



Electrical Construction and Maintenance Workers'

Safety Manual

2008

Accident Prevention Educational Program (APEP) for Electrical Construction and Maintenance Workers

PROGRAM OUTLINE

Prerequisite for Job Placement		Hours
WHMIS Training	minimum	5
Standard First Aid with CPR (1 rescuer)		
Level I		
1001	Occupational Health and Safety Act*	2
1002	Personal Protective Equipment*	2
1003	Access Structures*	2
1004	Housekeeping*	2
1005	Tools**	2
1006	Electrical Hazards**	2
1007	Installing Wire and Cable**	2
1008	Powder-Actuated Tools**	2
1009	Fall Protection*	3
Total		24

Level II

2001	Hoisting and Rigging*	16
2002	Working in Confined Spaces*	3
2003	Tagging and Lockoff Procedures*	3
Total		22

Level III

3001	Working Around Live Apparatus*	3
3002	Forklift Training (including propane cylinder replacement)*	18
3003	WHMIS Update*	1
3004	OHSA & Construction Regulations Update*	2
Total		24

Level IV

4001	CSAO Construction Supervisors Training*	21
------	---	----

* Delivered by CSAO consultant or local electrical industry trainer

** Delivered by local electrical industry trainer



Electrical Construction and Maintenance Workers' Safety Manual

Construction Safety Association of Ontario

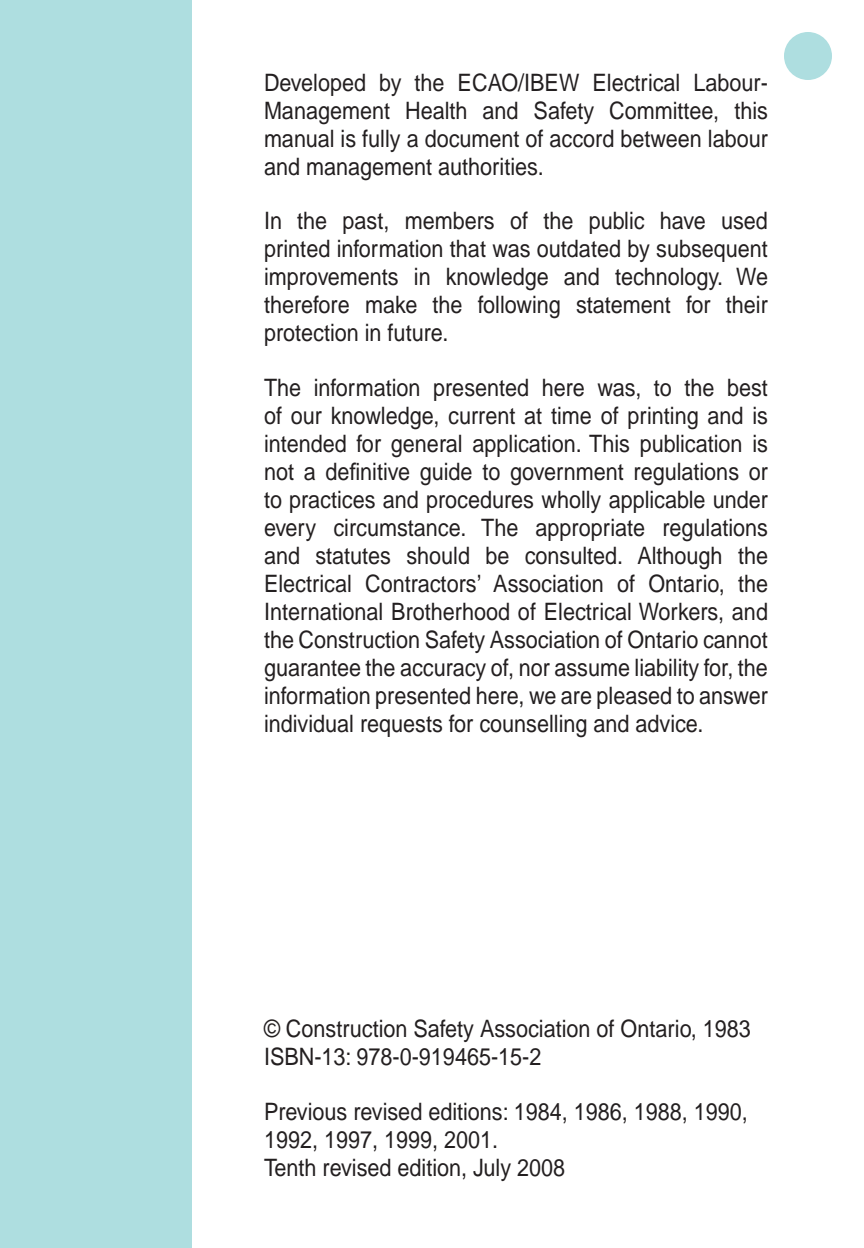
21 Voyager Court South
Etobicoke, Ontario M9W 5M7 Canada
(416) 674-2726 1-800-781-2726

Fax: (416) 674-8866

info@csao.org

www.csao.org





Developed by the ECAO/IBEW Electrical Labour-Management Health and Safety Committee, this manual is fully a document of accord between labour and management authorities.

In the past, members of the public have used printed information that was outdated by subsequent improvements in knowledge and technology. We therefore make the following statement for their protection in future.

The information presented here was, to the best of our knowledge, current at time of printing and is intended for general application. This publication is not a definitive guide to government regulations or to practices and procedures wholly applicable under every circumstance. The appropriate regulations and statutes should be consulted. Although the Electrical Contractors' Association of Ontario, the International Brotherhood of Electrical Workers, and the Construction Safety Association of Ontario cannot guarantee the accuracy of, nor assume liability for, the information presented here, we are pleased to answer individual requests for counselling and advice.

© Construction Safety Association of Ontario, 1983
ISBN-13: 978-0-919465-15-2

Previous revised editions: 1984, 1986, 1988, 1990,
1992, 1997, 1999, 2001.

Tenth revised edition, July 2008



Labour-Management

The Construction Safety Association of Ontario thanks the ECAO/IBEW Electrical Labour-Management Health and Safety Committee for their valued and significant contribution in preparing the original manual and subsequent editions.

First Edition (1983)

WILLIAM ARNEZEDER
Business Manager
International Brotherhood of
Electrical Workers
Local 120, London

HUGH CARROLL
Electrical Contractors
Association of Ontario,
Toronto

GUENTHER CASPARY
Construction Safety
Association of Ontario,
Toronto

ALEX GLEN
International Brotherhood of
Electrical Workers,
Local 303, St. Catharines

JOHN HYMSON
Construction Safety
Association of Ontario,
Toronto

BERT LINDGREN
(Chairman)
B.A. Lindgren Electric Ltd.
Thunder Bay

RICHARD MAULE
State Contractors Inc.
Toronto

ROBERT RYNYK
Assistant Business Manager
International Brotherhood of
Electrical Workers
Local 353, Toronto

RALPH TERSIGNI
Secretary
International Brotherhood
of Electrical Workers—
Construction Council of
Ontario

FRANK TOPA
Canal Contractors—
A Division of Upper Lakes
Shipping Ltd.
St. Catharines

LLOYD WARNER
(Co-Chairman)
Business Manager
International Brotherhood of
Electrical Workers
Local 1739, Barrie

Tenth Edition (2008)

GARY BEER
Electrical Contractors
Association of Ontario
Toronto

SUSAN BOORMAN
Electrical Contractors
Association of Ontario
Toronto

PATRICIA BOYER
Construction Safety
Association of Ontario
Etobicoke

ED BRAITHWAITE
C & C Enterprises Electrical
Construction Limited
Sarnia

RAY HOPKINS
Construction Safety
Association of Ontario
Etobicoke

STEVEN MARTIN
International Brotherhood of
Electrical Workers Local 353
Toronto

BRETT MCKENZIE
International Brotherhood
of Electrical Workers
Construction Council of
Ontario
Toronto

IAN REECE
Construction Safety
Association of Ontario
Etobicoke



Foreword

This manual has been written for electrical workers. It is a useful tool that apprentices, journeypersons, supervisors, and management can use to help keep safety in mind when planning work.

This publication reflects the requirements of Ontario's *Occupational Health and Safety Act*, the Construction Regulation (Ontario Regulation 213/91), and the Ontario Electrical Code. Depending on the type of work or project type, different regulations may need to be consulted for a best practice—industrial or mining regulations for example. For a more complete study of workplace safety, this manual should be used with the Construction Safety Association of Ontario's *Construction Multi-Trades Health and Safety Manual* (M033). It provides a resource on safety concerns relating to a wider range of topics relevant to the mechanical trades. In addition, at the time of printing of this manual, CSA Z462 *Workplace Electrical Safety* is being developed. CSA Z462 will be another resource regarding electrical safety concerns.

Although service and maintenance is generally an industrial activity, use the more stringent of the industrial or construction regulation for effective worker safety when applicable. For example, if an issue is not covered in the industrial regulations but is covered in the construction regulation, look to the guidance



provided in the construction regulation to perform the activity safely.

With cooperation among workers, supervisors, constructor management, and industry clients, health and safety can be continually improved in the electrical construction and maintenance industries. This manual was created as an aid for implementing good jobsite health and safety practices, with the goal of preventing accidents, reducing injuries, and providing a healthy work environment.

Contents

1. INJURIES IN THE ELECTRICAL TRADE..	1
Electrical worker lost-time injuries	
1997 through 1999	1
Hearing damage.....	6
2. PREVENTION	9
Health issues	9
● WHMIS	9
● Specific hazardous substances.....	12
■ PCBs	12
■ Asbestos	12
■ Mould	14
■ Dusts, gases, fumes.....	16
■ Heater emissions	17
■ Hearing protection.....	20
Injury	22
● Clothing	23
● Head protection	23
● Foot protection.....	24
● Eye protection	24
● Back care.....	25
● Cable pulling.....	29
3. WORKPLACE OVERSIGHT	30
Workplace responsibilities	30
● Constructor.....	30
● Employer	31
● Supervisor	32
● Worker	33
● Health and Safety Representative.....	34
● Joint health and safety committee (JHSC).....	37
● Worker trades committee	37
● Ministry of Labour inspectors	38
Reporting accidents/incidents	38
● Critical injury or fatality	39
● Notice of accident, explosion, or	
fire causing injury	40
● Notice of occupational illness	40
● Reporting of incidents where	
no injury occurs.....	41
● Reporting a serious electrical incident	
to the ESA	42
● Contact with an overhead powerline	43

Jobsite orientation for new workers.....	44
First aid.....	44
Safety standards.....	47
4. SPECIFIC TOPICS.....	49
Confined spaces.....	49
Authorized personnel in a manhole, vault, or switchroom.....	50
Trenches and excavations.....	50
Lockout and tagging.....	57
● Background and introduction.....	57
● Forms of energy.....	58
● Procedure.....	61
● Return to service.....	68
● Service contractor personnel.....	69
● Discontinued use.....	70
Working on or near energized equipment.....	71
Flash hazard (arc flash) protection.....	75
● Arc flash resistant clothing.....	79
● Controlling arc flash.....	82
Multimeters.....	84
Fishing and pulling wire.....	88
Illumination.....	89
Temporary wiring and power.....	91
Portable tools and extension cords.....	95
Fall protection.....	96
Portable ladders.....	101
Scaffolding.....	103
Powered elevating work platforms and vehicle-mounted aerial devices.....	105
Housekeeping, storage, and tool maintenance.....	110
Fire extinguishers.....	111
Service vehicles.....	112
Working alone.....	122
5. MISCELLANEOUS INFORMATION.....	126
Metric conversion factors.....	126
Pipe bending charts.....	127
Copper wire gauges and dimensions.....	130

1. INJURIES IN THE ELECTRICAL TRADE

Electrical worker lost-time injuries (LTIs) 1997 through 1999

An analysis was done on the lost-time injuries (LTIs) that occurred on construction projects during the three-year period of 1997 through to 1999*. Although the data is several years old, these statistics still seem to be reflective of the current work environment.

Back/spine injuries were recorded as the most common body injury.

Back/spine injuries were recorded as the most common “Part of Body” injury to electricians, accounting for 21% of LTIs. Lifting was implicated in 23% of back/spine injuries. The rest of the back/spine injuries were related to a wide range of activities.

By preventing back injuries, electrical workers, their supervisors, and employers can significantly reduce injuries suffered in the electrical trade.

We can further describe the injury distribution according to the following classifications:

* Information from Construction Safety Association of Ontario's *Injury Atlas* (RR003)



Installing (installing switchgear, pulling cable, mounting equipment)


- Represents 50% of LTIs.
- Falls from ladders while installing accounted for 77% of all falls from ladders.
- Back/spine injuries while installing accounted for 37% of all back/spine injuries.
- Overexertion was cited in 65% of back/spine injuries while installing.
- Of the cable pulling injuries, back/spine injuries were cited most often at 35%.

Material handling (carrying equipment, pulling cable)

- Represents 25% of LTIs.
- Back/spine injuries were recorded in 46% of material handling injuries, and these represented 51% of all back/spine injuries.
- Cable pulling was indicated in 23% of material handling injuries.
- Overexertion was recorded in 51% of material handling injuries.

In transit (worker was traveling, e.g., up or down a ladder, along the ground, etc.)

- Represented 23% of LTIs.
- Falls from ladders while in transit accounted for 21% of all falls from ladders.
- Strain/sprains were the most common in-transit “injury type”, accounting for 33% of



injuries. Of the in-transit strains/sprains, 44% were attributable to slipping and 23% to stepping on something (a rock for example). These injuries often occurred while walking, climbing up or down stairs and ladders, or stepping on and off equipment.

Part of body most commonly injured

Back/spine injuries

Back/spine injuries were recorded as the most common “Part of Body” injury to electricians, accounting for 21% of LTIs. Overexertion was cited in 65% of back/spine injuries. Lifting was implicated in 23% of back/spine injuries. The rest of the back/spine injuries were related to a wide range of activities.

Hand, finger, thumb, and wrist injuries (hand area)

When hand injuries are grouped together with finger, thumb, and wrist injuries, this “hand area” grouping becomes the #2 part of body being injured. However, the count of injuries is just one incident below the #1-ranked injury, making “hand” injuries as prevalent as back/spine injuries. About half of these “hand” injuries resulted from the worker slipping or losing balance in some manner.

Knee

The percentage of injuries to the knee represented 6.5% of all LTIs, and it ranked

as the #3 part of body being injured just ahead of ankle injuries at 6.3%. Descending or ascending ladders, steps, and stairs are activities strongly associated with knee injuries.

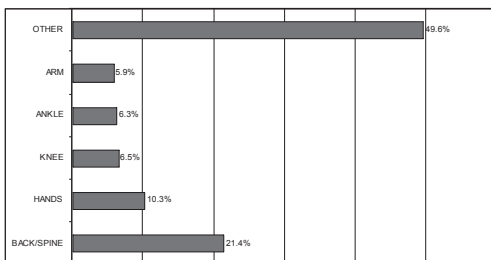
Ankle, foot, heel, metatarsal (upper foot), and toes (foot area)

When foot injuries are grouped together with ankle, heel, metatarsal (upper foot), and toe injuries, these “foot area” injuries are the #3 part of body that is injured (ahead of knee). Ankle injuries were the most common injury to the foot area. There were five times more injuries while dismounting or descending than while climbing.

Cable Pulling

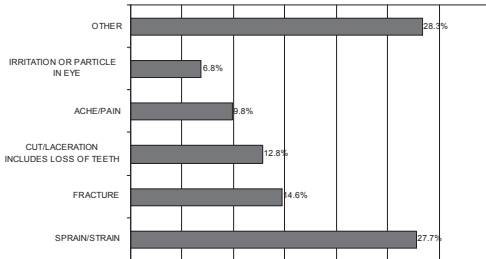
Of just the cable pulling injuries, back/spine injuries were cited most often at 35%. Overexertion is cited 33% of the time as the root cause of injury when cable pulling.

Part Of Body
Electricians 1997-1999 LTI summary



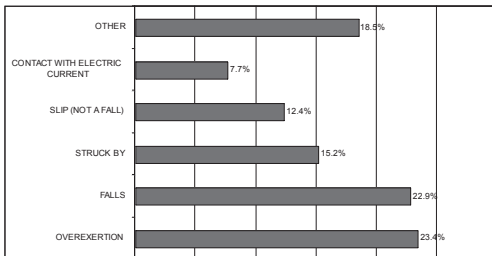
Injury Type

Electricians 1997-1999 LTI summary



Type Of Accident

Electricians 1997-1999 LTI summary



can also kill. When inhaled, asbestos has been shown to cause the following diseases:

- asbestosis
- lung cancer
- mesothelioma (cancer of the lining of the chest and/or abdomen).

The early widespread use of asbestos has left a potentially dangerous legacy. The improper handling of asbestos-containing products can release harmful amounts of fibre.

Protective measures must be taken to protect yourself, family members, co-workers, and others from asbestos.

Most structures built between 1930 and 1975 will contain products having substantial amounts of asbestos. See the chart below.

ASBESTOS PRODUCTS IN CONSTRUCTION			
Product	Residential	Commercial/ Institutional	Industrial
Sprayed-On Fireproofing		XX*	
Pipe and Boiler Insulation	X	X	XX
Loose Fill Insulation	X		X
Vermiculite Insulation	X		
Asbestos Cement Products	X	X	X
Acoustical Plaster	X	X	
Acoustical Tiles	X	XX	
Vinyl Asbestos Tiles	X	X	
Gaskets		X	XX
Roofing Felts	X	X	X
Asphalt/Asbestos Limpet Spray			X
Drywall Joint-Filling Compound	X	X	
Coatings and Mastics	X	X	X

*"XX" means extensive use.

Hearing damage

Exposure to excessive noise leads to hearing damage such as hearing loss and tinnitus. Each year in Ontario there are about 300 new compensation claims for noise-induced hearing loss (NIHL) in the industry.

Hearing damage can happen quickly, but it usually develops slowly over a person's working career. Unfortunately, once a worker begins to notice hearing damage, the damage is irreversible and will likely worsen with time.

Because the hearing loss is usually gradual, impairment often isn't noticed until a substantial degree of hearing loss has already occurred. The occupational and personal consequences are significant:

- Workers with NIHL may not hear audible warnings and safety signals.
- Hearing impairment jeopardizes the safety of not only the affected employees but also others who work with them.
- The increased effort to listen and understand may lead to fatigue, anxiety, and stress.
- NIHL may interfere with daily life, especially during social activities in noisy settings.
- Those affected may feel increasingly isolated from family and friends.

Some people with NIHL also suffer from *tinnitus*, causing them to continually hear

ringing, buzzing, rushing, whistling, or hissing when there are in fact no such sounds to be heard.

Noise can be measured using a decibel scale: dB(A). A noise level of 85 dB(A) over an 8-hour workday is potentially damaging. The louder the noise, the faster the damage. Sound intensity doubles every 3 dB. So **for each 3 dB increase in sound level, potential damage to the ear doubles**. Noise exposure must be controlled accordingly.

Noise Levels Of Common Tools	
<i>Exposures measured in decibels (dB) at an operator's ear, except where otherwise indicated.</i>	
Tool	Noise level will probably exceed...
Chopsaw	92
Drill	87
Drywall drill	98
Electric grinder	98
Generator	72 (at 15 metres)
Impact wrench	115
Portable band saw	83
Reciprocating saw	105
Torch cutting	87



Contact with Electrical Energy

Making electrical contact with an electrical hazard represents a relatively small portion (7.7%) of the accidents electricians' experience. Still, the number of electrical contact incidents should be much lower. Any work on or near energized equipment must only be done as a last resort and can only be done when measures are in place to provide protection from electric shock and burn. With appropriate safety measures in place, shock and burn injuries are preventable.

