1. Electrical safety hazards, safe working techniques, procedures, and applicable codes

Overview

Purpose

Gas technicians/fitters often work in a variety of situations with electrical equipment that can cause injury to themselves and others. Students must be thoroughly familiar with electrical hazards, applicable electrical codes, and safety procedures that relate to their work as gas technicians/fitters.

Objectives

At the end of this Chapter, you will be able to:

- identify electrical safety hazards;
- describe electrical code safety requirements;
- describe lock-out and tagging procedures for electrical equipment; and
- describe requirements of applicable electrical safety codes and standards.

Terminology

Term	Abbreviation (symbol)	Definition
Arcing		Lightning-like discharge of electricity across an insulating medium or air space
Electric shock		Physiological reaction or injury that results from electric current passing through the (human) body
Equipotential		Having the same potential
Static charge		Accumulated electric charge that is present on an object
Static electricity		Energy in the form of a stationary electric charge such as that stored in thunderclouds or produced by friction

CSA Group Gas Trade Training Materials – Red Seal Alignment

Red Seal		CSA Gas Trade Unit	1	2	3	4	4A	5	6	7	8	9
2014 Red Seal Block	2014 Red Seal Task	Title	Safety	Fasteners, Tools and Testing Instruments	Properties, Characteristics, and Safe Handling of Fuel Gases	Utilization Codes, Acts and Regulations	Utilization Codes, Acts, and Regulations – Ontario Supplement	Introduction to Electricity	Technical Manuals, Specifications, Drawings and Graphs	Customer Relations	Introduction to Piping and Tubing Systems	Introduction to Gas Appliances
A - Common Occupational Skills	Task 1	Performs safety-related functions.	✓									
	Task 2	Maintains and uses tools and equipment.	✓	✓	✓							
	Task 3	Plans and prepares for installation, service and maintenance.	✓			✓	✓	✓	✓			
B - Gas Piping Preparation and Assembly	Task 4	Fits tube and tubing for gas piping systems.									✓	
	Task 5	Fits plastic pipe for gas piping systems.									✓	
	Task 6	Fits steel pipe for gas piping systems.									✓	
C - Venting and Air Supply Systems	Task 7	Installs venting.									✓	✓
	Task 8	Installs air supply system.										
	Task 9	Installs draft control systems.										
D - Controls and Electrical Systems	Task 10	Selects and installs electronic components.						✓				
	Task 11	Selects and installs electrical components.										
	Task 12	Installs automation and instrumentation control systems.										
E - Installation of Systems and Equipment	Task 13	Installs gas-fired system piping and equipment.									✓	✓
	Task 14	Installs gas-fired system components.										
	Task 15	Installs propane storage and handling systems.										
F - Testing & Commissioning of Gas-fired Systems	Task 16	Tests gas-fired systems.										
	Task 17	Commissions gas-fired systems.	✓	✓	✓	✓	✓	✓			✓	✓
G - Servicing Gas-fired Systems	Task 18	Maintains gas-fired systems.										✓
	Task 19	Repairs gas-fired systems.										✓
	Task 20	Decommissions gas-fired systems.	✓	✓	✓	✓	✓	✓			✓	✓

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Term	Abbreviation (symbol)	Definition
Zero mechanical state		State when you make all energy sources, including electrical, pneumatic, hydraulic, or gravitational, inoperative
Milliampere	mA	Unit of electric current equal to one thousandth of an ampere

Electrical safety hazards

Two common electrical hazards are static electricity and electric shock.

Static electricity

Static electricity is energy in the form of a stationary electric charge such as that stored in thunderclouds or produced by friction. A static charge is the accumulated electric charge that is present on an object.

The main danger from static electricity is arcing. Arcing is a lightning-like discharge of electricity across an insulating medium or air space. The arc can ignite flammable gases or materials that it comes in contact with. A good example of this phenomenon is the ignition of the fuel mixture by a spark plug in an automobile engine.

Electric shock

When working with electrical equipment, you must be constantly aware of the hazard of electric shock. You must know what factors increase the danger of shock, how to avoid shock, and what to do when dealing with a shock victim.

