device and interpret results. • Know how to set test probes at correct distances. • Understand the theory of harmonics. (most of the waveforms in electrical systems are periodic but not sinusoidal so the waveforms consist of harmonics.) • Diagnostic ability is, especially important in identifying sources of interference (harmonics theory) and excessive heat.	• Testing and diagnostics require the correct selection and use of testing equipment and the correct application of electrical theory to interpret the results. • Incorrect testing procedures can result in faulty equipment not being fixed or properly performing equipment and installations being unnecessarily replaced.