Additional information on lost time injuries can be found in CSAO's *Injury Atlas* which you can download at www.csa.org.

2. PREVENTION

Health issues

Hazardous materials in the workplace may cause disease in the body at four main sites:

- where they enter the body—entry routes such as the lungs, skin, and intestines
- in the blood that carries the hazardous materials throughout the body
- in the central nervous system
- in the organs which have the ability to remove toxic agents from the body: i.e., the liver, kidneys, and bladder (exit routes).

For added worker protection, maintain your own personal medical record, and include known exposures to hazardous substances.

WHMIS (Workplace Hazardous Materials Information System)

The Workplace Hazardous Materials Information System or WHMIS is a Canada-wide system designed to protect the health and safety of workers by providing information about hazardous materials used on the job.

Right to know

WHMIS gives every worker the right to know about hazardous materials they work with and ensures workers have access to that information. Information is provided using

Specific hazardous substances

PCBs (Polychlorinated biphenyls)

Older transformers, capacitors, lighting fixture ballasts, and high-voltage equipment may contain polychlorinated biphenyls (PCBs). A common trade name for PCB is Askarel.

Transformers containing PCB or Askarel can be identified by the letter “L” on the nameplate. Look for LFAF, LFAN, LFWN, LNAF, LNP, LNS, LNWN and LNWN. Transformers containing mineral oil bear the letter “O” on the nameplate, such as ONAN.

Workers must be extremely careful when handling or cleaning up spills of Askarel and other PCBs. All work should be carried out in accordance with the guidelines issued by the Ontario Ministry of Environment. Contact the Ministry for further information.

Smoking or eating must not be permitted in or near PCB operations. Workers should wash their hands and face with soap and water immediately after any contact with PCBs and before eating, smoking, or going to the toilet.

Asbestos

Asbestos is a naturally occurring material once used widely in the construction industry. Its strength, ability to withstand high temperatures, and resistance to many chemicals made it useful in hundreds of applications. But asbestos

(1) labels, (2) material safety data sheets (MSDSs), and (3) worker training and education.

Before using any caulking, solvent, or glue, read the MSDS to ensure that you take required precautions with the specific products you're using.

Suppliers must label their hazardous products and provide a current MSDS with their product. MSDS information must not be more than 3 years old. Workers should receive annual refresher training on WHMIS every year.

Hazardous materials

WHMIS divides hazardous materials into six classes



CLASS A:
Compressed gas



CLASS B:
Flammable and combustible material



CLASS C:
Oxidizing material



CLASS D:
Poisonous and infectious material



CLASS D:
2. Materials causing other toxic effects



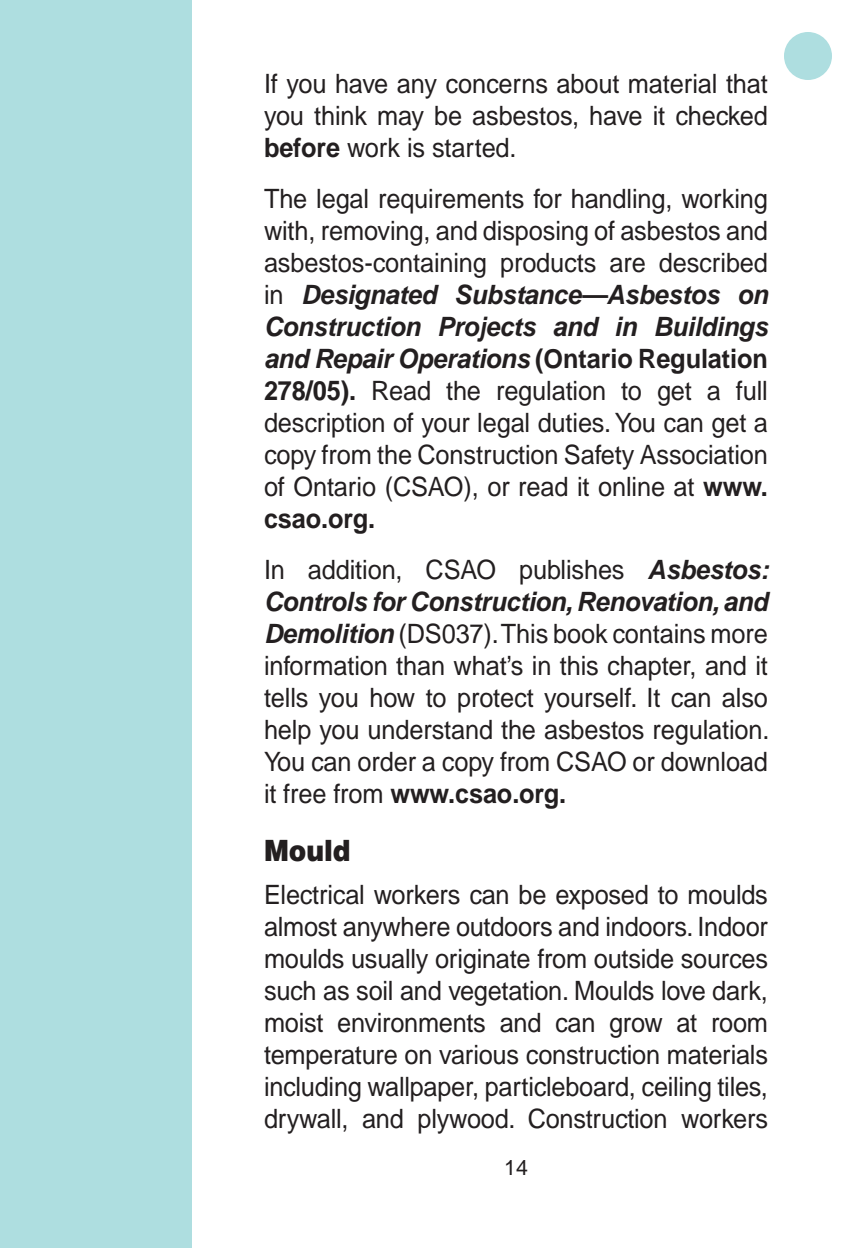
CLASS D:
3. Biohazardous infectious material



CLASS E:
Corrosive material



CLASS F:
Dangerously reactive material




If you have any concerns about material that you think may be asbestos, have it checked **before** work is started.

The legal requirements for handling, working with, removing, and disposing of asbestos and asbestos-containing products are described in ***Designated Substance—Asbestos on Construction Projects and in Buildings and Repair Operations (Ontario Regulation 278/05)***. Read the regulation to get a full description of your legal duties. You can get a copy from the Construction Safety Association of Ontario (CSAO), or read it online at **www.csao.org**.

In addition, CSAO publishes ***Asbestos: Controls for Construction, Renovation, and Demolition*** (DS037). This book contains more information than what's in this chapter, and it tells you how to protect yourself. It can also help you understand the asbestos regulation. You can order a copy from CSAO or download it free from **www.csao.org**.

Mould


Electrical workers can be exposed to moulds almost anywhere outdoors and indoors. Indoor moulds usually originate from outside sources such as soil and vegetation. Moulds love dark, moist environments and can grow at room temperature on various construction materials including wallpaper, particleboard, ceiling tiles, drywall, and plywood. Construction workers



can be exposed to toxic spores when working on buildings with water damage from flooding, plumbing leaks, or leaks in the structure itself.

Mould colonies are usually visible as colourful, woolly growths. They can be virtually any colour: red, blue, brown, green, white, or black. Moulds are microorganisms that produce thousands of tiny particles called spores in a process called “sporulation.” The mould sends out spores when it is disturbed, as part of its reproductive cycle. Spraying bleach or other compounds on the mould can also cause sporulation. Mould spores feed off dirt and moisture, both of which are present in HVAC/R systems.

Air movement and the handling of contaminated material can release toxic spores into the atmosphere. These spores can cause adverse health effects. Not all exposed workers, however, will develop symptoms. Once released, toxic spores must contact the skin or be inhaled before symptoms can develop. Exposure to toxic moulds may irritate the skin, eyes, nose, and throat, resulting in allergy-like symptoms such as difficulty in breathing, runny nose, and watery eyes. Other symptoms such as fatigue and headache have also been reported. Workers who are allergic to moulds could experience asthmatic attacks upon exposure. People with weakened immune systems are particularly susceptible to mould-related illness and should not work in mould-contaminated areas.




Workers should know how to protect themselves against sporulation. Although there are no Ontario regulations specifically addressing moulds, an employer must, under the *Occupational Health and Safety Act*, take every precaution reasonable in the circumstances for the protection of a worker. Work practices set out by Health Canada in *Fungal Contamination of Public Buildings: A Guide to Recognition and Management* provide a reasonable standard.

Employers have a duty to instruct workers in the safe removal or handling of mould-contaminated material. Workers in turn have the duty to follow these instructions. Where mould is observed, it should be left undisturbed if possible. Where the growth is extreme or must be disturbed, contact the employer for instruction. As a minimum, workers should wear an N95 respirator to prevent exposure to mould and dust.

Dusts, gases, and fumes

A work area does not have to be designated a confined space for a hazardous atmosphere to develop. All work areas must have adequate ventilation.

In places where a hazardous atmosphere could develop, measures must be taken to prevent workers from harm. Safety measures may include redesigning the work procedure or using ventilation to reduce hazards.



Atmospheric testing may be undertaken on its own or in conjunction with other controls to ensure levels do not reach hazardous concentrations. Where ventilation or monitoring is not practical, workers must be provided with personal protective equipment such as respirators that are appropriate to the hazard, and be trained to use and maintain the respirators properly.


Heater emissions

During the winter, direct-fired heaters are used across Ontario to keep construction workers warm. The heaters also make concrete placement, bricklaying, plastering, drywalling, and painting possible under cold conditions.

Direct-fired heaters release combustion emissions directly into the air where people work. Although carbon monoxide (CO) is the main concern, carbon dioxide (CO₂) may also be a problem.

Both CO and CO₂ can asphyxiate a worker. CO₂ displaces oxygen in the air, but you need high concentrations of CO₂ for that to happen. By contrast, CO is a *chemical* asphyxiant. It acts in the bloodstream to reduce oxygen availability. CO affects a worker's health at lower concentrations and therefore causes greater concern.

When heated construction sites are well ventilated, concentrations of emissions tend to be low. Large buildings and tarped sites



record the lowest levels of emission products. CO levels are higher at ceiling level.

Buildings such as houses at the drywall stage with windows and doors in place are considered “tight.” Emission gases accumulate in these buildings when ventilation openings are closed or restricted. Tight buildings lead to higher ambient readings of CO and CO₂ and lower levels of oxygen.

Electricians can begin protecting themselves by understanding the key issues with direct-fired construction heaters. The following are recommendations for safe operation of construction heaters:

- Ensure that heaters are adequately ventilated. Ventilation disperses CO and CO₂, and provides O₂ for combustion. Ask suppliers to label heaters regarding CO hazards and ventilation.
- Vary work at ceiling level with work at lower levels to reduce exposure to CO.
- Make sure that heaters are maintained according to manufacturers’ instructions. Visual inspection alone may not accurately indicate whether a heater is functioning properly. Check when the heater was last serviced and tested (test at least every 12 months).

Training is essential in alerting employees to heater hazards.

- Describe the symptoms of CO exposure.
- Provide an electronic carbon monoxide

detector. A CO home alarm is not a detector.

- Explain emergency response procedures in the event of a CO incident.
- Remind workers that CO levels are higher at ceiling level.
- Warn workers to keep their distance from direct-fired heaters because high temperatures extend beyond the visible flames.

Adequate ventilation must be provided and maintained. Workers must not block or close openings such as windows and doors. When the temperature in a heated area is too cold, workers should request more or bigger heaters.



Do not restrict ventilation of combustion gases by blocking openings

Hearing Protection

Hearing damage is preventable, and the prevention is simple: use hearing protection. It's available in three general types:

1. Disposable earplugs. They are made of pliable material. One size fits all. They should be used only once.
2. Permanent custom-fit earplugs. They are available to provide protection for specific frequencies of noise. They provide a good seal and can be washed and reused.
3. Earmuffs. They need to fit properly to provide maximum protection.

The noise reduction rate (NRR) for a particular device is identified on its packaging. To attain the maximum rated protection, devices must be worn according to the manufacturers' instructions.

For exposure levels over 105 dB(A), double protection may be required, that is, earmuffs and earplugs. It's also important to avoid overprotection. Using more protection than necessary can make workers feel isolated from their work environment. Take care to select protectors with sufficient, but not excessive, attenuation to keep noise below the safe limit of 85 dB(A).

Guidelines are legislated in some North American jurisdictions, but there are no

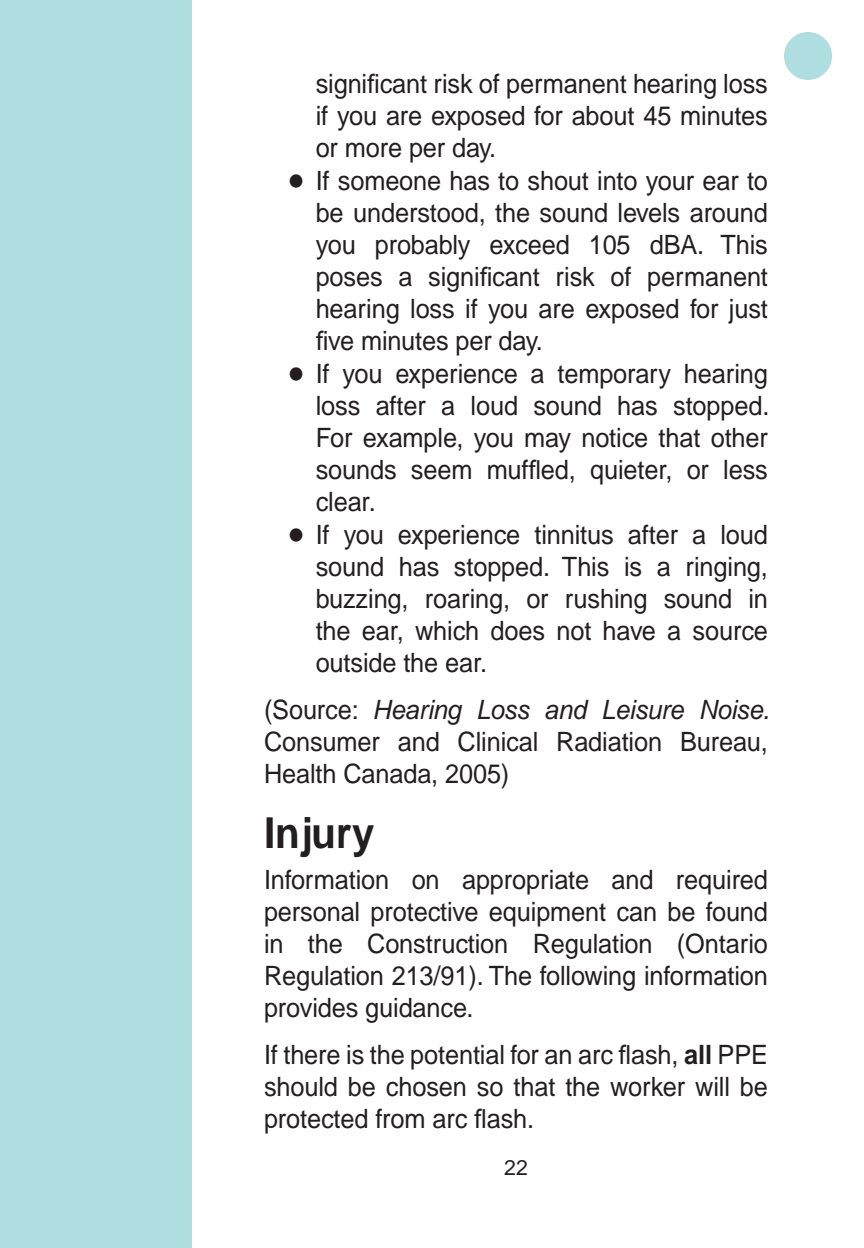
standards for noise on construction sites in Ontario.

Maximum permitted daily duration in hours	Decibels (dB) (increasing in units of 3)
8	85
4	88
2	91
1	94
½	97
¼	100

Individuals exposed to noise in excess of 85 dB(A) averaged over an 8-hour shift should undergo periodic audiometric testing to determine whether they are developing noise-induced hearing loss (NIHL). Anyone showing a significant deterioration in hearing compared to previous tests should have a thorough medical examination.

The following indicators provide an estimate whether the workplace sound levels around you and the duration of your exposure pose a risk of gradual, noise-induced hearing loss:

- If someone standing a metre away from you has to shout to be understood, the sound levels around you probably exceed 85 dBA. You face a significant risk of permanent hearing loss if you are exposed to these sound levels for eight hours or more per day.
- If someone standing 30 cm away has to shout to be understood, the levels probably exceed 95 dBA. This means a



significant risk of permanent hearing loss if you are exposed for about 45 minutes or more per day.

- If someone has to shout into your ear to be understood, the sound levels around you probably exceed 105 dBA. This poses a significant risk of permanent hearing loss if you are exposed for just five minutes per day.
- If you experience a temporary hearing loss after a loud sound has stopped. For example, you may notice that other sounds seem muffled, quieter, or less clear.
- If you experience tinnitus after a loud sound has stopped. This is a ringing, buzzing, roaring, or rushing sound in the ear, which does not have a source outside the ear.

(Source: *Hearing Loss and Leisure Noise*. Consumer and Clinical Radiation Bureau, Health Canada, 2005)

Injury

Information on appropriate and required personal protective equipment can be found in the Construction Regulation (Ontario Regulation 213/91). The following information provides guidance.

If there is the potential for an arc flash, **all** PPE should be chosen so that the worker will be protected from arc flash.



Clothing

When there is the potential for an arc flash, workers must wear clothing that offers flame resistance properties. For more specific guidance see “Arc Flash Protection” under the heading “Working on or Near Energized Equipment” in this manual.

Head protection

The following hard hats comply with the Construction Regulation:

- CSA Z94.1-1992 Class E
- ANSI Z89.1-1997 Type II Class E
- ANSI Z89.1-1997 Type I Class E.

Note that under the latest ANSI standard, there are two types of Class E hardhats: Type I and Type II. Type I hats are exactly the same as the old CSA Class B hardhats, which provide limited lateral impact protection. The Type II hats have enhanced lateral protection, like the CSA Class E. So don't assume that an ANSI Class E is equivalent to the CSA Class E. That's only true if it's Type II. In fact, there are very few ANSI Type II Class E hardhats on the market. Those few are clearly labeled “Type II.” If your hardhat just says “ANSI Class E,” assume it's Type I.

There are no prescribed expiry dates for hard hats. Ensure your hard hat meets current classifications as outlined above and follow the manufacturer's recommendations when replacing a worn hard hat.

Foot protection

Construction workers require Grade 1 toe protection with sole protection in accordance with Canadian Standards Association standard CSA Z195-02. Protective footwear which complies with the regulation is identified by a green triangular patch on the tongue or ankle of the boot or shoe.

Electrical workers continually face the potential for receiving an electric shock due to the presence of



energized equipment in their work environment. Whether on a construction project or service call, appropriate personal protective equipment must be worn to protect against inadvertent electrical contact. Footwear tested to provide additional shock protection for the worker is identified by a white rectangular label with the CSA trademark and the Greek letter omega in orange.

Eye protection

Canadian Standards Association (CSA) standard CAN/CSA Z94.3-99 *Industrial Eye and Face Protectors* can assist you in classifying hazards and recommending protectors. Appropriate protection according to this standard meets with the intent of the Construction Regulation requirements for eye protection.