Factors affecting electric shock

When a person receives a shock, the electric current passes through the person, (usually to the earth or ground). The severity of the shock depends upon how much current passes through the body. The factors that affect the severity of a shock are:

- amount and path of current;
- type of voltage (ac or dc);
- value of voltage;
- length of time the body is energized;
- condition of the skin; and
- area of contact.

Current

Any current over 10 mA can produce painful shock. Depending on the voltage and other conditions, a current greater than 15 mA passing through the body can paralyze the victim and make it impossible to let go of the energized wire. This is a very small current. An ordinary flashlight uses more than 30 times this current. Any current over 50 mA can kill the victim.

Table 1-1 lists the physiological effects of various currents.

Table 1-1
Physiological effects of various currents

Range	mA	Effect
Non-lethal	1 or less	No sensation
	1–8	Shock is felt but not painful. Victim can let go. Muscular control is kept.
	8–15	Shock is painful. Victim can let go. Muscular control is kept.
	15–20	Shock is painful. Victim cannot let go. Muscular control is lost. Breathing is difficult.
	20–50	Shock is very painful. Victim cannot let go. There are severe muscular contractions.
Lethal	50–200	Severe muscular contractions and nerve damage. Possible ventricular fibrillation of the heart, causing death.
	Over 200	Severe burns and muscular contractions. Victim cannot breathe during shock.

Note: *Currents in the lethal range do not always cause death if the victim is given immediate medical attention.*

Voltage

In practice, operating a flashlight is usually perfectly safe. This is because the flashlight cell has a very low voltage that cannot overcome the resistance of human skin and current flow is limited.

The danger of shock increases as voltage increases, but low voltages are not necessarily safe. Contact with 120 volts ac, the common household voltage, has led to more deaths than with any other voltage. Note that AC voltages above 750 volts are high voltage.

DC voltages can be very dangerous. Industrial voltages as small as 42 volts dc can be lethal. Chapter *5. Theory of direct and alternating current* discusses the differences between ac and dc.

Although 75 volts can be just as lethal as 1000 volts, victims of high-voltage shock usually respond better to resuscitation. Provided that they receive the artificial respiration immediately, their chance of survival is good. On the other hand, victims of low-voltage shock do not respond well to artificial respiration, because the low-voltage shock causes uncoordinated twitching of the walls of the heart, which interferes with sudden restoration of normal pulses.

Resistance of the human body

The electrical resistance of the human body varies because of moisture, salt, and abrasions on the skin. Resistance of the skin varies from 100 ohms to over 500 000 ohms. The applied voltage, the duration of applied voltage, and the points of contact also affect skin resistance.

Moisture and salt

When skin is wet or salty, its resistance drops to several hundred from several thousand ohms. Therefore, weather can affect the hazard of shock. Wet, humid, or hot weather causes perspiration, thus reducing resistance. On the other hand, cold, dry weather may increase skin resistance. Vigorous exercise can also increase perspiration and reduce resistance.

Abrasions

Because the insulating layers of skin are absent, abrasions reduce body resistance to well below 100 ohms.

Applied voltage and its duration

Skin resistance changes according to the applied voltage. Resistance is lower at high voltages. The longer the application of the voltage to the skin, the lower the resistance.

Contact points

The body has different resistance at different contact points. Between the ears, body resistance is only 100 ohms. Measured from hand to foot, resistance is nearly 500 ohms.

Rescuing shock victims

You must always take general precautions in the case of electrical shock.

The most important thing is to ACT FAST. The resistance of the victim decreases with time, and the victim can die in just a few seconds.

Never touch a victim who is still connected to the electric power. If you do, you will also experience shock.

First, try to disconnect the electricity. If you cannot quickly find the switch or plug, try to pull the victim and live conductor(s) apart. Use a dry wooden pole or some other dry insulating material (such as wood, glass, paper, cloth, etc.). Do not use your hands or a conducting material.

If the victim is unconscious and has stopped breathing, start artificial respiration at once. DO NOT STOP until a medical authority advises you to stop.