In any case, eye protection should be industrial quality. It can be in the form of safety glasses incorporating side-shields or a wrap-around style. Cover goggles and face shields provide extra protection and are recommended for workers drilling overhead or into concrete, masonry, and drywall, or performing any other task involving the potential for flying debris. Arc flash protection requires a face shield that is rated for arc flash, with eyeglasses underneath.

It is essential that regular plastic face shields are not used to provide arc flash protection.

They can burn and melt in an arc flash incident.

Use a face shield that is designed and rated for arc flash protection.

Back care

The back/spine is the body part most frequently involved in a lost-time injury to an electrician. These injuries can last a lifetime, and have a significant negative impact on the quality of life of the injured worker. See “Injuries in the Electrical Trade” in this manual. Both young and old workers are at risk of back/spine injuries.

Regardless of the circumstances, workers can do something to reduce their risk of injury. Before attempting to do a physically demanding task, workers can do some stretching and warm up exercises. Also, in many circumstances, you can do the following:

Maintain good posture

Correct posture is not an exaggerated military pose. It means maintaining the naturally occurring curves in your spine. You have two inward curves—at the neck and low back—and one outward curve at the upper back.

Keeping your spine aligned in this manner reduces everyday stresses on your back and minimizes the effects of the normal aging process on the spine.

When working in a crouched, bent, or stooping position for a prolonged period, take regular breaks by standing up and bending backwards three times. Maintain good posture to reduce back strain. Kneel on a pad or sit on a box to work near ground level.



Whenever possible, avoid awkward postures such as this.



Better work posture for short duration.

When working overhead in an arched position for prolonged periods, take regular breaks by returning to stable footing and bending forward three times.



*For bench work,
the right height is vital.*

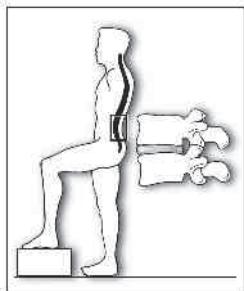


Work Overhead

Bend forward three times

Normal Posture

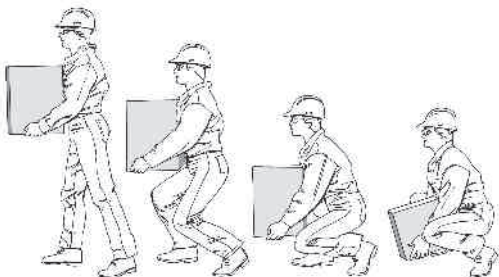
Prolonged standing often causes an increased curve in your back. Elevating one foot on a stool or any other object (a phone book or brick will do) will take stress off the lower spine.




If possible, avoid working on ladders. Use scaffolds or an elevating work platform instead, especially for long-duration tasks or for jobs where you must handle heavy materials.

Lift properly

- Plan your move.
 - Size up the load and make sure the pathway is clear.
 - Use a mechanical device if necessary or get help.
- To lift,
 - use a wide-balanced stance with one foot slightly ahead of the other
 - get as close to the load as possible
 - tighten your stomach muscles as the lift begins
 - when lifting, keep your lower back in its normal arched position and use your legs to lift.
- To turn, don't twist your back, pick up your feet and pivot.
- To lower, lower the load slowly, maintaining the curve in your lower back.





Your back can manage most lifts—if you lift correctly. Avoid lifting above shoulder height. This causes the back to arch, placing heavy stress on the small joints of the spine.

Cable pulling

Implement measures to reduce chances for overexertion. Reduce your risk of injury by asking for help, using mechanical devices, and taking a few moments for stretching and warming up exercises before pulling.

3. WORKPLACE OVERSIGHT

Information in this chapter has been taken from Ontario's *Occupational Health and Safety Act* (OHSA) and the *Construction Regulation*. The following is a generalized summary of the duties required of personnel on jobsites.

Workplace responsibilities

Constructor

“Constructor” means a person who undertakes a project for an owner, and includes an owner who undertakes all or part of a project by himself or by more than one employer.

—OHSA

The constructor must ensure that

1. the measures and procedures required by the current *Occupational Health and Safety Act and Regulations for Construction Projects* are carried out on the project;
2. employers and workers on the project comply with the Act and Regulations;
3. the health and safety of workers on the project are protected.

Employer

“Employer” means a person who employs one or more workers or contracts for the services of one or more workers and includes a contractor or subcontractor who performs work or supplies services and a contractor or subcontractor who undertakes with an owner, constructor, contractor or subcontractor to perform work or supply services.

—OHSA

The employer must ensure that

1. the equipment, materials, and protective devices that are prescribed are provided;
2. the equipment, materials, and protective devices provided are maintained in good condition and used as prescribed;
3. the measures and procedures required by law are carried out in the workplace;
4. information, instruction, and supervision are provided to protect the health and safety of workers;
5. the appointed supervisor is a competent person (see box below);
6. every precaution reasonable in the circumstances for the protection of the worker has been taken;
7. additional duties imposed upon the employer in the Act under section 25 and 26 are also followed.

“Competent person,” means a person who,

- (a) is qualified because of knowledge, training and experience to organize the work and its performance,*
- (b) is familiar with this Act and the regulations that apply to the work, and*
- (c) has knowledge of any potential or actual danger to health or safety in the workplace.*

—OHSА

Supervisor

“Supervisor” means a person who has charge of a workplace or authority over a worker.

—OHSА

The supervisor must ensure that workers

1. work in the manner and with the protective devices, measures, and procedures required by the Act and Regulations;
2. use or wear the equipment, protective devices, or clothing that the employer requires to be used or worn;
3. are advised of any potential or actual danger to their health or safety;
4. are given written instruction for their protection, where written instruction is prescribed;
5. have been afforded every precaution reasonable in the circumstances.



Worker

“Worker” means a person who performs work or supplies services for monetary compensation...

—OHSA

The worker must

1. work in compliance with the provisions of the Act and the Regulations;
2. use or wear the equipment, protective devices or clothing that the employer requires to be used or worn;
3. report to the employer or supervisor any problem with equipment which may endanger the worker or other workers;
4. report to the employer or supervisor any contravention of the Act or the Regulations and any hazard on the project;
5. never work in a manner that may endanger himself or others;
6. never engage in any prank, contest, feat of strength, unnecessary running or rough and boisterous conduct on the project.

“Competent worker”, in relation to specific work, means a worker who,

- (a) is qualified because of knowledge, training and experience to perform the work,*
- (b) is familiar with the Occupational Health and Safety Act and with the provisions of the regulations that apply to the work, and*
- (c) has knowledge of all potential or actual danger to health or safety in the work.*

—The Construction Regulation
(Ontario Regulation 213/91)

Health and Safety Representative

For details about the selection of health and safety representatives and their duties, consult the *Occupational Health and Safety Act*.

General duties

The health and safety representative performs site inspections, helps to mediate disputes over unsafe conditions, assists in investigating serious accidents, and confers with supervisors, workers, and Ministry of Labour inspectors whenever necessary. A health and safety representative will be effective only where there is full cooperation and respect between the health and safety representative, management, and the workforce.



Requirements

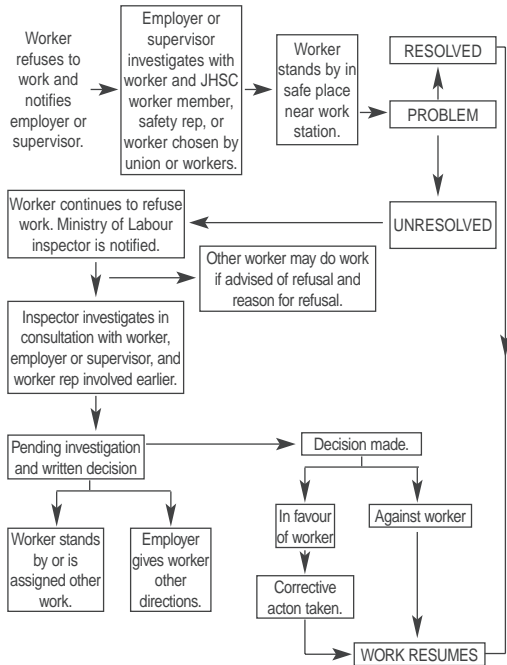
1. At a project or other workplace where no committee is required under the *Occupational Health and Safety Act* and where the number of workers regularly exceeds five, the constructor or employer must cause the workers to select at least one health and safety representative from among the workers at the workplace who do not exercise managerial functions.
2. The selection must be made by workers or by the trade union or unions when represented by them.
3. The employer and workers must provide the health and safety representative with any information and assistance necessary to carry out inspections on the project.

Guidelines

1. The health and safety representative should have current first aid and cardiopulmonary resuscitation (CPR) certificates. This training is part of the Accident Prevention Educational Program for Electrical Construction and Maintenance Workers.
2. The representative must be familiar with requirements of the current *Occupational Health and Safety Act and Regulations for Construction Projects*.

- The representative should be familiar with the procedures involved in a refusal to work where health and safety is in danger.

Right to Refuse Work where Health or Safety in Danger (Occupational Health and Safety Act, Part V)





Joint health and safety committee (JHSC)

A joint health and safety committee (JHSC) is required

- at a workplace at which 20 or more workers are regularly employed and work is expected to last three months or more.
- at a workplace, other than a construction project where fewer than 20 workers are regularly employed, with respect to which a regulation concerning designated substances applies.

For details about the selection of a joint health and safety committee, consult the *Occupational Health and Safety Act*.

Worker trades committee

The joint health and safety committee (JHSC) must establish a worker trades committee, consisting of workers employed in each of the trades at the workplace, to assist it on all projects employing more than 49 workers and lasting more than three months. Members of the worker trades committee must be employed on the project.

The purpose of the worker trades committee is to

- identify health and safety problems affecting individual trades
- notify the site supervisor and the JHSC of their findings
- make written recommendations to the JHSC

- meet as often as required by the JHSC
- assist the JHSC, when requested, in addressing health and safety problems relating to trade work or to trade technology.

Refer to *Guidelines for the Structure and Function of a Worker Trades Committee* (B028), available from CSAO, and the *Occupational Health and Safety Act*.

Ministry of Labour inspectors

A Ministry of Labour inspector can exercise fairly broad powers to inspect, ask questions, and give orders. If the inspector approaches a worker directly, the worker should answer questions and cooperate. The supervisor must be informed of any orders given or recommendations made.

Reporting accidents/ incidents

Report all accidents, **regardless of severity**, promptly to your supervisor. A record should be kept at the jobsite. When a serious or fatal injury involves a union member, the union office and steward must be notified immediately. Labour and management should cooperate fully in conducting an investigation.

Both the *Occupational Health and Safety Act* and the Ontario Electrical Safety Code contain legislated requirements for reporting certain types of accidents to the Ministry of Labour

(MOL) and the Electrical Safety Authority (ESA) as specified in following sections. In the event of an accident which requires reporting and investigation, care should be taken not to disturb the accident scene, nor should any equipment or tools involved in the accident be removed.

Critical injury or fatality


In the event of a critical injury or fatality, the constructor and employer must immediately notify an MOL inspector, the joint health and safety committee, the health and safety representative, and the trade union (if applicable).

For the purpose of the Act, the Regulations, and the Ontario Electrical Safety Code, “**critically injured**” means an injury of a serious nature that,

- places life in jeopardy;
- produces unconsciousness;
- results in substantial loss of blood;
- involves the fracture of a leg or arm but not a finger or toe;
- involves the amputation of a leg, arm, hand, or foot but not a finger or toe;
- consists of burns to a major portion of the body; or,
- causes the loss of sight in an eye.

Note:

Ontario Regulation 834 and the *Ontario Electrical Safety Code* (OESC) (twenty third edition, 2002) use virtually identical wording for the definition of “critically injured”.



The employer must send a written report to the MOL within 48 hours.

The following requirements are quoted from the *Occupational Health and Safety Act*:


Notice of accident, explosion, or fire causing injury

If a person is disabled from performing his or her usual work or requires medical attention because of an accident, explosion, or fire at a workplace but no person dies or is critically injured because of that occurrence, the employer shall, within four days of the occurrence, give written notice of the occurrence containing the prescribed information and particulars to the following:

1. The [joint health and safety] committee, the health and safety representative, and the trade union if any.
2. The [Ministry of Labour] Director, if an inspector requires notification of the Director.

Notice of occupational illness

If an employer is advised by or on behalf of a worker that the worker has an occupational illness or that a claim in respect of an occupational illness has been filed with the Workplace Safety and Insurance Board by or on behalf of the worker, the employer shall give notice in writing, within four days of being so advised, to a [Ministry of Labour] Director, to the



[joint health and safety] committee or a health and safety representative, and to the trade union, if any, containing such information and particulars as are prescribed. This applies with all necessary modifications if an employer is advised by or on behalf of a former worker that the worker has or had an occupational illness or that a claim in respect of an occupational illness has been filed with the Workplace Safety and Insurance Board by or on behalf of the worker.

Reporting of incidents where no injury occurs

Where a notice or report is not required under section 51 or 52 and an accident, premature or unexpected explosion, fire, flood or inrush of water, failure of any equipment, machine, device, article or thing, cave-in, subsidence, rockburst, or other incident as prescribed occurs at a project site, mine or mining plant, notice in writing of the occurrence shall be given to a [Ministry of Labour] Director and to the [joint health and safety] committee, health and safety representative and trade union, if any, by the constructor of the project or the owner of the mine or mining plant within two days of the occurrence containing such information and particulars as are prescribed.

—*OHSA Section 53.*

For the purpose of section 53 of the Act, a **prescribed incident** (as mentioned in the above paragraph) includes:

- accidental contact by a worker or by a worker's tool or equipment with energized electrical equipment, installations or conductors.
 - Accidental contact by a crane, similar hoisting device, backhoe, power shovel or other vehicle or equipment or its load with an energized electrical conductor rated at more than 750 volts.
- The Construction Regulation, Section 11.

Reporting a serious electrical incident to the Electrical Safety Authority (ESA)

An owner, contractor, or operator of a facility must report to the Inspection Department of the Electrical Safety Authority (ESA) any serious electrical incidents within 48 hours after the occurrence. To report an incident call 1-877-372-7233 (1-877-ESA-SAFE).

See the next page for the definition of a serious electrical incident.

- “Serious electrical incident”** means,
- b) Any electrical contact which causes death or critical injury* to a person, or
 - c) Any fire or any explosion or any condition suspected of being electrical in origin which might have caused a fire, explosion, loss of life, critical injury* to a person, or damage to property, or
 - d) Any electrical contact with electrical equipment operating at over 750 volts, or
 - e) Any explosion or fire of electrical equipment operating at over 750 volts.

—*Ontario Electrical Safety Code, 2002*

* see definition of “critical injury” under “Fatality or Critical Injury,” above.

Contact with an overhead powerline

Contact with an overhead powerline must be reported to multiple parties. If accidental contact occurs with an energized powerline carrying 750 V or more, report the contact to the inspection department of the Electrical Safety Authority (ESA), and provide written notice to the Ministry of Labour and to the joint health and safety committee, health and safety representative, and trade union.

Jobsite orientation for new workers

New workers on the job must be given an orientation to the jobsite. Include the following points in the orientation:

- emergency procedures
- location of facilities such as first aid station, fire extinguishers, exits, and toilets
- possible hazards, both electrical hazards and those related to the work of other trades
- the need to be familiar with the content of this manual
- the names of:
 - the health and safety representative on the project
 - the representative on the worker trades committee
 - the representatives on the joint health and safety committee
 - the jobsite first-aiders.

First aid

First aid requirements

Prompt and correct treatment of injuries not only reduces pain and suffering but also saves lives. A valid St. John Ambulance Emergency First Aid certificate or its equivalent provides the training for personnel to respond quickly in an emergency. First Aid requirements for the

workplace are described in Regulation 1101 under the *Workplace Safety and Insurance Act*.

Service vehicles

Of special interest to electrical workers are first aid stations in service vehicles. In general, each service vehicle must be equipped with a fully stocked first aid station and a current St. John Ambulance first aid manual. The person in charge of the station must hold a valid St. John Ambulance emergency first aid certificate or equivalent. A first aid station *in a service vehicle* must contain as a minimum:

- first aid kit
- valid first aid certificates of trained workers on duty
- inspection card for recording the date of the most recent kit inspection and the inspector's signature. Employers are responsible for ensuring that the kit is inspected at least four times per year.

The first aid station must be the responsibility of a worker who works in the immediate vicinity. Stations must be easily accessible for the prompt treatment of personnel at all times while work is in progress.

Note:

The requirements above apply to service vehicles only. At permanent sites, the first aid station must contain additional items to be complete.

Kit components

Every employer employing not more than five workers in any one shift at a worksite must provide and maintain a first aid station with a first aid kit containing as a minimum:

- current edition of a standard St. John Ambulance first aid manual
- 1 card of safety pins
- dressings consisting of
 - 12 adhesive dressings individually wrapped
 - 4 sterile gauze pads, 3 inches square
 - 2 rolls of gauze bandage, 2 inches wide
 - 2 field dressings, 4 inches square, or 2 four-inch sterile bandage compresses
 - 1 triangular bandage.

In addition, workers should have clean water available to rinse skin or eyes, and other additional first aid components that would be required to address specific hazards that can be expected on the jobsite.

Every employer employing more than five workers and not more than fifteen workers in any one shift at a worksite must provide and maintain a first aid station with a first aid box containing as a minimum:

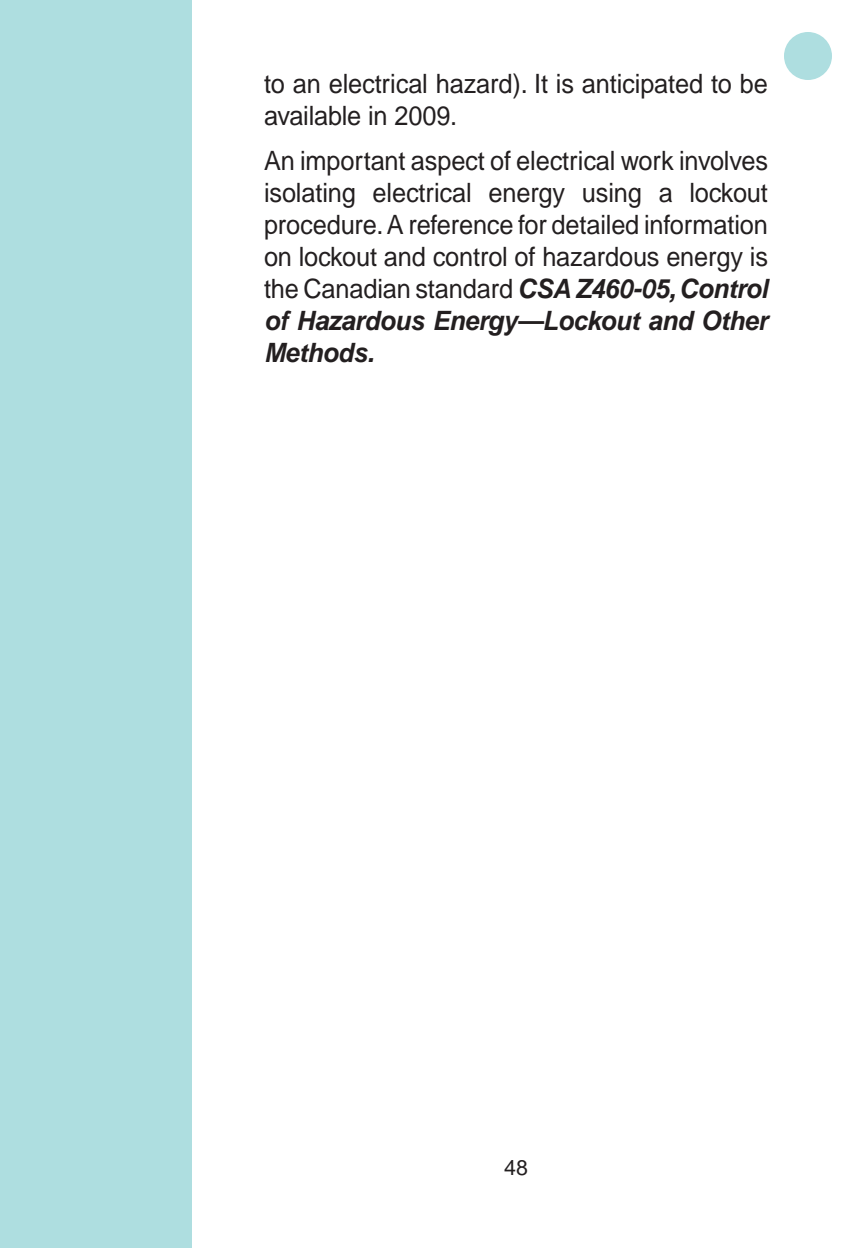
- current edition of a standard St. John Ambulance first aid manual
- 1 card of safety pins
- dressings consisting of

- 24 adhesive dressings individually wrapped
- 12 sterile gauze pads, 3 inches square
- 4 rolls of gauze bandage, 2 inches wide
- 4 rolls of gauze bandage, 4 inches wide
- 4 sterile surgical pads suitable for pressure dressings, individually wrapped
- 6 triangular bandages
- 2 rolls of splint padding
- 1 roll-up splint.