Summary

In the absence of other instructions, follow these five simple steps to rescue a shock victim:

1) Protect yourself—do not touch the energized victim.
2) Free the victim from electrical contact.
3) Apply cardiopulmonary resuscitation (CPR) or artificial respiration, as necessary.
4) Have someone call a doctor, nurse, fire department, rescue Unit, or police Unit.
5) Continue resuscitation attempts until a medical authority advises you to stop.

Grounding

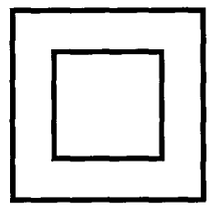
Proper grounding of tools, equipment, and sources of static discharge is essential for reducing the risk of electrical hazards.

You shall effectively ground portable tools and equipment that require grounding and are not permanently connected to the wiring system through the use of approved three-wire cords and three-prong polarized plugs inserted in grounded polarized receptacles.

You must install ground straps where necessary to prevent static discharge.

Many modern portable tools may not have a three-pronged plug but instead are double-insulated and have a two-pronged plug. A tool that is double-insulated provides equivalent shock hazard protection as a tool with a three-pronged grounded plug. If you use a power tool with a two-pronged plug, ensure that the tool is double-insulated. To determine if the tool is double-insulated, the tool should have certification (e.g., by CSA) and marking with either the words "DOUBLE INSULATED" or the following symbol:

Figure 1-1
Double insulated symbol



Electrical code safety requirements

Electrical safety codes contain sections and specific rules that deal with the installation and maintenance of electrical equipment as it relates to gas-fired equipment. Most provincial electrical codes are either based on or fully adopt the *Canadian Electrical Code*. However, some differences may exist, and you should always make reference the code accepted locally or provincially. The following provisions are part of the *Canadian Electrical Code, Part I* (*C22.1-18*).

Section 2—General rules

Rule 2-032 Damage and interference

1) *No person shall damage any electrical installation or component thereof.*

2) *No person shall interfere with any electrical installation or component thereof except that when, in the course of alterations or repairs to non-electrical equipment or structures, it may be necessary to disconnect or move components of an electrical installation, it shall be the responsibility of the person carrying out the alterations or repairs to ensure that the electrical installation is restored to a safe operating condition as soon as the progress of the alterations or repairs will permit.*

Rule 2-100 Marking of equipment (see Appendix B)

1) *Each piece of electrical equipment shall bear those of the following markings necessary to identify the equipment and ensure that it is suitable for the particular installation:*
   a) *the maker's name, trademark, or other recognized symbol of identification;*
   b) *catalogue number or type;*
   c) *voltage;*
   d) *rated load amperes;*
   e) *watts, volt amperes, or horsepower;*
   f) *whether for ac, dc, or both;*
   g) *number of phases;*
   h) *frequency in hertz;*
   i) *rated load speed in revolutions per minute;*
   j) *designation of terminals;*
   k) *whether for continuous or intermittent duty;*
   l) *short-circuit current rating or withstand rating;*
   m) *evidence of approval; or*
   n) *other markings necessary to ensure safe and proper operation.*

2) *At the time of installation, each service box shall be marked in a conspicuous, legible, and permanent manner, to indicate clearly the maximum rating of the overcurrent device that may be used for this installation.*

3) *At each distribution point, circuit breakers, fuses, and switches shall be marked, adjacent thereto, in a conspicuous and legible manner to indicate clearly*
   a) *which installation or portion of installation they protect or control; and*

b) *the maximum rating of overcurrent device that is permitted.*

4) *Where the maximum continuous load allowed on a fused switch or circuit breaker as determined in accordance with Rule 8-104 5) and 6) is less than the continuous operating marking of the fused switch or circuit breaker, a permanent, legible caution marking shall be field applied adjacent to the fused switch or circuit breaker nameplate to indicate the maximum continuous loading permitted for connection to the fused switch or circuit breaker.*

5) *The marking on electrical equipment shall not be added to, or changed, to indicate a use under this Code for which the equipment has not been approved.*