In addition, workers should have clean water available to rinse skin or eyes, and other additional first aid components that would be required to address specific hazards that can be expected on the jobsite.

Safety standards

At the time of printing of this manual, a Canadian version of the US electrical safety standard *NFPA 70E Standard for Electrical Safety in the Workplace* is being developed. The Canadian version, tentatively called **CSA Z462 Workplace Electrical Safety**, will be an in-depth resource for additional information dealing with electrical safety concerns. It addresses topics such as establishing an electrical safe work area and determining the required personal protective equipment to protect against electrical shock and burn (whether the person is working directly on energized components or is otherwise exposed



to an electrical hazard). It is anticipated to be available in 2009.

An important aspect of electrical work involves isolating electrical energy using a lockout procedure. A reference for detailed information on lockout and control of hazardous energy is the Canadian standard **CSA Z460-05, *Control of Hazardous Energy—Lockout and Other Methods***.

4. SPECIFIC TOPICS

Confined spaces

“Confined space” means a fully or partially enclosed space,

- (a) that is not both designed and constructed for continuous human occupancy, and
- (b) in which atmospheric hazards may occur because of its construction, location or contents or because of work that is done in it.

—The Construction Regulation,
Section 221.2

In some situations it may be best to treat the area as a confined space even if the definition does not apply.

Before work begins in any confined area such as a manhole or vault, assess whether a hazard exists and determine if the area is a confined space. If the work area is a confined space, work must be performed under the appropriate confined space regulation. For example, confined spaces are addressed under section 221.1 of the Construction Regulation (Ontario Regulation 213/91), and in section 119.1 of the regulation Industrial Establishments (Ontario Regulation 851). If the area does not meet the definition of a confined space but a hazard

still exists, appropriate safety measures must be taken to address the hazard and to protect the worker. In some situations, the appropriate safety measure may be to treat the area as a confined space even if the definition does not apply.

Authorized personnel in a manhole, vault, or switchroom

In accordance with Sections 44(4) and 184 of the Construction Regulation, only authorized personnel are permitted access to a room or other enclosure containing exposed energized electrical parts.

Trenches and excavations

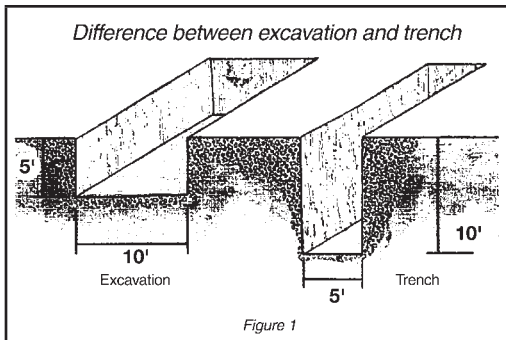
“Excavation” means the hole that is left in the ground, as a result of removing material;

“Trench” means an excavation where the excavation depth exceeds the excavation width.

—The Construction Regulation

See Figure 1 for an illustration.

Before starting any excavation, ensure all utilities are located. Call the local utility companies or use the Ontario One Call system at 1-800-400-2255.



Protection against cave-ins

There are three basic methods of protecting workers against trench cave-ins:

- Sloping
- trench boxes
- shoring.

Most fatal cave-ins occur on small jobs of short duration such as service connections and excavations for drains and wells. Too often people think that these jobs are not hazardous enough to require safeguards against collapse.

***Unless the walls are solid rock,
never enter a trench deeper
than 1.2 metres (4 feet)
unless it is properly sloped, shored,
or protected by a trench box.***

Sloping

One way to ensure that a trench will not collapse is to slope the walls. Where space and other requirements permit sloping, the angle of slope depends on soil conditions (Figures 8, 9 and 10).

Soil type

The type of soil determines the strength and stability of trench walls. Identifying soil types requires knowledge, skill, and experience. Even hard soil may contain faults in seams or layers that make it unstable when excavated.

The foreperson or supervisor must be knowledgeable about soil types found on a project and plan protection accordingly. This knowledge must include an awareness that soil types and conditions can change over very short distances. It is not unusual for soil to change completely within 50 metres, or for soil to become saturated with moisture over even smaller distances. The Construction Regulation sets out four soil types:

- **Type 1** It is hard to drive a pick into Type 1 soil. Hence, it is often described as “hard ground to dig”. In fact, the material is so hard, it is close to rock.
- **Type 2** A pick can be driven into Type 2 soil relatively easily. It can easily be excavated by a backhoe or hand excavated with some difficulty.

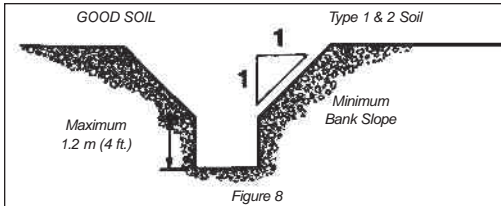


Figure 8

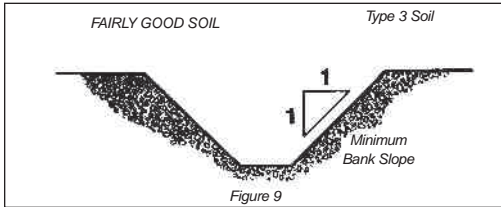


Figure 9

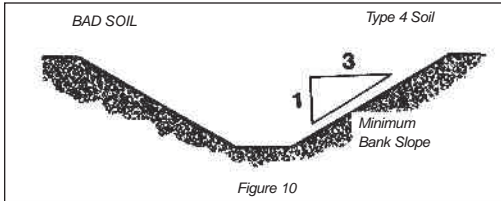


Figure 10

- **Type 3** Much of the Type 3 soil encountered in construction is previously excavated material. Type 3 soil can be excavated by hand.
- **Type 4** Type 4 soil can be excavated with no difficulty using a hydraulic backhoe. The material will flow very easily and must be supported and contained to be excavated to any significant depth.

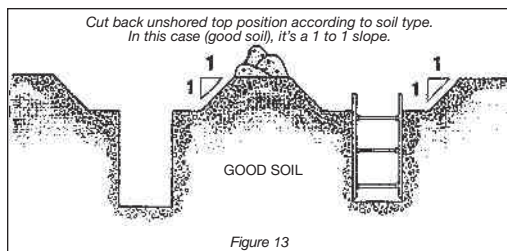
For Type 1 and 2 soils, cut trench walls back at an angle of 1 to 1 (45 degrees). That's one metre back for each metre up. Walls should be

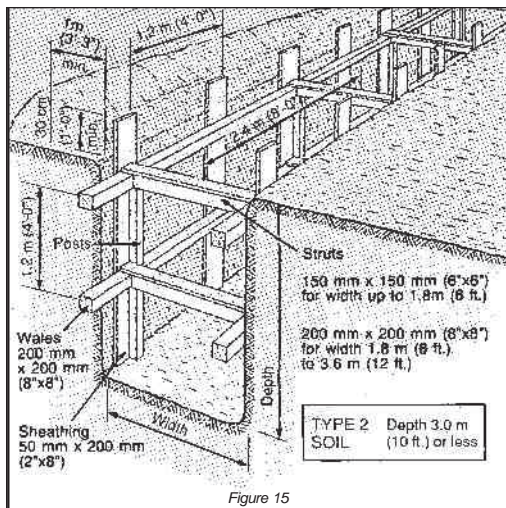
sloped to within 1.2 metres (4 feet) of the trench bottom (Figure 8). For Type 3 soil, cut walls back at a gradient of 1 to 1 from the trench bottom (Figure 9). For Type 4 soil, slope the walls at 1 to 3. That's 3 metres back for every 1 metre up from the trench bottom (Figure 10). Although sloping can reduce the risk of cave-in, the angle must be sufficient to prevent spoil not only from sliding back but also from exerting too much pressure on the trench wall.

Sloping is commonly used with shoring or trench boxes to cut back any soil above the protected zone. It is also good practice to cut a bench (a landing or shoulder) at the top of the shoring or trench.

Trench boxes

Trench boxes are not usually intended to shore up or otherwise support trench walls. They are meant to protect workers in case of a cave-in. If sloping is to be used above a trench box, the top portion of the cut should first be sloped according to the soil type (see above). Then the box should be lowered into the trench (Figure 13).





Shoring

Shoring is a system which “shores” up or supports trench walls to prevent movement of soil, underground utilities, roadways, and foundations.

Shoring should not be confused with trench boxes. A trench box provides worker safety but gives little or no support to trench walls or existing structures such as foundations and manholes holes.

The two types of shoring most commonly used are timber and hydraulic. Both consist of posts, wales, struts, and sheathing. Figure 15 identifies components, dimensions, and other requirements for timber shoring in some typical trenches.

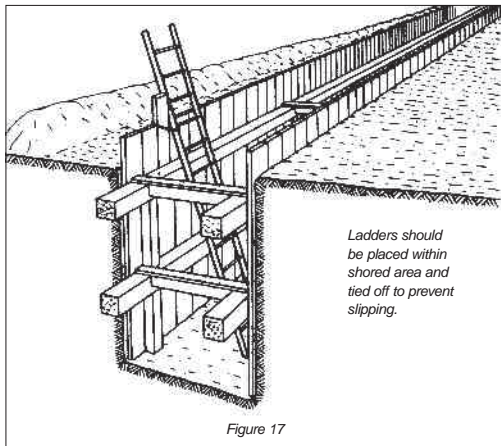


Figure 17


Entry and exit

Whether protected by sloping, boxes, or shoring, trenches must be provided with ladders so that workers can enter and exit safely (Figure 17). Ladders must

- be placed within the area protected by the shoring or trench box
- be securely tied off at the top
- extend above the shoring or box by at least 1 metre (3 feet)
- be inspected regularly for damage.

Additional requirements for excavations and trenches

- Working alone is not permitted in a trench. Work may only be performed in the trench when another worker is working above



ground in close proximity to the trench or to the means of access to it.


- Excavations which workers are required to enter should be kept reasonably free of water.
- Equipment, construction material, and excavated soil must be kept at least one metre (3 feet) from the edge of an excavation or trench.
- No person shall operate or locate a vehicle or other machine in such a way as to affect the stability of a wall of an excavation.

Lockout and tagging

Background and introduction

Lockout is the primary means of preventing the unplanned release of hazardous energy. For electrical workers, it often involves workers using a padlock to keep a switch in the “off” position. It may also be necessary to isolate the energy of moving parts, chemical reactions, falling counterweights, and other actions that can endanger lives. Lockout is a physical way to ensure that the energy source is de-energized, deactivated, or otherwise inoperable. Lockout involves:

- a. identifying all energy sources that may affect the work and work area
- b. redirecting or stopping the energy from doing what it is normally intended to do

- 
- c. physically preventing the accidental reenergizing of the system, and
 - d. verifying zero energy.

It is important to control all energy systems involved in the work. A piece of equipment may have an electrically-operated component but a hydraulic or pneumatic primary power source. Failure to control each energy system could jeopardize the safety of workers involved. In addition, gravity, momentum, and stored energy can present unexpected hazards.


Tags are an important part of a lockout. After attaching his or her personal lock, the worker attaches a tag to the lock. Tags are a means of communication. Tags are used to inform others that the device is locked out, who has locked it out, and why. Tagged devices and systems must not be re-energized without the authority of those named on the tag.

It is absolutely essential for an employer to have an effective lockout and tag policy in place and to ensure it is diligently practiced without exception.

A reference for detailed information on lockout and control of hazardous energy is the CSA Standard Z460-05, *Control of Hazardous Energy—Lockout and Other Methods*.

Forms of energy

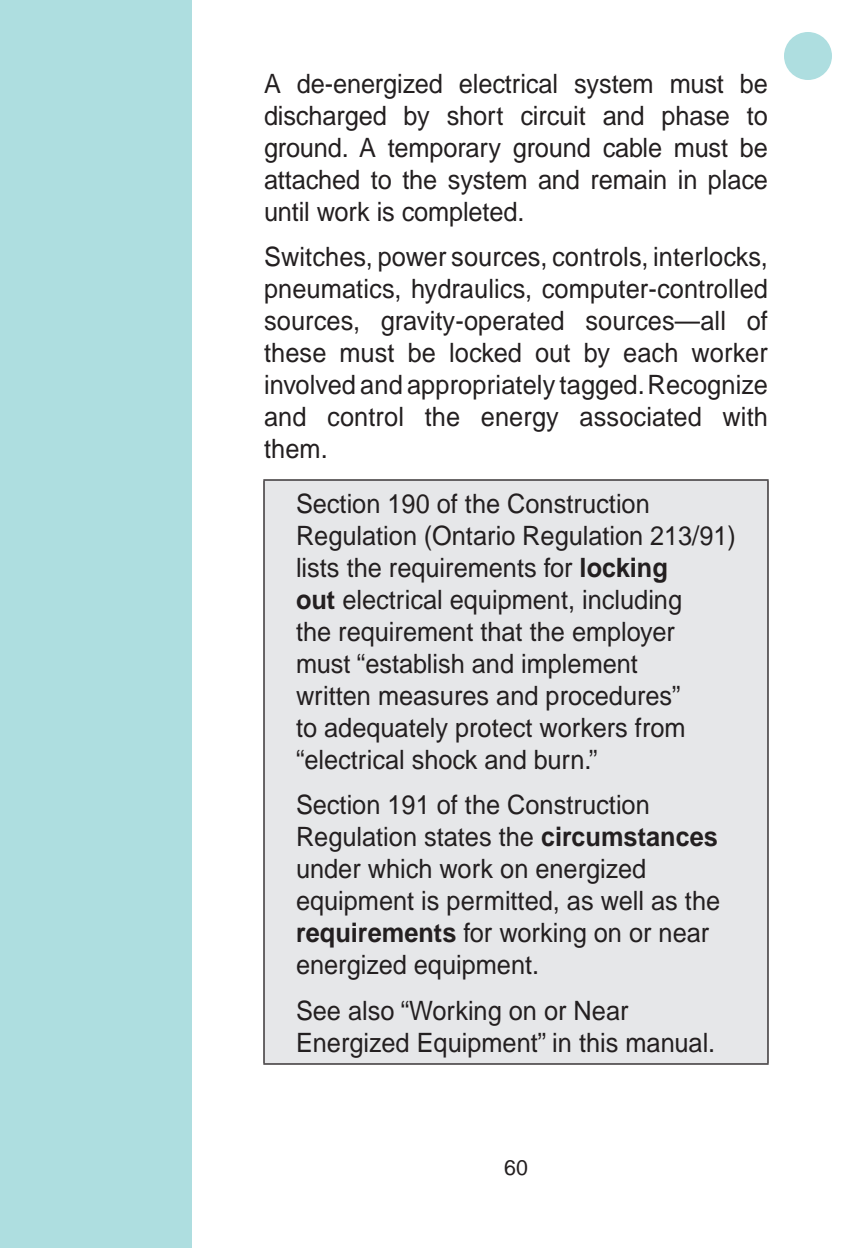
When most people think of uncontrolled hazardous energy, they think of electricity. But



electricians overseeing a lockout procedure need to consider a variety of energy sources. Here are the main types of energy.

- Electrical (electrical panels, generators, lighting systems, storage batteries, etc.)
- Mechanical—the energy of moving parts (flywheels, blades, fans, conveyor belts, etc.)
- Potential—stored energy that can be released during work. Examples of systems having potential energy include suspended loads, compressed air, electrical capacitors, accumulated bulk goods, coiled springs, chemical reactions, changing states (solid—liquid—gas), etc.
- Hydraulic (presses, rams, cylinders, cranes, forklifts, etc.)
- Pneumatic (lines, compression tanks, etc.)
- Thermal (steam, hot water, fire, etc.)
- Chemical (flammable materials, corrosive substances, vapours, etc.)

Some equipment may involve more than one type of energy, and pose unexpected hazards. For example, a machine may have an electrically operated component but a hydraulic or pneumatic primary power source, or it may become activated on a timed schedule. With some equipment, gravity and momentum can present unexpected hazards.



A de-energized electrical system must be discharged by short circuit and phase to ground. A temporary ground cable must be attached to the system and remain in place until work is completed.

Switches, power sources, controls, interlocks, pneumatics, hydraulics, computer-controlled sources, gravity-operated sources—all of these must be locked out by each worker involved and appropriately tagged. Recognize and control the energy associated with them.

Section 190 of the Construction Regulation (Ontario Regulation 213/91) lists the requirements for **locking out** electrical equipment, including the requirement that the employer must “establish and implement written measures and procedures” to adequately protect workers from “electrical shock and burn.”

Section 191 of the Construction Regulation states the **circumstances** under which work on energized equipment is permitted, as well as the **requirements** for working on or near energized equipment.


See also “Working on or Near Energized Equipment” in this manual.



Procedure

Employers must have a lockout policy as part of their overall health and safety policy and program. Under the lockout policy, there should be a procedure which provides guidance for how the lockout is carried out and to ensure site-specific hazards are addressed. Both the industrial [Section 42 (7)] and construction [Section 190(2)(a)] regulations require written procedures to address electrical hazards. See “Working On or Near Energized Equipment” in this manual.

When working in plants or industrial establishments, there may be specific in-house procedures for lockout and tagging at that location. This makes sense because the in-plant workforce will have proven its procedures through use on the particular system or the machine in question. If in-plant procedures are followed, it is important to verify that these procedures (which may have been designed solely for maintenance type work) have isolated **all energy sources**. The contractor's work activity may vary from routine plant maintenance, creating additional hazards. The shutdown of machines, equipment, or processes may be carried out by plant personnel. In other cases, plant representatives may issue a work permit to allow work on their equipment and/or a lockout permit to ensure that lockout procedures are followed before work begins.



There are typically three recommended methods of locking out equipment: **individual lockout**, **group lockout**, and **complex group lockout**.

Individual lockout


This is the basic and most preferred approach to lockout. It requires each worker to be authorised to perform lockout. The authorized individual knows the hazards associated with the machine, equipment, or process to be isolated, and knows the method of isolation required to protect workers. Each individual involved in the work is accountable to himself or herself for ensuring that before work begins, the required energy isolating devices are

- in place to isolate and control hazardous energy,
- locked in place with their own personal locks
- and then tagged.

The machine, equipment, or process is then verified to be de-energized.

If several workers or trades are working on the circuit, use a lockout bar to provide space for additional locks. This arrangement can accommodate any number of locks by placing another lockout bar in the last hole of the previous bar.

Locks must be uniquely identified. Identify a lock by applying the worker's name directly to the lock. You could also use some other



means of identifying the owner of the lock, such as a colour, a tag, or some other marking applied directly to the lock. You must also have a means of determining the date and reason for lockout. This information can be written on a tag attached to the lock, or the lock can be marked with a symbol that you can use to look up the required information. The application of a lockout device must not itself create a hazard. You must recognize that, even though the disconnect switch may already be locked, you are not protected until you attach your own personal lock.

A **tag** is required on the power supply lockout device. The tag must identify the name of the person that disconnected the equipment and their employer, the date and time of lockout, and the reason for the lockout. A tag alone should not be relied on as proof that a machine or system is locked out. The tag provides information about the lockout, but does not guarantee that the energy has been isolated. Tags may also be used to identify the owner of the lock.


Use signs placed on the system to indicate that it is not to be energized or operated, and that guards, locks, temporary ground cables, chains, tags, and other safeguards are not to be tampered with or removed. If more than one worker is involved, information must be posted, or otherwise communicated, to show the purpose and status of the lockout.



Group lockout

Group lockout simplifies the lockout process when there are many devices to lock out and many authorized workers. The group lockout process still provides individual authorized workers to control hazardous energy with their own locks. Here are typical steps for group lockout:

1. The primary authorized individual is assigned responsibility for controlling all energy sources by applying any required energy-isolating devices and placing a lock and tag on each.
2. The key for each lock applied to lockout devices is placed in a lockable container such as a lock box. The lock box is then in turn locked by the primary authorized individual and a tag is applied.
3. Zero energy is then verified to ensure that the lockout is effective. Ideally, the verification is done in the presence of the work crew.
4. Before work begins, each worker



assesses the lockout procedure and its adequacy to achieve zero energy relative to the work each worker will do. Once satisfied, each worker applies his or her own identifiable lock (and tag if used) to the lock box. Each crew member would ideally have been present when zero energy was verified. Otherwise, each worker must satisfy themselves that the lockout is effective.

5. As each worker completes his or her work and has removed all non-essential items from the work site, their own personal lock (and tag if used) is removed from the lock box.
6. Once all crew members have removed their personal locks and tags from the lock box, the primary authorized individual assigned responsibility for the lockout inspects the work site to check that all tools and workers are clear. Then, each lock and isolating device is removed.

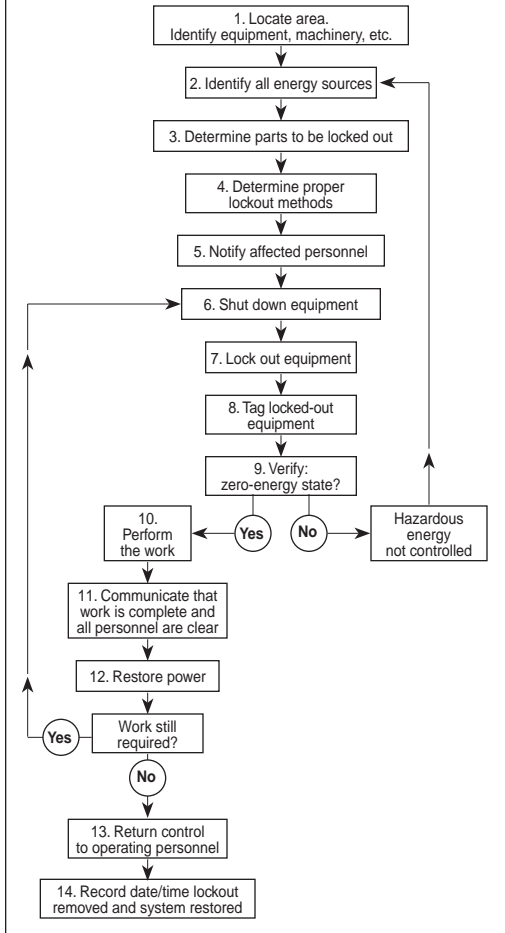
Complex group lockout


A workplace can use complex group lockout when it's not practicable to use an individual lockout or group lockout approach due to any of the following:

1. the physical extent of the equipment and/or process being serviced
2. inaccessibility of the energy-isolating devices

PLANNING STEPS

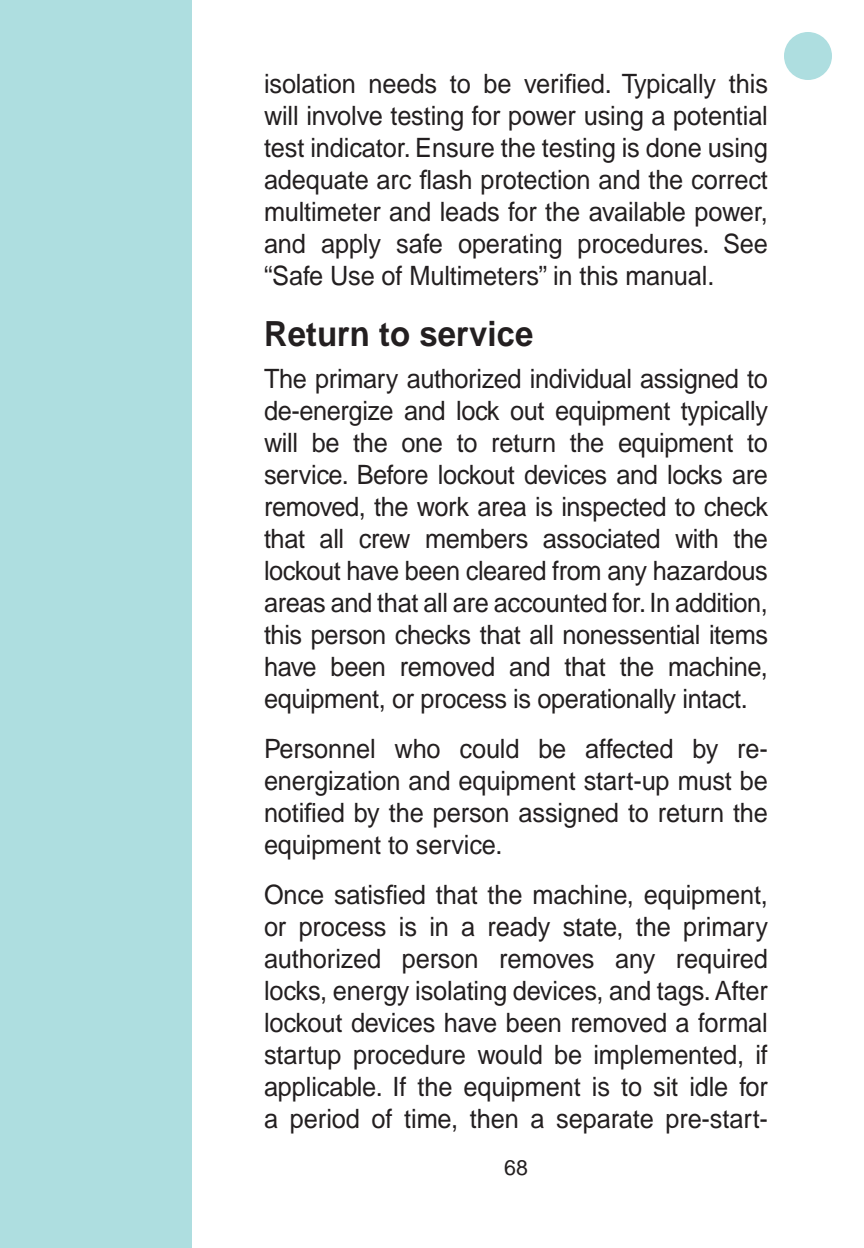
Specific lockout procedures will vary depending on the work and the processes which must be shut down. The following chart can help you develop specific procedures.



- 
3. the number of energy-isolating devices
 4. the length of time the equipment or processes will be isolated
 5. the number of authorized individuals involved
 6. the interdependence and interrelationship of the components in the system or between different systems.

Implementation of a complex group lockout must provide the equivalent level of personal protection for each member of the work crew as is afforded by individual lockout. Complex group lockout uses control measures such as work permits, administrative control measures, and control boards. After all energy sources are isolated and locked out, work crew members verify the isolation and the effectiveness of the energy isolation for the work they are performing. For very large processes such as a nuclear plant shut down, verification may be achieved by understanding and having confidence in the process for the shut down and lockout. Individual crew members do not apply personal locks on each isolation device, but rather rely on process and controls put in place to assure reliability of the lockout.

Although electricians need to consider all possible forms of energy, most work may simply require the lockout of a single electrical device. After shutting down the equipment, applying the lockout device, applying a personal lock, and attaching a tag, the




isolation needs to be verified. Typically this will involve testing for power using a potential test indicator. Ensure the testing is done using adequate arc flash protection and the correct multimeter and leads for the available power, and apply safe operating procedures. See “Safe Use of Multimeters” in this manual.

Return to service

The primary authorized individual assigned to de-energize and lock out equipment typically will be the one to return the equipment to service. Before lockout devices and locks are removed, the work area is inspected to check that all crew members associated with the lockout have been cleared from any hazardous areas and that all are accounted for. In addition, this person checks that all nonessential items have been removed and that the machine, equipment, or process is operationally intact.

Personnel who could be affected by re-energization and equipment start-up must be notified by the person assigned to return the equipment to service.

Once satisfied that the machine, equipment, or process is in a ready state, the primary authorized person removes any required locks, energy isolating devices, and tags. After lockout devices have been removed a formal startup procedure would be implemented, if applicable. If the equipment is to sit idle for a period of time, then a separate pre-start-



up process should address the notification requirements.

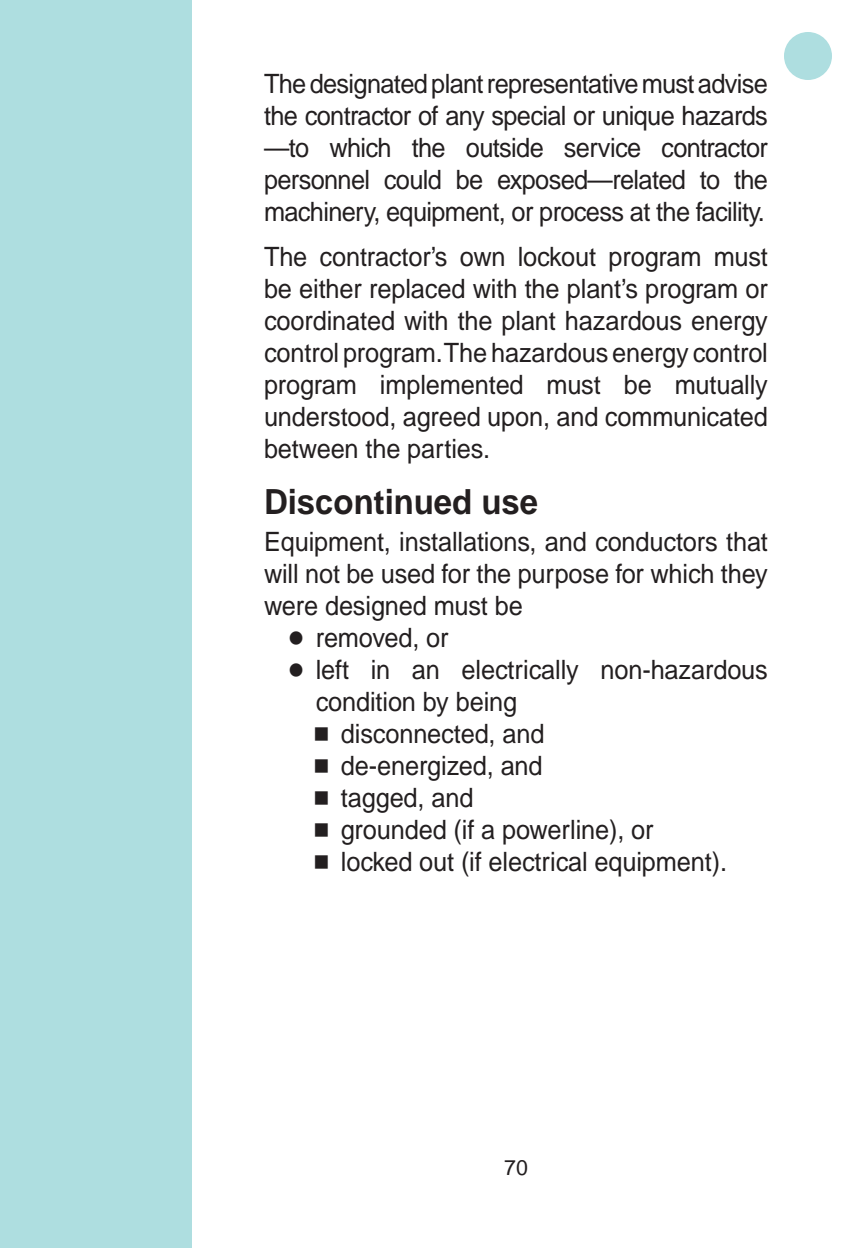
Lockout and tag removal when authorized person is absent

Occasionally a worker leaves the jobsite and leaves a lock in place intentionally or accidentally and may not be present when the equipment needs to be re-energized. Removing the lock may expose that worker and possibly others to danger. There must be a written procedure about how to remove lockout devices and tags safely. The procedure must cover locating the absent worker and obtaining permission to remove their lock. It must also cover how, if the worker cannot be found, to validate if it is safe to cut the lock from the lockout device and re-energize the system.

The person removing the lock should be identified in the lockout documentation.

Service contractor personnel

Communication is a key element of a hazardous energy control program. The plant and contractor should each designate a representative responsible for determining their relationship, as well as their individual responsibilities and obligations regarding hazardous energy control. To eliminate confusion on contractor-controlled lockouts, it may be useful for the plant to provide locks and tags that are recognisable by plant personnel.



The designated plant representative must advise the contractor of any special or unique hazards—to which the outside service contractor personnel could be exposed—related to the machinery, equipment, or process at the facility.

The contractor's own lockout program must be either replaced with the plant's program or coordinated with the plant hazardous energy control program. The hazardous energy control program implemented must be mutually understood, agreed upon, and communicated between the parties.

Discontinued use

Equipment, installations, and conductors that will not be used for the purpose for which they were designed must be

- removed, or
- left in an electrically non-hazardous condition by being
 - disconnected, and
 - de-energized, and
 - tagged, and
 - grounded (if a powerline), or
 - locked out (if electrical equipment).

Working on or near energized equipment


For the purpose of this manual an “electrical hazard” means

- a dangerous condition where a worker could make electrical contact with energized equipment or a conductor and from which the person may sustain an injury from shock, or
- a situation where there is potential for the worker to receive an arc flash burn, thermal burn, or blast injury.

Note:

An electrical hazard is considered to be removed when protective measures are put in place at the source (remove hazard or de-energize), or along the path (place electrical insulation between the worker and the electrical hazard). If personal protective equipment is the method of worker protection, the electrical hazard itself hasn't gone away. It is still necessary to address safety requirements for other workers in the area.

Where an electrical hazard exists and work must be done on an energized electrical component, or near enough to the hazard




that the worker can make electrical contact or be exposed to injury from arc flash, work is permitted while the system is energized **only if:**

- it is not reasonably possible to disconnect the equipment, installation, or conductor from the power supply
- the equipment is rated at a nominal voltage of 600 volts or less, and disconnecting the equipment would create a greater hazard to workers than proceeding without disconnecting it, or
- the work consists only of diagnostic testing.

The constructor must ensure that written procedures for work on or near live equipment are established and implemented to protect workers from electrical shock and burn. The constructor must have copies of the procedures available for employers on the project.

The employer must provide, and explain, the written procedures to workers before they start work on or near live equipment. The constructor and the employer both have a general duty to ensure that the health and safety of workers is protected.

*Testing with a meter **is** live work and requires appropriate personal protective equipment.*



Unless the work consists only of diagnostic testing or involves a nominal voltage under 300 volts, an adequately equipped competent worker who can perform rescue operations, including cardiopulmonary resuscitation (CPR), must be stationed where he or she can see the workers performing the live work.

Live work on equipment nominally rated greater than 400 amperes and greater than 200 volts, or greater than 200 amperes and greater than 300 volts, can be done only if

1. the owner of the equipment provides the employer and the constructor with a record showing that it has been maintained according to the manufacturer's specifications
2. a copy of the maintenance record is readily available at the project
3. the employer has determined from the maintenance record that work on the equipment can be performed safely without disconnecting it, and
4. before beginning live work, the worker has verified that points 1), 2), and 3) have been done.

Repair or permanently disconnect defective equipment.

Section 2-300 of the *Ontario Electrical Safety Code, 2002*, requires operating electrical equipment to be kept in safe and proper working condition.

Tools and equipment for working on or near energized electrical equipment

Workers exposed to an electrical hazard must use mats, gloves, shields, flame resistant clothing, and any other protective equipment required to protect themselves from electric shock and burn. Electrical workers should

- a. remove watches, rings, neck chains, or other current-conducting jewelry
- b. wear electric-shock-resistant footwear
- c. wear flame-resistant (FR) clothing and protective equipment
- d. wear a CSA-approved Class E hard hat or equivalent, and
- e. wear safety glasses with side shields.

See the section on “Injury” in this manual.

Tools, devices, and equipment, including personal protective equipment, used for live work must be designed, tested, maintained, and used in ways that provide adequate protection for workers.

Rubber gloves and leather protectors must be adequate to protect the worker from electrical shock or burn. The rubber gloves must have been tested and certified for working live.

All rubber gloves, no matter what the class, must be air-tested and visually inspected for damage and adequacy immediately before use. If the requirements of the E&USA's *Electrical Utility Safety Rules* (“E&USA Rule

Book”) are being followed, all classes of rubber gloves are required to be dielectrically tested every 90 days. If the requirements of the Construction Regulation are being followed, rubber gloves of Class 1 to Class 4 are required to be dielectrically tested every 90 days if they are in service, or every 180 days if not in service. The Construction Regulation does not require dielectric testing of Class 0 or Class 00 rubber gloves.

Workers must be trained in the proper use, care, and storage of rubber gloves and leather protectors.

Flash Hazard (Arc Flash) Protection

“Flash hazard” means a dangerous condition associated with the release of energy caused by an electric arc. The release of energy is often referred to as an arc flash.

— National Fire Protection Association’s *Standard for Electrical Safety in the Workplace* (NFPA 70E), 2004

An **arc flash** is a release of energy caused by an electric arc. The flash causes an explosive expansion of air and metal. The blast produces

- a dangerous pressure wave
- a dangerous sound wave

- shrapnel
- extreme heat
- extremely bright light.

These dangers can result in blast injuries, lung injuries, ruptured eardrums, shrapnel wounds, severe burns, and blindness. Arc flash injuries can also result in death.




ARC FLASH

Statistics gathered by the Ontario Ministry of Labour show that arc flash injuries represent a large percentage of the electrical injuries that occur in Ontario workplaces.

2006 Ontario Arc Flash Injuries for all industries			
Injury Type	Total Electrical injuries	Arc Flash Burns	Percent of Total
Critical	18	7	39%
Non-critical	112	23	20%

Ontario Ministry of Labour




The nature of an electrical worker's job can put the worker close to energized electrical equipment. As a result, electricians can be exposed to an arc flash during the course of a normal work day, even if they're not working on a potential source of an arc flash. Electrical workers should wear clothing that provides for a basic level of arc flash protection. Electrical workers should wear—as a minimum—non-melting, untreated natural fibre with a fabric weight of at least 4.5 oz/yd².

Tasks with potential for arc flash:

- Operating a switch or circuit breaker
- Inserting or removing a circuit breaker
- Opening an enclosure door
- Removing a cover (bolted or hinged)
- Testing for voltage.