Rule 2-110 Circuit voltage-to-ground — Dwelling Units

Branch circuits in dwelling Units shall not have a voltage exceeding 150 volts to ground except that, where the calculated load on the service conductors of an apartment or similar building exceeds 250 kVA and where qualified electrical maintenance personnel are available, higher voltages not exceeding the voltage to ground of a nominal system voltage of 600Y/347V shall be permitted to be used in the dwelling Unit to supply the following fixed (not portable) equipment:

a) *space heating, provided that wall-mounted thermostats operate at a voltage not exceeding 300 volts-to-ground;*

b) *water heating; and*

c) *air conditioning.*

Rule 2-122 Installation of electrical equipment (see Appendix G)

Electrical equipment shall be installed so as to ensure that after installation there is ready access to nameplates and access to parts requiring maintenance.

Rule 2-124 Installation of other than electrical equipment

Equipment or material of other than an electrical nature shall not be installed or placed so close to electrical equipment as to create a condition that is dangerous.

Rule 2-136 Insulation Integrity (see Appendix B)

All wiring shall be so installed that, when completed, the system will be free from short circuits and from grounds except as permitted in Section 10.

Rule 2-306 Shock and arc flash protection (see Appendix B)

1) *Electrical equipment such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centres that are installed in other than dwelling Units and are likely to require examination, adjustment, servicing, or maintenance while energized*

	shall be field marked to warn persons of potential electric shock and arc flash hazards. 2) *The marking referred to in Subrule 1) shall be located so that it is clearly visible to persons before examination, adjustment, servicing, or maintenance of the equipment*
Rule 2-320 Flammable material near electrical equipment	*Flammable material shall not be stored or placed in dangerous proximity to electrical equipment.*
Rule 2-326 Electrical equipment near combustible gas equipment	*The clearance distance between arc-producing electrical equipment and a combustible gas relief device or vent shall be in accordance with the requirements of CSA B149.1.*

Section 4—Conductors

Section 4 applies to conductors for lighting, appliance, and power supply circuits. It contains rules regarding the following:

- size of conductors;
- current ratings;
- insulation requirements; and
- permitted uses.

Section 10—Grounding and bonding

Rule 10-002 Object

The overall objective for grounding and bonding is to minimize the likelihood and severity of electric shock by establishing equipotentiality between exposed non-current-carrying conductive surfaces and nearby surfaces of the earth and to prevent damage to property during a fault, as follows:

a) *the objective of solidly grounding an electrical system and bonding its associated equipment is to establish a low impedance connection between the grounded conductor and the non-current-carrying conductive parts of the system to stabilize system voltage;*

b) *the objective of grounding an electrical system through an impedance is to*
   i) *limit the magnitude of ground fault currents;*
   ii) *minimize the damage to equipment resulting from a single ground fault; and*
   iii) *stabilize system voltage;*

c) *the objective of an ungrounded system is to*
   i) *limit the magnitude of ground fault currents resulting from a single ground fault; and*
   ii) *minimize the damage to equipment on the occurrence of a single ground fault;*

d) *the objective of bonding is to interconnect the non-current-carrying conductive parts of electrical equipment and the system grounded point, where one exists, with sufficiently low impedance to*
   i) *facilitate the operation of protective devices; and*
   ii) *establish equipotentiality; and*

e) *the objective of equipotential bonding is to establish equipotentiality.*

10-700 Equipotential bonding of non-electrical equipment (see Appendix B)

The following parts of non-electrical equipment shall be made equipotential with the non-current-carrying conductive parts of electrical equipment:

a) *the continuous metal water piping system of a building supplied with electric power;*

b) *the continuous metal waste water piping system of a building supplied with electric power;*

c) *the continuous metal gas piping system of a building supplied with electric power;*

d) *raised floors of conductive material with electrical wiring under the raised floor;*

e) *the conductive metal parts of structures that livestock access; and*

f) *metal tower and station structures of passenger ropeways, passenger conveyors, or material ropeways.*

10-706 Equipotential bonding connections to non-electrical equipment (see Appendix B)

Equipotential bonding connections to non-electrical materials shall be made mechanically secure and be suitable for the condition(s) to which they are subjected.