Canadian Electrical Code 2006

Warning labels are required on equipment that pose shock and flash hazards.

 WARNING	
Arc Flash and Shock Hazard Appropriate PPE Required	
24 inch	Flash Hazard Boundary
3	cal/cm ² Flash Hazard at 18 inches
480 VAC Shock Hazard when Cover is removed	
42 inch	Limited Approach
12 inch	Restricted Approach - 500 V Class 00 Gloves
1 inch	Prohibited Approach - 500 V Class 00 Gloves
Date: 8/28/2001	
Bldg. ECR #1	Equipment Name: Slurry Pump Starter

Electrical equipment shall be field marked to warn persons of potential electric shock and arc flash hazards —*Rule 2-306, Shock and Flash Protection, Canadian Electrical Code 2006*

Adding the information from the results of an arc flash calculation, and for electric shock, arms workers with the knowledge to protect themselves and makes the labels more useful.



Photos compliments of Salisbury Electrical Safety L.L.C.

Arc-flash-resistant clothing

Flame-resistant (FR) clothing

- protects a worker from receiving severe burns if the worker is exposed to a flame.
- is self-extinguishing when the source of the flame is removed.

FR clothing can be designed to protect against the increased levels of energy generated from the intense flash flame of an arc flash. Following the requirements of the National Fire Protection Association's *Standard for Electrical Safety in the Workplace* (NFPA 70E, 2004) will limit the incident energy level of an arc flash to 1.2 cal/cm^2 against the worker's chest. The worker may still receive a second-

degree burn under the clothing. A second-degree burn occurs when skin is exposed to 1.2 cal/cm² for more than 0.1 second or 1.5 cal/cm² for 0.1 second or less. More serious third-degree burns occur typically when clothing not rated for arc flash continues to burn on the worker's body after the arc flash.


FR clothing that provides arc flash protection will meet ASTM F1506, and bear a label stating ASTM F1506 approval and the arc rating of the garment. The buyer should know that **all** materials used in manufacturing arc-flash garments must be FR rated: thread, buttons, insulation, and zippers for example.

Arc-rated clothing may be layered to increase the level of protection, e.g., wearing FR coveralls over an FR shirt and FR pants. Layered clothing is more versatile and may result in a lighter set of clothing than if a single heavy garment were used. The manufacturer must verify (through testing) the new arc flash rating of the layering.

Not all personal protective equipment (PPE) is FR tested to ASTM F1506. When purchasing PPE, advise the supplier that arc flash protection and FR rated clothing is required. When PPE is not made with this



*Photo compliments of
Salisbury Electrical Safety
L.L.C.*



specific certification, the PPE must still offer resistance to flame, ignition, and melting.

For example, hard hats, safety glasses, leather work boots, and leather gloves may either be inherently flame resistant or designed to another standard that provides some protection.

The material used in manufacturing makes a difference. Generally, ear canal inserts made of PVC are more flame resistant than inserts made from polyurethane. Non-rated clothing and other PPE that can melt or catch fire exposes the worker to serious burn injury. Even though the arc-rated clothing easily survives an arc flash, workers are too often severely injured by non-rated apparel that either burns or melts on the workers' skin. The result is extremely painful and leads to lengthy hospitalization and rehabilitation, as well as permanent changes to their quality of life.

Clothing made of synthetic fibres can be readily ignited by arc flash and melt to the worker's skin. Cotton or wool fabrics are more flame-retardant and therefore recommended as outer-wear and inner-wear work clothes for electrical workers. Clothing that is flame resistant (FR) protects a worker from receiving severe burns to the body if the worker is exposed to a flame. FR clothing is self-extinguishing when the source of the flame is removed.

In some cases it may be possible to “design out” the electrical hazard with equipment designed to offer flash protection. The plug in the picture below is designed for flash protection and can be used as a disconnect switch.



Flash-protection is designed into this disconnect switch/plug. Photos courtesy of Meltric Corporation.



Controlling arc flash

At the source

- Reduce the fault clearing time.
- Reduce the short-circuit current.
- Improve equipment maintenance.
- Use arc-flash-resistant equipment.

Along the path

- Increase the working distance.
- Reduce the energy exposure.
- Use hinged doors instead of bolted doors to eliminate the risk of bolts falling into the panel.
- Work de-energized.

At the worker

- Use energized electrical work permits.
- Use barriers.
- Ensure workers have the necessary training and skills.
- Provide workers with pre-job briefings.
- Use PPE.
- Use proper tools.

Photo compliments of Salisbury Electrical Safety L.L.C.



Protection from an arc flash is afforded by employing protective clothing and equipment such as

- flame-resistant clothing
- safety glasses (FR face shield or flash hood is often required as well)
- hand protection
- hearing protection.

A flash suit and face shield are required for the more powerful flash hazards.

CSA Z462 *Workplace Electrical Safety* is currently being developed. Upon completion, CSA Z462 will be another resource for information dealing with electrical safety concerns such as arc flash. The US standard NFPA 70E 2004 is a currently available reference.

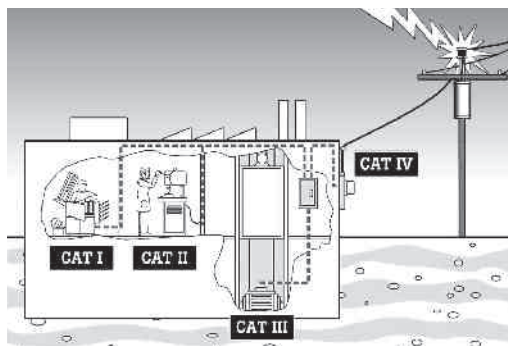
Multimeters

In the process of troubleshooting, electrical workers face the risk of injury from improper multimeter selection or use. Multimeters that are designed to meet the International Electro-technical Commission (IEC) 1010 and overvoltage category standards, when properly used, offer the electrician an acceptable level of protection that is recognized by the electrical industry.

Why use overvoltage category-rated multimeters?

Momentary high-voltage transients or spikes can travel through a multimeter at any time and without warning. Motors, capacitors, lightning, and power conversion equipment, such as variable speed drives, are all possible sources of spikes.

The IEC 1010 standard defines categories I through IV that are abbreviated as CAT I,



CAT II, etc. The higher-numbered categories represent an electrical environment that is susceptible to higher-energy spikes. For example, multimeters designed to the CAT IV standard provide the worker more protection from high transient voltage spikes than do CAT III, CAT II, or CAT I designs. See the accompanying diagram and table for an explanation of each category.



Test leads should be fused, and rated at the same or greater voltage than the multimeter.

Be sure the multimeter model has been tested. Simply being *designed* to CAT III, for example, does not mean the multimeter was also *tested* to that standard. **Look for proof of independent testing by an organization accredited by the Standards Council of Canada—such as the logo of CSA (Canadian Standards Association) International—along with the appropriate category rating on the equipment.**

Understanding overvoltage installation categories

The division of a power distribution system into categories is based on the fact that a dangerous high-energy transient such as a lightning strike will be attenuated or dampened as it travels through the impedance (AC resistance) of the system. A higher CAT number refers to an electrical environment with higher power available and higher-energy transients. Thus a multimeter designed to a CAT III standard is resistant to much higher-energy transients than one designed to CAT II standards. *Categories I through IV apply to low voltage (less than 1000 V) test equipment.*

OVERVOLTAGE CATEGORY	IN BRIEF	EXAMPLES
CAT IV	Three-phase at utility connection, any outdoors conductors	<ul style="list-style-type: none">• Refers to the "origin of installation", i.e., where low-voltage connection is made to utility power.• Electricity meters, primary overcurrent protection equipment.• Outside and service entrance, service drop from pole to building, run between meter and panel.• Overhead line to detached building, underground line to well pump.
CAT III	Three-phase distribution, including single-phase commercial lighting	<ul style="list-style-type: none">• Equipment in fixed installations, such as switchgear and polyphase motors.• Bus and feeder in industrial plants.• Feeders and short branch circuits, distribution panel devices.• Lighting systems in larger buildings.• Appliance outlets with short connections to service entrance.
CAT II	Single-phase receptacle connected loads	<ul style="list-style-type: none">• Appliance, portable tools, and other household and similar loads.• Outlet and long branch circuits.• Outlets at more than 10 meters (30 feet) from CAT III source.• Outlets at more than 20 meters (60 feet) from CAT IV source.
CAT I	Electronic	<ul style="list-style-type: none">• Protected electronic equipment.• Equipment connected to source circuits in which measures are taken to limit transient overvoltages to an appropriately low level.• Any high-voltage, low-energy source derived from a high-winding resistance transformer, such as the high-voltage section of a copier.

Parts of the above section are reprinted with permission from material by Fluke Electronics Canada Inc.

Safe Use of Multimeters

- Use only multimeters that display **both** the CSA logo (or equivalent) **and** the CAT (I, II, III, or IV) designation. *Catagories I through IV apply to low voltage (less than 1000 V) test equipment.*
- Check and ensure that the meter's voltage rating is appropriate for the work being done. *Beware of multimeters with maximum voltage ratings typical of other countries (550V for example).*
- Use personal protective equipment such as eye protection, flame-resistant clothing, long sleeve shirts, dielectric safety boots, rubber gloves with leather protectors, mats, blankets, and shields. **Do not wear synthetic inner-wear or outer-wear that can melt if an arc flash occurs.**
- Check the manufacturer's manual for special cautions. Moisture and cold may affect the performance of your meter.
- Wipe the multimeter and test leads clean to remove any surface contamination before use.
- Ensure that test leads are in the correct input jacks.
- Use fused test leads. Ensure fused leads and internal probe fuse are rated as high as or higher than the equipment you are going to work on. A minimum of 30 kA (200 kA desirable).


- When the values to be measured are uncertain, start testing with high ranges of the multimeter, then move to the lower ranges.
- Connect to ground first, and disconnect from ground last.
- Test the multimeter on a known power source to verify the meter's proper function before and after testing the suspect circuit, using the same power function for all three tests.

Testing for power with a meter

Set the meter to the power function to be used for validating the lockout. Test to ensure the meter is functioning correctly by testing on a known power source, then test the locked out circuit to verify the power has been effectively isolated, and finally re-test on the same known power supply to verify the meter's fuse has not blown and the meter is still functioning correctly on that power setting.

Fishing and pulling wire

Conduit may provide a path along which noxious, toxic, or flammable fumes and gases can travel. If using gases, glues, solvents, or other chemicals that could produce a hazardous gas or fume, check locations where the gas or fume can exit the conduit. Ensure other workers are not exposed to the fume or gas, or that a hazardous condition is not



created as a result of the fume or gas building up in another room.

Pulling in confined spaces is particularly difficult. Workers should use care and caution under such conditions. Get help when necessary and use mechanical means if possible.

- When pulling heavy runs of steel cable, wear gloves for protection from sharp strands.
- When using jet lines, ensure that there is sufficient cross-ventilation to disperse carbon dioxide gas (CO₂). Jet lines must not be used in manholes unless forced ventilation is provided at each end of the run.


Illumination

General

All areas where workers must work or pass through must be adequately illuminated. Missing protective covers and burnt-out bulbs must be replaced. Suggested lighting level is a minimum of 55 lux (5 footcandles).

There are many ways to achieve the requirement of 55 lux. For example, 150-watt lightbulbs suspended

- 2.4 metres (8 feet) high and 7.5 metres (25 feet) apart; or,
- 3 metres (10 feet) high and 6 metres (20 feet) apart.




With lower wattage lighting, reduce the spaces between bulbs.

Fixed temporary wiring for illumination on construction projects

Branch lighting circuits shall be kept entirely separate from power circuits except for a common supply.—*Ontario Electrical Safety Code, Rule 76-014*

Minimum temporary lighting requirements do not include provisions for portable hand-held lamps used by various trades to illuminate their immediate work area.

- Lamps should be installed in suitable locations to illuminate the entire area and they must be protected by a mechanical device such as a cage. Where necessary, additional lights should be installed over and above the minimum requirements.
- The constructor should be responsible for regularly inspecting all temporary lighting and should promptly have a competent worker replace any burned-out or missing lamps. The constructor should require relocation of any lights that become obstructed by new work such as ceilings, ducts, piping, equipment, and partitions.
- Non-metallic sheathed cable of type NMWU is permitted to be used for branch circuits providing it is not less than No. 12 AWG copper and not smaller than No.



10 AWG when of aluminum. (*Ontario Electrical Safety Code, Rule 76-014*).


- All lamp holders should be hard-usage type, medium-base sockets.
- NMWU cable should be secured to the structure by an approved clip, manufactured for that purpose, on both sides of each light. The intervals between supports should not be more than 1.5 metres (4 feet, 11 inches).
- Each individual lighting branch circuit shall be protected by a circuit breaker or fuse with a rating of 15 amperes and the total load per circuit shall not exceed 12 amperes. (*Ontario Electrical Safety Code Rule 76-014*).
- Lighting stringers should not be plugged into a receptacle, but hard-wired directly into a distribution panel by a competent worker.

Temporary wiring and power

1. **Temporary wiring** for construction or demolition projects must be installed in accordance with the Ontario Electrical Safety Code 23rd Edition/2002 (as amended by Ontario Regulation 62/07) (Copies are available from Orderline at 1-888-361-0003 or www.orderline.com.)
2. Temporary wiring must be inspected and approved when initially installed and

should be checked regularly. (*Ontario Electrical Safety Code Rules 2-004, 2-014, 2-016*)

3. Temporary installations shall be constructed as separate installations and at no time shall they be interconnected with any of the circuits of the permanent installations except by special permission. (*Ontario Electrical Safety Code Rule 76-016*)
4. Feeders supplying fixed distribution centers shall be armoured cable or the equivalent. A feeder supplying a portable distribution center is permitted to be flexible cord or power cable of the outdoor type suitable for extra hard usage. Feeders shall be protected at all times from mechanical damage. (*Ontario Electrical Safety Code Rule 76-012*).
5. **A switch and panel board,**
 - a. must be securely mounted on a soundly constructed vertical surface;
 - b. must have a cover over uninsulated parts carrying current;
 - c. be located,
 - i. in an area where water will not accumulate; and
 - ii. within easy reach of workers and readily accessible to them;
 - d. must be kept clear of obstructions in the area in front of the panel board;
 - e. that controls a service entrance,

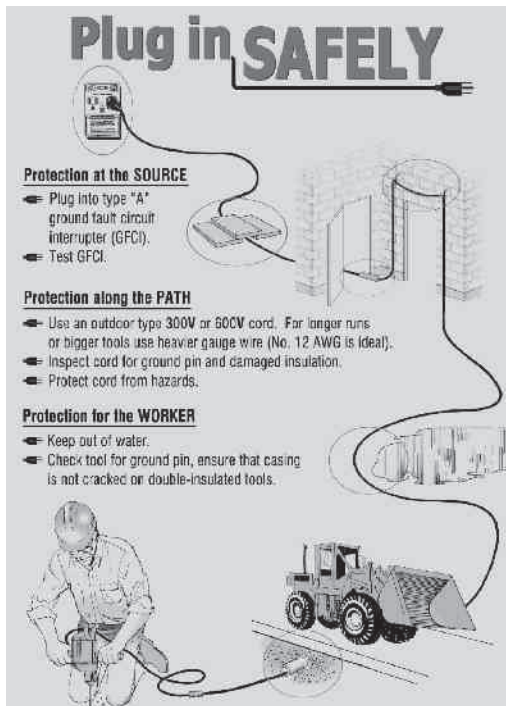


service feeder, or branch circuit providing temporary power,

- i. must not be locked in the energized position; and
 - ii. must be housed in an enclosure that can be locked and is provided with a locking device; *Construction Regulation Section 194*
- f. when supplying power to tools that will be used outdoors or in wet locations, the receptacle must be protected by a class A ground fault circuit interrupter (GFCI). *Construction Regulation Section 195*
6. **Portable generators** with no connection between the neutral and the case cannot be used as a stand-alone electrical supply for the operation of portable electrical equipment. Typically, generators with no connection between the neutral and the case are intended to be connected through a transfer switch to a distribution system for use as a standby back-up system in a residential home, in case of power outage. ***“Generators supplied by equipment rental stores for use as a stand-alone supply to portable electrical devices shall be a generator with the neutral bonded to the case to facilitate the operation of the overcurrent protection device(s)”*** (Electrical Safety Authority Flash notice 03-03-FL). Labeling on newer portable

generators must indicate the status of the neutral conductor and shall be marked on each machine as follows: NEUTRAL FLOATING or NEUTRAL BONDED TO FRAME.

7. **Electric tools used outdoors or in wet locations** must be protected by a Class A ground-fault circuit interrupter (GFCI). *Construction Regulation Section 195*



Portable tools and extension cords

1. Unless double-insulated, tools must have:
 - a. the casing grounded
 - b. a polarized plug connection.
2. Extension cords must be of the outdoor type, rated for 300 volts, and have an insulated grounding conductor.
3. Defective cords must not be used. They should either be destroyed or be tagged and removed from the jobsite until repaired.
4. Extension cords should be protected during use to prevent damage.
5. Extension cords should be plugged into a Class A ground-fault circuit interrupter (GFCI). When built-in GFCI receptacles are not available, protection can be attained with an in-line GFCI plugged directly into the supply receptacle.



In-line Class A GFCI.

Photo courtesy of EGS Electrical Group Canada Ltd.

Fall protection

A means of fall protection must be used wherever workers are exposed to the hazard of falling

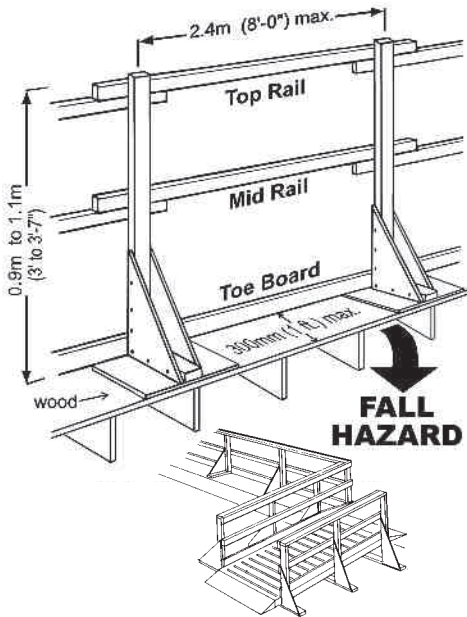
- more than 3 metres (10 feet)
- more than 1.2 metres (4 feet) if the work area is used as a path for a wheelbarrow or similar equipment
- into operating machinery
- into water or another liquid
- into a hazardous substance or object
- through an opening in a work surface.

A worker at risk of falling must be protected by a guardrail system. If such a system is not practical, then a travel-restraint system, fall-arrest system, or safety net must be used. In many cases, guardrails are the most reliable and convenient means of fall protection. Other areas to be protected by guardrails include

- openings in floors, roofs, and other working surfaces not otherwise covered or protected
- edges of slab formwork for floors and roofs.

Basic requirements for wood guardrails include:

- top rail, mid rail, and toeboard secured to vertical supports
- top rail between 91 cm (3 feet) and 1.07 metres (3 feet 6 inches) high
- toeboard at least 10.2 cm (4 inches) high—



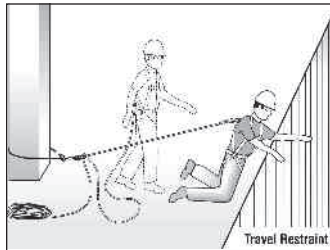
89 mm (3½ inches) high if made of wood
—and installed flush with the surface

- posts no more than 2.4 metres (8 feet) apart.

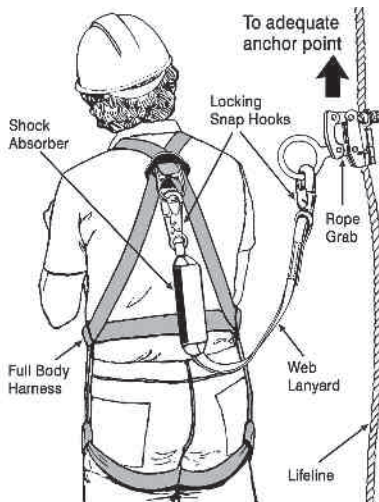
When guardrails or opening covers are temporarily removed, workers in the area must be protected by a safety harness with the lanyard tied off to a suitable anchor. Barricades, guardrails, and covers must be replaced immediately after work is completed.

Regardless of type, every component of a fall protection system in Ontario construction must meet the requirements of the *Occupational*


Health and Safety Act, the Construction Regulation (Ontario Regulation 213/91) and any applicable standards from the National Standards of Canada.



A travel-restraint system lets a worker travel just far enough to reach the edge but not far enough to fall over.



Personal fall protection equipment consists of the components shown in the following illustration. This equipment can be used for travel restraint or fall arrest.



The employer must develop and have written procedures available to guide the rescue of a worker whose fall has been arrested. Workers using fall protection must be trained in its use and the employer must keep a written record of the training.

Safety harnesses and lanyards

- Harnesses must be snug-fitting and worn with all hardware and straps intact and properly fastened.
- Lanyards used for fall arrest must be equipped with a shock absorber to reduce the force of an arrested fall, except where clearance is limited and the shock absorber may cause the worker to strike an object or surface below.
- Choose the right length of lanyard. **Calculate the total fall distance.** The lanyard must be long enough to accommodate the work, yet short enough to ensure a fall will be arrested before hitting anything below. Take into account the extra distance the lanyard will extend when arresting a fall.

Lifelines

All vertical lifelines must be

- securely anchored to a fixed support that meets regulated load requirements
- used by only one worker at a time
- protected from any danger of chafing

- free of cuts, abrasions, and other defects.

All vertical lifelines must also be

- long enough to reach the ground; or
- long enough to reach the lowest level at which the worker can safely disconnect from the lifeline (without extending past this level); or
- knotted at the end to prevent the lanyard from running off the lifeline.


A vertical lifeline must meet the standard CAN/CSA-Z259.2.1-98 *Fall Arresting devices and Vertical Lifelines*. Vertical lifelines sold on a reel or in a container will have the CSA standard information attached or etched on the container or reel. Once removed from the original packaging, pertinent information such as the purchase order number and CSA certification information should be identified on the lifeline (e.g., with tags) to ensure it does not get confused with hoisting rope and cable.

All horizontal lifelines must be designed by a professional engineer.

Retractable lifelines offer flexibility. They can provide for worker movement and minimize free fall distance when providing fall protection, or they can be used as travel restraint.

Rope Grabbing Devices

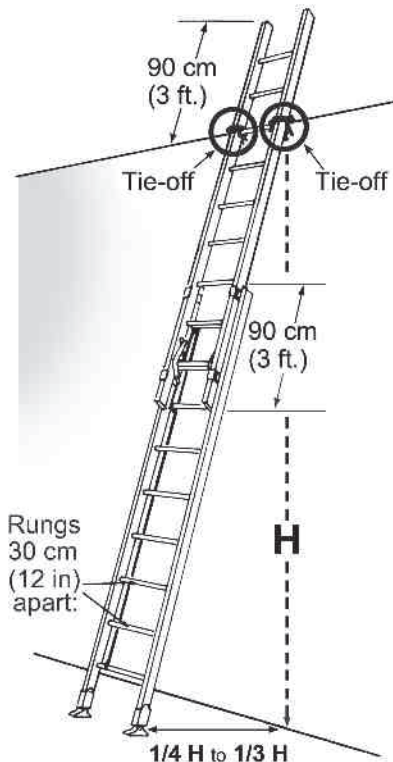
Minimize the distance you could fall by keeping



the rope grab as high as is practical—at shoulder height or higher for example.

Portable Ladders

- Electrical contractors should provide non-conductive ladders because of widespread electrical hazards in the trade.
- Before setting up straight or extension ladders, check the area for overhead powerlines.
- All portable ladders must be construction grade (Grade 1) equipped with non-slip bases.
- Set ladders up on a firm level surface. Use a mudsill on uncompacted soil.
- Set up straight or extension ladders at a safe angle: one foot out for every three or four feet up.
- Tie off or otherwise secure ladders to prevent movement. If this is not possible, one worker should hold the base of the ladder while another uses it.
- When work must be done from an extension ladder, the ladder should be long enough that a worker has to stand on a rung no higher than the fourth from the top. The ladder must be secured.
- Always maintain three-point contact and face the ladder when climbing up and down or working from it.
- Wherever possible and applicable, use 1) a worker support system that connects



the worker to the ladder and restricts travel or 2) a fall-arrest system tied to a lifeline or fixed support.

- Unless suitable barricades have been erected, do not set up ladders in passageways, doorways, driveways, or other locations where they can be struck.
- Do not paint wooden ladders. Paint can hide defects.


- All ladders erected between levels must be securely fastened at the top and bottom and extend 90 centimetres (3 feet) above the top landing.
- Ensure clear access at top and bottom of ladders.
- Ladders transported on the top or side of vehicles should be supported and secured in proper racks to withstand braking and bumps. Check regularly for damage to the ladder where it contacts supports.
- Nothing should be piled on ladders being stored or transported.

Refer to the chapter on “Ladders” in CSAO’s ***Multi-Trades Construction Health and Safety Manual*** (M033).

Scaffolding


The erection and dismantling of scaffolds must be carried out under the supervision of a competent worker knowledgeable and experienced in such operations. A competent worker must inspect the scaffold before it is used. Workers can recognize a properly built scaffold by observing the following:

1. Scaffolds must be erected as required by the manufacturer with all braces, pins, screwjacks, baseplates, and other fittings installed.
2. Guardrails are recommended for all scaffolds, and are required whenever



the working platform is 2.4 metres (8 feet) or more above floor level. Guardrails require a top rail, a mid-rail, and a toeboard.

3. Scaffold platforms must be at least 46 centimetres (18 inches) wide and if they are over 2.4 metres (8 feet) high they must be planked across their full width.
4. Scaffolds must be tied in to a building at vertical intervals not exceeding three times the least lateral dimension, including the dimension of any outrigger stabilizing devices.
5. Scaffold planks must be securely fastened to prevent them from sliding.
6. Scaffold planks made of sawn lumber must be
 - of good quality
 - No 1 spruce or better when new
 - free of defects such as loose knots, splits, or rot
 - 48 mm x 248 mm (1⁷/₈" x 9³/₄") in cross section.
7. Scaffolds must be erected, used, and maintained in a reasonably plumb condition.
8. Scaffold planks must be installed so that they overhang by at least 15 centimetres (6 inches) but no more than 30 centimetres (12 inches).
9. Scaffolds must be equipped with a ladder for access.
10. Frame scaffolds over 15 metres (50



feet) high and tube-and-clamp scaffolds over 10 metres (30 feet) high must be designed by a professional engineer and constructed in accordance with the design.

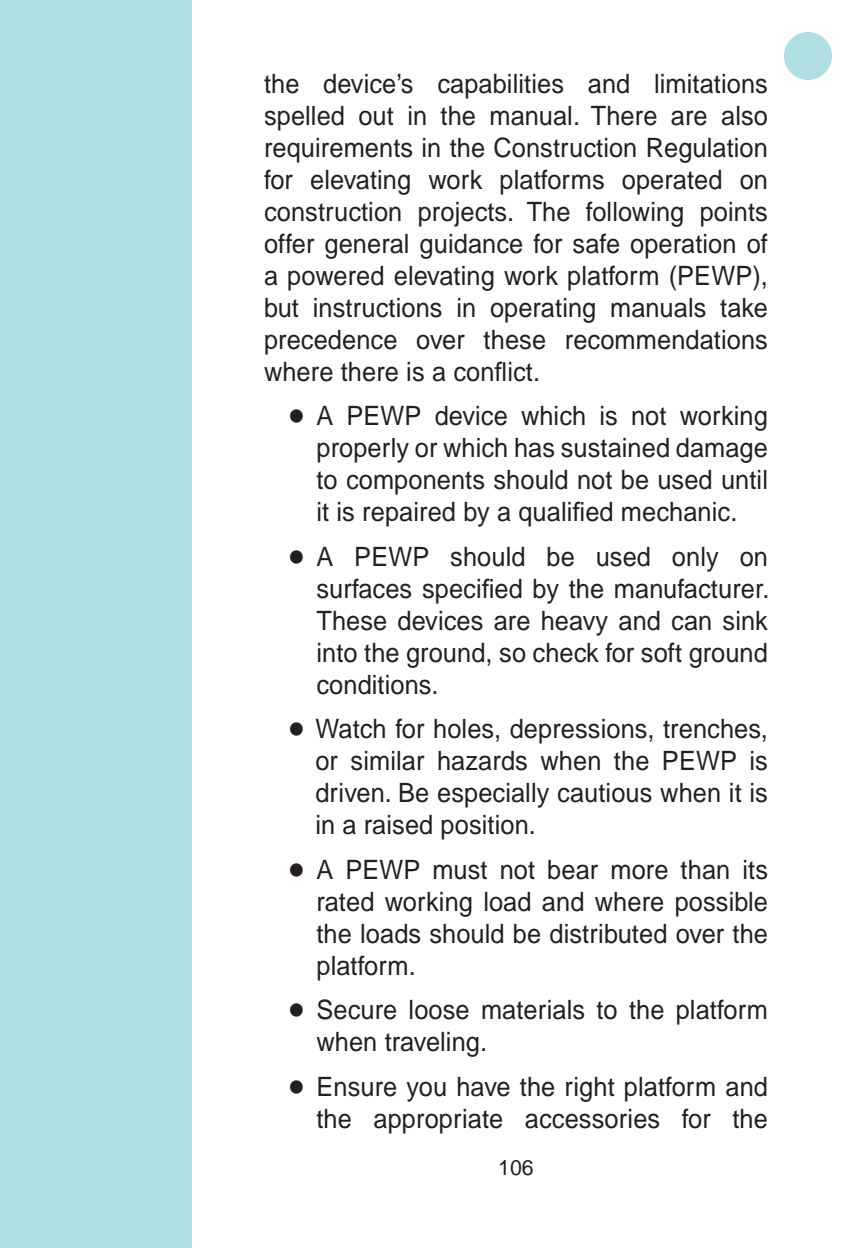
11. Wheels or casters on rolling scaffolds must be equipped with braking devices and securely pinned to the scaffold frame.

Working from scaffolds

- Wheels and casters must be locked when personnel are working on a rolling scaffold.
- If the scaffold is more than 2.4 metres (8 feet) high, it must not be moved with personnel on it unless,
 - a. they wear safety harnesses with the lanyards tied off to a fixed support, and
 - b. the floor is firm and level.
- Workers erecting, dismantling, or using a scaffold more than 3 metres (10 feet) high must use fall protection—such as guardrails or a harness and lanyard tied off to a suitable anchor.


Powered elevating work platforms (PEWPs) and vehicle-mounted aerial devices

Always familiarize yourself with the operating manual before using the platform. Understand



the device's capabilities and limitations spelled out in the manual. There are also requirements in the Construction Regulation for elevating work platforms operated on construction projects. The following points offer general guidance for safe operation of a powered elevating work platform (PEWP), but instructions in operating manuals take precedence over these recommendations where there is a conflict.

- A PEWP device which is not working properly or which has sustained damage to components should not be used until it is repaired by a qualified mechanic.
- A PEWP should be used only on surfaces specified by the manufacturer. These devices are heavy and can sink into the ground, so check for soft ground conditions.
- Watch for holes, depressions, trenches, or similar hazards when the PEWP is driven. Be especially cautious when it is in a raised position.
- A PEWP must not bear more than its rated working load and where possible the loads should be distributed over the platform.
- Secure loose materials to the platform when traveling.
- Ensure you have the right platform and the appropriate accessories for the



platform. Approved platform accessories can increase safety and make the work more efficient. Discuss what accessories are available for the PEWP with the supplier or manufacturer, and order them with the platform.

- An PEWP should not be used for pulling, pushing, or dragging materials.
- Always maintain 3-point contact (one hand and two feet or two hands and one foot on the equipment) when getting on or off the platform.
- Use caution under windy conditions. Platform stability could be significantly compromised.
- Beware of carbon monoxide emission when operating internal combustion engines indoors.
- PEWPs used on ramps or on sloping or uneven surfaces must be designed for such use. Refer to and follow the manufacturer's directions before attempting to use a PEWP under these conditions.

A worker who will be operating an elevating work platform must be given oral and written instruction on the operation of the platform and hands-on training for the class of equipment being used.

Forklifts as work platforms

A forklift must never be used to support, raise, or lower a worker on a construction site.

The Construction Regulation states that “no worker shall use as a workplace a platform, bucket, load, hook, or sling that is capable of moving and that is supported by a fork-lift truck, front-end loader, or similar machine.”

Do not operate a PEWP near electrical hazards unless the necessary precautions have been taken. Here are some necessary precautions:

- If the work takes place in the vicinity of an electrical hazard operating under 750 volts, take steps to remove the electrical hazard. For example, lock out the power or put up a barrier to prevent the possibility of making electrical contact.
- If the PEWP is capable of reaching the “minimum distance” to energized overhead powerlines, several safety measures must be undertaken to comply with the Construction Regulation—one of which is that the constructor must have written procedures to prevent encroaching upon the minimum permitted distances.
- An exemption to these measures is only available if, under the authority of the owner of the electrical conductor (typically

the local utility), protective devices and equipment are installed and written procedures are implemented (using the *Electrical Utility Safety Rules*—the “E&USA Rule Book”—for example) that are adequate to protect the equipment operator from electrical shock and burn.



This crane boom could reach within the minimum distance.

Keep the minimum distance from powerlines

Normal phase-to-phase voltage rating	Minimum distance
750 or more volts, but no more than 150,000 volts	3 metres
Over 150,000 volts, but no more than 250,000 volts	4.5 metres
More than 250,000 volts	6 metres
Beware: The wind can blow powerlines, hoist lines or your load. This can cause them to cross the minimum distance.	

Work that must be undertaken within the minimum distances to energized overhead powerlines requires special **training**, specific **rules**, and a platform device that is **CSA certified** for work on energized powerlines. Vehicle-mounted aerial devices are certified to the standard CAN/CSA C225. They are designed for working on overhead powerlines, but the work must be carried out under the *Electrical Utility Safety Rules*—the “E&USA Rule Book.”

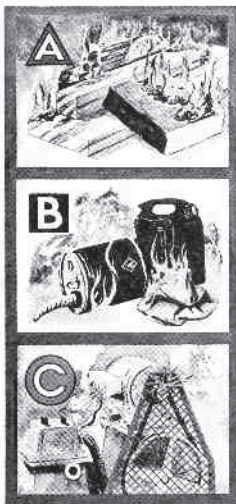
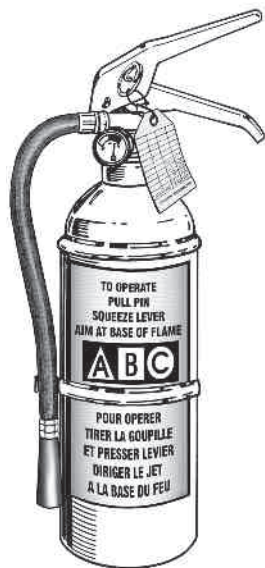


Housekeeping, storage, and tool maintenance

1. Waste material and debris must be removed from work and access areas on a regular basis or at least once a day.
2. Waste material and debris must not be thrown from one level to another, but must be carried down, lowered in containers, or deposited in a disposal chute.
3. Material must be piled, stacked, or otherwise sorted to prevent tipping and collapsing.
4. Materials to be lifted by a crane or other hoisting device must not be stored under energized overhead powerlines. Items that can conduct electricity must not be used or stored so close to energized electrical equipment that they can make electrical contact.
5. It is the employer's responsibility to supply and maintain shop tools and other power equipment in good repair. It is the worker's responsibility to use such tools properly and to report any defect to the supervisor.
6. Large tools such as pipe vises and benders should be set up so as not to create a hazard to either the public or co-workers.

Fire extinguishers

Portable extinguishers are classified according to their ability to handle specific types of fires. Fire extinguishers must be readily accessible, properly maintained, regularly inspected, and promptly refilled after use.



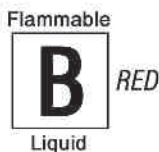
**Every worker
who may be required
to use a fire extinguisher
must be trained in its use.**

Class "A" Extinguishers



For fires in ordinary combustible materials such as wood, paper and textiles where a quenching, cooling effect is required.

Class "B" Extinguishers



For flammable liquid and gas fires, such as oil, gasoline, paint and grease where oxygen exclusion or flame-interruption is essential.

Class "C" Extinguishers



For fires involving electrical wiring and equipment where the non-conductivity of the extinguishing agent is crucial.

This type of extinguisher should be present wherever functional testing and system energizing take place.

Service vehicles

This section highlights some basic requirements specifically applicable to drivers of service trucks. If you have any questions or concerns, ask for information from the appropriate association or ministry to ensure that the responsibilities of all personnel are clearly understood.



Legislation

Highway Traffic Act

All vehicles must be operated in compliance with the *Highway Traffic Act* while on public roads and highways. Comprehensive information on the *Highway Traffic Act* can be obtained through training facilities such as the Transportation Health and Safety Association of Ontario (THSAO).


Commercial plates

Commercial plates are required on any motor vehicle having a permanently attached truck or delivery body. The requirement for commercial plates on a van or pickup truck does not automatically classify it as a commercial vehicle.

Commercial vehicles

Loading a vehicle with equipment and supplies can quickly increase its weight. Whenever the gross vehicle weight rating, registered gross weight, or actual weight, loaded or empty, exceeds 4,500 kilograms, the vehicle and operator are subject to the regulations under the *Highway Traffic Act* that apply to commercial vehicles and commercial vehicle operators.

Under the *Highway Traffic Act*, commercial vehicle operators are required to obtain a Commercial Vehicle Operator's Registration (CVOR) as well as adhere to additional



restrictions and obligations (such as annual inspections) which the Act specifies. A trailer's weight must be added to the weight of the vehicle when determining total weight.


The *Highway Traffic Act* defines an operator as the “person responsible for the operation of a commercial motor vehicle including the conduct of the driver and the carriage of goods or passengers, if any, in the vehicle or combination of vehicles.” The operator does not necessarily have to be the vehicle owner. If the vehicles are leased or contracted, the operator must hold a valid CVOR certificate.

If you have any questions or doubts about how the Highway Traffic Act is to be applied, contact the local Ministry of Transportation enforcement office.

Gross axle weight

With any commercial or passenger vehicle, the gross weight of the vehicle, or combination of vehicles (e.g. van and trailer), unless exempted under the regulations, must not exceed the manufacturer's gross axle weight rating. The manufacturer's gross axle weight rating is usually found on a sticker placed on the driver's door.

Exceeding the manufacturer's gross axle weight rating has two consequences. First, it is an offence under the *Highway Traffic Act*, and second (as stated earlier), the vehicle can become classified as a commercial



vehicle if the gross weight is more than 4,500 kilograms.

Trailers

If a vehicle is towing a trailer such as a utility trailer, the trailer's weight must be added to the weight of the vehicle when determining total weight. Add the highest weight of the vehicle to the highest of the trailer's gross vehicle weight rating (if provided on trailer) or the actual weight, empty or loaded, to determine whether the combined weight exceeds 4,500 kilograms.