Lock-out and tagging procedures for electrical equipment

General lock-out and tagging procedures

As a gas technician/fitter, you may often be in an area where employees carry out maintenance procedures on powered machinery. During these times, detailed lock-out procedures are essential to prevent unexpected operation and energizing of the machinery you are working on.

Lock-out must involve more than merely disconnecting the power source. Electrically de-energized machinery that has its hydraulic systems still pressurized has already killed workers. Thus, you must assess the machine thoroughly, and make all energy sources, including electrical, pneumatic, hydraulic, or gravitational, inoperative. This is what you often call zero mechanical state.

As a technician/fitter, you should have your own lock and key (combination locks are not allowed), and use only these locks to lock out energy sources. Inform the machine operator of maintenance plans and tag the lock to identify the individual who has locked out the machinery.

The only person permitted to remove the lock is the individual who placed the lock on the machinery. Note that these procedures apply not only to stationary industrial equipment but also to mobile equipment, including passenger cars, truck equipment, and heavy construction equipment.

Refer to Unit *1 Safety* > Chapter *3. Hazardous Materials* Chapter for additional details on lock-out.

Canadian Electrical Code lock-out requirements

Rule 2-304 Disconnection (see Appendix B)

1) *No repairs or alterations shall be carried out on any live equipment except where complete disconnection of the equipment is not practicable.*
2) *Three-way or four-way switches shall not be considered as disconnecting means.*
3) *Adequate precautions, such as locks on circuit breakers or switches, warning notices, sentries, or other equally effective means, shall be taken to prevent electrical equipment from being electrically charged when work is being done.*

Lock-out requirements

Reference CSA Z460 *Control of hazardous energy—Lockout and other methods* and CSA Z462 *Workplace Electrical Safety*.

Hazardous energy control devices and locks

Controlling hazardous energy associated with potentially harmful machines, equipment, or processes requires the safety team and individuals to follow strict guidelines. CSA Z460 and CSA Z462 are recognized Standards for the protection of personnel from injury from the inadvertent release of hazardous energy. Release of hazardous energy can include any motion, energization, start-up, or release of stored energy that, from the perspective of the person(s) at risk, is either unintended or deliberate. Lock-out is recognized as the primary method of hazardous energy control.

Workers must consult the employer's policies and procedures before conducting any work on equipment and systems with hazardous energy. Training and supervision are a requirement: always attain authorization from the employer or supervisor before attempting any work.

Responsibility of workers

Each worker who works on the machinery or equipment requiring lock-out procedures must be responsible for:

- locking the control devices; and
- removing his or her own locks on the completion of his or her work.

Checking locked-out machinery

The person applying the first lock in a lock-out procedure must forthwith ensure that operation is not possible for the locked-out machinery or equipment.

Removal of locks

Only the following can perform removal of locks:

- the person or persons who installed them; or
- in emergency, the senior shift supervisor on duty who must first make every effort to contact the individual who installed the lock and then ensure safe operation of the machinery or equipment.

Workers coming on shift shall place their own locks on all control devices before the individuals going off shift remove their locks, or shift supervisors may lock out the control devices during shift changes to allow workers going off shift to remove their locks.

Key box system

The use of a key box system as outlined below is acceptable when multiple lock-outs are involved:

a) Two qualified workers, one of whom may be a supervisor, must be responsible for:
   i) locking out the multiple control devices, each using a set of locks, keyed alike, but not keyed to the other set;
   ii) completing, signing, and posting the checklist adjacent to the key box; and
   iii) placing in the key box the keys for the locks or other positive sealing devices acceptable to the authority having jurisdiction.

b) All other workers who must work on the machinery or equipment must also lock out the key box using personal locks before commencing maintenance or repair work.

c) On the completion of the work, all workers must remove their locks from the key box.

d) The two qualified workers who locked out the equipment must then remove their locks from the key box and from the multiple lock-out points.

e) A written key box lock-out procedure must remain posted at the key box location.

Exception for central control system

Where a central control operator controls systems, the operator shall lock out the central control and record the portion locked out and the time. He or she shall re-energize the system on the instructions of the person who requested the de-energization, who has first determined that it is safe to do so.