Transportation of Dangerous Goods Act (TDG Act)

On August 15, 2002, Transport Canada began enforcing new regulations under the Transportation of Dangerous Goods Act (TDG Act), sometimes referred to as the "Clear Language" Regulations.

Whenever hazardous material is being transported on a road or highway, the *TDG Act* applies. Be aware not only of the dangers involved, but also of the restrictions and obligations of the *TDG Act* that apply to both the driver and owner of the vehicle.

This section identifies only some of the TDG Act's regulations and exemptions that apply to a service vehicle, vehicle owner, and driver. For more information or training, contact the Transportation Health and Safety Association of Ontario (THSAO).

If you have any questions or doubts about how the TDG Act is to be applied, contact the local Ministry of Transportation enforcement office.

While transporting propane gas, a driver must also follow the *Propane Storage and Handling Code*. See “Propane Storage and Handling Code” below. In addition, read the Material Safety Data Sheet (MSDS) of the products being transported. Specific information regarding transportation may be stated there.

Special Provisions of the TDG Regulations under the TDG Act

Regulations under the *TDG Act* always apply to transporting dangerous goods such as compressed gases. The *TDG Act* does, however, allow exemptions from some of the requirements.

Exemptions from driver training, documentation, and placarding of the vehicle may be applicable. (Placarding refers to affixing signs to the vehicle for identifying the contents being transported.) For example, certain exemptions may be provided in the following circumstances:

- When propane, acetylene, or oxygen is being transported in an open vehicle and
 - the amount of such gas is less than 500 kilograms gross mass, or

- such gas is contained in not more than five cylinders.

In such a situation, the *TDG Act* requires the label on the cylinder to be visible from outside the vehicle. Also see “Propane Storage and Handling Code” below.

- When gases are being transported in an enclosed vehicle such as a van, different restrictions apply. While transporting class 2.2 gases such as nitrogen, argon, oxygen, and most refrigerants, or class 2.1 gases (in cylinders under 45 litres) such as acetylene and propane, and the gross mass is less than 500 kilograms, the vehicle is exempt from placarding; however, the following are required:
 - shipping documents
 - training certification (as required in the regulations under the *TDG Act*)
 - labeling
 - proper ventilation
 - isolation of flammable gases.

In all cases the cylinders being transported must be securely stowed in the vehicle to prevent movement. A dry chemical fire extinguisher of at least 10BC rating, listed by the Underwriters’ Laboratories of Canada (ULC), should be carried in the vehicle.

Many compressed gas cylinders must be stored in an upright position. Check the MSDS or contact the gas supplier to determine whether the gas cylinder being transported can be stored lying down before doing so. On construction projects, the Construction Regulation requires all compressed gas cylinders to be stored in an **upright** position.

Propane Storage and Handling Code

The storage and transportation of propane cylinders in a vehicle requires special precautions as per the *Propane Storage and Handling Code* B149.2-00, in addition to the requirements of the *TDG Act*.

General *Propane Storage and Handling Code* requirements:

- The space where cylinders are transported or stored in a vehicle must be vented outside.
- The cylinder valve must be closed during storage.
- The relief valve must remain in contact with the vapour space at all times.
- The cylinder cannot be exposed to any source of ignition or to temperatures higher than 125°F (50°C).

A dry chemical fire extinguisher of at least 10BC rating, listed by the Underwriters'

Laboratories of Canada (ULC), should be carried in the vehicle.

**During transportation,
the *TDG Act* takes precedence over the
Propane Storage and Handling Code.**

Maintenance

Every employer should establish a system to periodically inspect, repair and maintain all motor vehicles and trailers that are operated on highways.

An employer must not permit a motor vehicle to be driven, or a trailer to be towed, on a highway if there is reason to believe that the vehicle or trailer will not meet safety standards. A driver who reasonably believes or suspects that a vehicle or trailer does not meet safety standards should advise the employer accordingly.

Trip inspections

A basic vehicle inspection (or Daily Circle Check) shown below should be done before each shift.

Circle check explanations:

Parking brake—Adequate to hold vehicle.

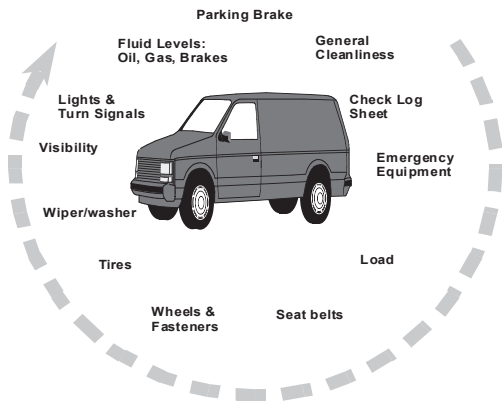
Fluid levels—Oil, gas, bakes. Check for leaks.

Lights and turn signals—Functioning.

Visibility check—Adjust mirrors; windows clean and intact.

Wiper/washer—Functioning.

DAILY CIRCLE CHECK



Tires—Pressure, tread depth, or damage.

Wheels and fasteners—Defects in rim; loose or missing fasteners.

Seat belts—Must be used.

Load—Secure.

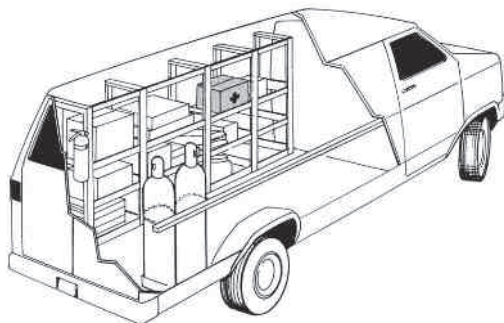
Emergency equipment—Install and inspect as required by law or company policy.

Record and report any defects to your supervisor immediately!

A more detailed inspection may be required for commercial vehicles.

Vehicle layout

Before you drive, make sure that equipment and materials are evenly distributed. Secure any cargo that could shift during travel, especially cylinders of compressed gas. Do not let scrap and debris accumulate in the vehicle.



The design and layout of service vehicles should include the following points:


1. A strong reinforced divider should separate the driver compartment from the back.
2. Compressed gas cylinders should be located in a compartment that is vented outside the vehicle. Cylinders should be solidly supported and fit in specific places.
3. A designated location should be provided for the first aid station, MSDS information, and fire extinguisher.
4. Strong storage racks for tools and supplies should be provided to allow even distribution of weight and prevent shifting in the event of sudden stops or sharp turns.

Working alone

Electrical workers sometimes work alone, particularly during service calls. Working alone means the worker is the only person on site or is isolated from other workers. In either case, when someone is working alone and becomes injured, trapped, or otherwise incapacitated, that worker may not be able to call for help. It may be some time before anyone becomes aware of the worker's situation. That's why construction personnel working alone have died from injuries or conditions that would not have been fatal if the victims had been found sooner.

Various factors can make it difficult for an injured worker to get help:

- The worker is unable to move, cannot reach a phone, or has no means of communication.
- The worker is unconscious and cannot call for help.
- The worker is unable to move and is beyond the sight or hearing of other workers.
- No one is aware of the worker's situation because the worker does not have a scheduled time for calling in or, if a schedule is established, the interval between calls is too long.
- The location is remote and emergency services cannot respond quickly, they encounter difficulties locating the site or



the worker, or they aren't available locally and must come from further away.

Under the *Occupational Health and Safety Act*, employers and supervisors have a general duty to take every precaution reasonable in the circumstances for the protection of a worker. This includes help and support for personnel working alone.

Under the Construction Regulation, the constructor must establish and implement written procedures to be followed in the event of an emergency (Section 17). The constructor also has a duty to ensure that every worker on a project has ready access to a telephone, two-way radio, or other system of two-way communication in the event of an emergency.


Taken together, these responsibilities dictate that contractors have a policy, procedure, and means in place to protect the health and safety of employees working alone.

Hazard awareness

The employer or supervisor should ensure that any worker working alone is

- aware of real and potential hazards in the area
- trained to recognize and control hazards
- provided with procedures and equipment to do the job safely.

All safety and work-related procedures should be spelled out under the company health and



safety policy and be reviewed with personnel before they work alone.


Communication is crucial. At regular intervals, someone should check on the worker or the worker should report to a designated person. Where hazard exposure is high, intervals should be kept short. Contact should be predetermined and understood by both parties.

In all cases the employer or supervisor must ensure that

- a method of checking in with the worker has been established
- check-in-intervals are clearly understood
- the designated contact person is aware of the work schedule
- communication equipment is in good working order
- no obstructions or interference can block radio or phone communications.

A worker working alone should make every reasonable effort to advise the dispatcher, on-duty person, answering service, supervisor and/or client of job progress, expected time of completion, actual time of completion, and departure from the site.

With an answering service, the procedure involves phoning in regularly. If the worker fails to report at one of the designated times, the answering service phones the employer, who goes to the project, or sends someone there, to check on the worker.



Some jobs should simply not be done by anyone working alone. These include work:

- in confined spaces
- with acutely toxic chemicals such as hydrogen sulphide, ammonia, or accumulated fumes
- with high voltages
- in extreme temperatures or weather
- in areas where a gas leak could displace oxygen and reduce the oxygen level
- on or over moving equipment or machinery.

Jobs posing a higher than normal risk when performed by an employee working alone should be identified and require extra precautions such as being assigned to at least two workers. In some situations—working in confined spaces, for instance—regulations under the *Occupational Health and Safety Act* prohibit entry or work without another person standing by outside the area.

Provisions for employees working alone should be included under the company health and safety policy and in the emergency response plan. Emergency services should be identified and contacted to confirm phone numbers and availability. These services may be provided by on-site emergency response personnel or through local municipal services.

5. MISCELLANEOUS INFORMATION

Metric Conversion Factors

	To convert imperial units	to metric units	multiply by
Length	inches (in)	millimetres (mm)	25.400
	feet (ft)	metres (m)	0.305
	yards (yds)	metres (m)	0.914
	miles (mi)	kilometres (km)	1.609
Area	square inches (in ²)	square centimetres (cm ²)	6.452
	square feet (ft ²)	square metres (m ²)	0.093
	square yards (yd ²)	square metres (m ²)	0.836
	square miles (mi ²)	square kilometres (km ²)	2.590
	acres	hectares (ha)	.405
Volume	cubic measure (in ³)	cubic centimetres (cm ³)	16.387
	cubic feet (ft ³)	cubic metres (m ³)	0.028
	cubic yards (yd ³)	cubic metres (m ³)	0.765
	fluid ounces (oz)	millilitres (ml)	28.413
	quarts (qt) (Imp)	litres (L)	1.137
	gallons (ga) (Imp)	litres (L)	4.546
Mass	ounces (oz)	grams (g)	28.349
	pounds (lb)	kilograms (kg)	0.454
	tons (2000 lbs)	tonnes (t)	0.907
Force	pounds force	newtons (N)	4.448
	tons force	kilonewtons (kN)	8.896
Pressure	pounds per square inch (lb/in ²)	kilopascals (kPa)	6.895
	pounds per square foot (lb/ft ²)	kilopascals (kPa)	0.048
	tons per square foot (t/ft ²)	megapascals (MPa)	0.096
	standard atmosphere (14.7 psi)(760 mmHg)	kilopascals (kPa)	101.325
	Power	joules per second	watts (W)
horsepower	watts (W)	746.000	
	foot pound per second	watts (W)	1.356
Temperature	degrees Fahrenheit (°F)	degrees Celsius (°C)	(°F-32) x 0.555
	Illumination		
	foot candle	Lux (lx)	10.764

Pipe Bending Charts

CONDUIT BENDING 90° segment bend

1. Determine radius: to centre of pipe
2. Mark riser height measured to centre of pipe (subtract 1/2 O.D. if measured to back; to top add 1/2 O.D.)
3. Figure Developed Length: 1.57 x radius.
4. Figure gain of pipe: 2 x radius – D.L. or .43 x radius.
5. Lay out centre of bend: subtract 1/2 gain from riser mark (measured to centre of pipe)
6. Figure spacing for 15 shots 6° each: Divide D.L. by number of shots.
7. Lay out 7 shot marks each side of centre mark (total shot distance equals D.L. minus one space).
8. Measure riser and leg: cut off full gain (to back – O.D.; to top + O.D.)
9. Move front support in one hole after 1st shot to eliminate marks on pipe.

Offset Height x Multiplier = Distance,

Degree of Bend	Multiplier	Approx. Shrink	Fraction of 90° Take up	Decimal Equivalents
10°	6	1/16 in.	1/9	1/16 = .0625
15°	3.9	1/8 in.	1/6	1/8 = .125
22 1/2°	2.6	3/16 in.	1/4	3/16 = .187
30°	2	1/4 in.	1/3	1/4 = .250
45°	1.4	3/8 in.	1/2	5/16 = .312
60°	1.2	1/2 in.	2/3	3/8 = .375
Example: Offset 6" bend 30°				7/16 = .437
Between bends				1/2 = .500
Distance between marks: 6" x 2" = 12" centre				9/16 = .562
Pipe shortens: 6" x 1/4 = 1-1/2" approx.				5/8 = .625

Rise for 90° Bends

Conduit Size	Bender Shoe Size				
1/2"	3/4"	1"	1 1/4"	1 1/2"	
1/2"	4 15/16"	7 11/16"	9 7/8"	12"	13 13/16"
3/4"	7 1/4"	9 1/2"	11 7/8"	13 15/16"	
1"		9"	11 9/16"	13 3/4"	
1 1/4"			11"	13 1/8"	
1 1/2"				12 3/4"	

Gain for 90° Bends

Conduit Size	Bender Shoe Size				
1/2"	1"	1"	1 1/4"	1 1/2"	
1/2"	2 3/16"	3"	3 9/16"	4 1/4"	5 5/8"
3/4"	3 1/4"	3 3/4"	4 3/8"	4 13/16"	
1"		4 1/8"	4 1 1/16"	5 5/16"	
1 1/4"			5 3/8"	5 7/16"	
1 1/2"				6 1/4"	

Box Offsets

Bend	Center to Center Distance				
	1/4"	3/8"	1/2"	5/8"	3/4"
5°	2 7/8"	4 5/16"	5 3/4"	7 3/16"	8 5/8"
10°	1 7/16"	2 3/16"	2 7/8"	3 9/16"	4 5/16"

Offset Travel

Bend	Travel in Inches				
	1/2"	3/4"	1"	1 1/4"	1 1/2"
5°	1/4"+	7/16"-	9/16"	3/4"	1"
10°	1/2"-	1 1/16"	1 3/16"	1 3/8"	1 11/16"
15°	1 1/16"	1 1/4"	1 9/16"	2 3/16"	2 5/8"
20°	1 5/16"	1 5/8"	2 1/8"	2 13/16"	3 7/16"
22.5°	1 1/16"	1 7/8"	2 3/8"	3 3/16"	3 11/16"
30°	1 7/16"	2 7/16"+	3 1/16"	4 1/8"	4 3/4"
40°	1 7/8"	3 3/16"	4 1/8"	5 3/8"	5 1/2"
45°	2 1/8"	3 5/8"	4 3/8"	6"	6 1/4"
60°	2 3/16"+	4 7/8"	6 1/4"	8 1/8"	9 3/8"
90°	4 3/16"	7 7/16"	9 3/8"	12 1/16"	13 13/16"

Multiply height of offset by cosecant for angle of bend. Set bender. Mark travel distance from back of Bender's Guide. Repeat procedure for second bend.

Kick Adjustments

Bend	Adjustment in inches				
	1/2"	3/4"	1"	1 1/4"	1 1/2"
20°	1 19/32"	2 13/32"	2 11/16"	2 13/16"	3 3/8"
22.5°	1 5/8"	2 1/2"	2 19/32"	3"	3 5/8"
30°	1 27/32"	2 11/32"	3 19/32"	3 9/16"	4 5/32"
45°	2 7/32"	3 19/32"	4 5/16"	4 5/8"	5 17/32"
60°	2 23/32"+	4 3/8"	5 13/32"	5 25/32"	7"

COSECANTS FOR OFFSET BENDING

Degree	Cosecant	Degree	Cosecant	Degree	Cosecant	Degree	Cosecant
1	57.2987	24	2.45859	47	1.36733	69	1.07114
2	28.6537	25	2.36620	48	1.34563	70	1.06418
3	19.1073	26	2.28117	49	1.32501	71	1.05762
4	14.3356	27	2.20269	50	1.30541	72	1.05146
5	11.4737	28	2.13005	51	1.28676	73	1.04569
6	9.56677	29	2.06267	52	1.26902	74	1.04030
7	8.20551	30	2.00000	53	1.25214	75	1.03528
8	7.18530	31	1.94160	54	1.23607	76	1.03061
9	6.39245	32	1.88708	55	1.22077	77	1.02630
10	5.75877	33	1.83608	56	1.20622	78	1.02234
11	5.24084	34	1.78829	57	1.19236	79	1.01872
12	4.80973	35	1.74345	58	1.17918	80	1.01543
13	4.44541	36	1.70130	59	1.16663	81	1.01247
14	4.13357	37	1.66164	60	1.15470	82	1.00983
15	3.86370	38	1.62427	61	1.14335	83	1.00751
16	3.62796	39	1.58902	62	1.13257	84	1.00551
17	3.42030	40	1.55572	63	1.12233	85	1.00382
18	3.23607	41	1.52425	64	1.11260	86	1.00244
19	3.07155	42	1.49448	65	1.10338	87	1.00137
20	2.92380	43	1.46628	66	1.09464	88	1.00061
21	2.79043	44	1.43956	67	1.08636	89	1.00015
22	2.66947	45	1.41421	68	1.07853	90	1.00000
23	2.55930	46	1.39016				

At a given degree of angle the offset desired times Cosecant equals distance between bends.

Copper Wire Gauges And Dimensions

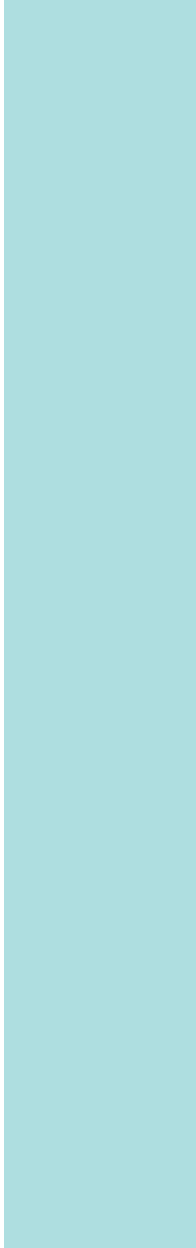
AMERICAN STANDARD WIRE GAUGES

Dimensions of Commercial Copper Wire

B & S Gauge No.	Diameter of Bare Wire	
	mm	inches
0000 (4/0)	11.68	0.460
000 (3/0)	10.40	0.410
00 (2/0)	9.27	0.365
0	8.25	0.325
1	7.35	0.289
2	6.54	0.258
3	5.83	0.229
4	5.19	0.204
5	4.62	0.182
6	4.11	0.162
7	3.66	0.144
8	3.26	0.128
9	2.91	0.114
10	2.59	0.102
11	2.30	0.091
12	2.05	0.081
13	1.83	0.072
14	1.63	0.064
15	1.45	0.057
16	1.29	0.051
17	1.15	0.045
18	1.02	0.040



NOTES



NOTES





ECAO
ELECTRICAL CONTRACTORS
ASSOCIATION OF ONTARIO

Construction Safety Association of Ontario

21 Voyager Court South
Etobicoke, Ontario M9W 5M7 Canada
(416) 674-2726 1-800-781-2726
Fax: (416) 674-8866
info@csao.org www.csao.org

ISBN-13: 978-0-919465-15-2

M010