Motor disconnects

Where the intent of installing motor disconnect switches is for lock-out purposes, they must simultaneously disconnect both the motor and motor control circuits from their sources of supply. Such motor disconnect switches must be readily accessible, and where installed in elevated positions, access must be by means of a permanent ladder or by a stairway to a platform.

Working on de-energized equipment

Before work commences on any part of an electrical power system that, for reasons of safety, must operate in a de-energized condition, the worker in charge shall ensure that de-energizing and grounding of the part of the system he/she is working on and lock-out of the controls are complete.

Assurance of de-energization

When the control devices are not under the direct control of the worker, he or she must receive assurance from the person in charge of the control devices that the work may safely proceed. The person giving the assurance must record such assurances.

Protection against re-energizing

Before commencing work on the de-energized part of the system, the worker in charge must ensure protection of all workers against re-energization.

Authority to re-energize

Re-energization of the system must not take place except on the instructions of the worker who had requested the de-energizing or a supervisor who has first determined that it is safe to do so.

Requirements of applicable electrical safety codes and standards

Electrical codes and standards

It is necessary for gas technicians/fitters working on or around electrical equipment to understand the national, provincial, and municipal codes and standards affecting electrical work.

These published codes and standards are the authority for rules governing the installation, maintenance, connection, and disconnection of electrical equipment and are the source of the following information:

- legal requirements affecting the connection and disconnection of electrical equipment;
- requirements for notification of inspecting authority;
- requirements for necessary permits; and
- requirements for additions or renovations to existing equipment.

Electrical inspections and permits

Most jurisdictions require permits for all electrical work. The locally recognized electrical code, typically in Section 2.—General Rules cover the general rules governing the administration of electrical permits.

It is the responsibility of the electrical contractor or others responsible for carrying out the work to obtain a permit from the local electrical inspection department before commencing work with respect to installation, alteration, repair, or extension of any electrical equipment. A copy of the electrical permit must remain posted in a conspicuous place on the site of the work until completion of the electrical inspection.

Responsible person/s must notify the inspection department in writing that work is ready for inspection at such time or times as will permit completion of the electrical inspection before concealing any work or portion of the work.

The local electrical inspection department may require changes to existing installations where through hard usage, wear and tear, or as a result of alterations or extensions, dangerous conditions have developed.

Canadian Electrical Code requirements

The *Canadian Electrical Code* contains sections and specific rules that deal with the installation and maintenance of electrical equipment as it relates to gas-fired equipment. The following criteria are part of the *Canadian Electrical Code, Part I* (CSA Standard C22.1-18), but it is important that you make reference to the Code approved in the jurisdiction of the work site.

Section 12—Wiring methods

Section 12 deals with wiring installation requirements.

Section 14—Protection and control

Section 14 covers the protection and control of electrical circuits and apparatus installed in accordance with Sections of the Code, including circuit breakers and fuses.

Section 26—Installation of electrical equipment

Heating equipment

Rule 26-800 Scope	*Rules 26-802 to 26-808 apply to circuits supplying power for the operation and control of non-portable heating equipment that uses solid, liquid, or gaseous fuel.*
Rule 26-802 Mechanical protection of cables	*Cables for all branch circuit or tap conductors within 1.5 m from the floor shall be adequately protected from mechanical damage.*
Rule 26-804 Fuel burner safety controls (see Appendix B)	*Fuel burner safety controls shall be installed in accordance with the requirements of CSA C22.2 No. 3.*

The following are excerpts from the C22.2 No. 3-M1988 *Electrical Features of Fuel-Burning Equipment:*

> 4.8.5 The nominal supply voltage of a safety control circuit shall not exceed 120 V.
>
> 4.8.6 A safety control circuit intended to be supplied by a nominal 120 V branch circuit shall comply with the following:
>
> (a) The circuit shall not be grounded within the equipment;
>
> (b) The ungrounded conductor shall have an overcurrent protection device rated at not more than 125% of the current drawn by the circuit, except that this value may be increased because of inrush currents and ambient temperatures. These requirements shall apply only where the maximum current to the appliance exceeds 12 A and the safety controls are in series with the total load they control.

4.8.7 A safety control circuit supplied by other than as specified in Clause 4.8.6, such as one supplied by a battery or a transformer, shall comply with the following:

(a) It shall be a 2-wire circuit not exceeding 120 V;

(b) One side of the circuit shall be grounded;

(c) Except for the condition specified in Item (d), the ungrounded conductor shall have an overcurrent protection device rated at not more than 125% of the current drawn by the circuit, except that for circuits drawing currents up to and including 2 A the protection shall be rated at not more than 200%. These values may be increased because of inrush currents and ambient temperatures; and

(d) A safety control circuit supplied by a Class 2 transformer shall not require overcurrent protection.

4.8.8 A safety control shall interrupt the current in the ungrounded conductor of the circuit between the overcurrent protection and the load.

4.8.9 Except for multiphase loads and circuits in which the load to be controlled exceeds the contact rating of the safety control*, safety controls which open an electrical circuit to the burner or to the shut-off device shall directly open the circuit regardless of whether the switching mechanism is integral with, or remote from, the sensing element.

* *In these instances, the safety control may interrupt the coil circuit of a magnetic relay or contactor which in turn directly opens the circuit to the burner or to the shut-off device.*

Rule 26-806 Heating equipment rated 117 kW and less (see Appendix B)	1) *Except as permitted by Subrule 3), all electric power for the heating Unit and associated equipment operating in connection with it shall be obtained from a single branch circuit that shall be used for no other purpose.* 2) *For the purpose of this Rule, circulating pumps and similar equipment need not be considered as associated equipment, provided that such equipment is not essential for the safe operation of the heating Unit.* 3) *Subrule 1) does not apply to a water heater using a gaseous fuel.* 4) *The branch circuit shall be permitted to be tapped as necessary to supply the various pieces of associated equipment, but there shall be no overcurrent protection supplied in the tap to any piece of associated equipment the operation of which is essential to the proper operation of the heating Unit, unless the control equipment is of such a nature that the heating Unit will be shut down if the associated equipment fails to function due to the operation of the overcurrent device.* 5) *Suitable disconnecting means shall be provided for the branch circuit.* 6) *The disconnecting means shall be permitted to be a branch circuit breaker at the distribution panelboard, provided that the panelboard is located between the furnace and the point of entry to the area where the furnace is located.* 7) *Where a separate switch is required due to the unsuitable location of the branch circuit breaker, it shall* a) *not be located on the furnace nor in a location that can be reached only by passing close to the furnace; and* b) *be marked to indicate the equipment it controls.*
Rule 26-808 Heating equipment rated at more than 117 kW	1) *All electric power for the heating Unit and associated equipment operating in connection with it shall be obtained from a single feeder or branch circuit that shall not be used for other purposes.* 2) *A suitable disconnecting means shall be provided for the feeder or branch circuit.*

Assignment Questions – Chapter 1

1) What is the main danger of static electricity?
   a) Shock
   b) Arcing
   c) Fire

2) Correctly complete the following statement with the appropriate word provided:
   _____ is a physiological reaction or injury caused by electric current passing through the (human) body.
   a) Electric shock
   b) Static shock
   c) Electrocution
   d) Arc burn

3) Which of the following factors does not affect the electrical resistance of the human body?
   a) Moisture
   b) Salt
   c) Temperature
   d) Abrasions on the skin

4) Correctly complete the following statement with the appropriate word provided:
   An electrical current over _____ can kill a victim.
   a) 15 mA
   b) 20 mA
   c) 30 mA
   d) 50 mA

5) Which of the following should you not do when rescuing a victim of electrical shock?
   a) Free the victim of electrical contact
   b) Touch the energized victim
   c) Apply CPR or artificial respiration
   d) Have someone call for help

6) What is the normal maximum voltage-to-ground allowable in the branch circuits of dwelling Units?
   a) 24 volts to ground
   b) 220 volts to ground
   c) 300 volts to ground
   d) 150 volts to ground