

UNIT 1

Commercial Building Plans and Specifications

OBJECTIVES

After completing the study of this unit, the student will be able to

- define the job requirements from the contract documents
 - explain the reasons for building plans and specifications
 - locate specific information on the building plans
 - obtain information from industry-related organizations
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PRINTS

Electrical and architectural drawings are the maps that the electrician must read and understand. This ability is essential to install a complete electrical system and to coordinate related activities with workers in other trades. This unit will provide a first step in developing the ability to read symbols appearing on the prints as they apply to the electrical work.

The several units in this text that deal with electrical drawings and plans will apply the information presented in other units. The print units will also introduce the special features of each area of the building. The questions at the end of each print unit will require the student to use the specifications, the prints, and the 1998 *Canadian Electrical Code, Part I*.

COMMERCIAL BUILDING SPECIFICATIONS (OVERVIEW)

When a building project contract is awarded, the electrical contractor is given the plans and specifications for the building. These two contract documents govern the construction of the building. It is very important that the electrical contractor and the electricians employed by the contractor to perform the electrical construction follow the specifications exactly. The electrical contractor will be held responsible for any deviations from the specifications and may be required to correct such deviations or variations at personal expense. Thus, it is important that any changes or deviations be verified—in writing. Avoid verbal change orders.

It is suggested that the electrician assigned to a new project first read the specifications carefully. These documents provide the detailed information that will simplify the task of studying the plans. The specifications are usually prepared in



book form and may consist of a few pages or as many as several hundred pages covering all phases of the construction. This text presents in detail only that portion of the specifications that directly affects the electrician; however, summaries of the other specification sections are presented to acquaint the electrician with the full scope of the document.

SPECIFICATION

The specification is a book of rules governing all of the material to be used and the work to be performed on a construction project. The specification is usually divided into several sections.

General Clauses and Conditions

The first section of the specification, titled *General Clauses and Conditions*, deals with the legal requirements of the project. The index to this section may include the following headings:

- Notice to Bidders
- Schedule of Drawings
- Instructions to Bidders
- Proposal
- Agreement
- General Conditions

Some of these items will affect the electrician on the job and others will be of primary concern to the electrical contractor. The following paragraphs give a brief, general description of each item and how it affects either the electrician on the job or the contractor.

Notice to Bidders. This item is of value to the contractor and his or her estimator only. The notice describes the project, its location, the time and place of the bid opening, and where and how the plans and specifications can be obtained.

Schedule of Drawings. This schedule is a list, by number and title, of all of the drawings related to the project. The contractor, the estimator, and

the electrician will each use this schedule prior to preparing the bid for the job. The contractor will determine if all the drawings required are at hand, the estimator will do a take-off from the drawings and formulate a bid, and the electrician will determine if all of the drawings necessary to do the installation are available.

Instructions to Bidders. This section provides the contractor with a brief description of the project, its location, and how the job is to be bid (lump sum, one contract, or separate contracts for the various construction trades, such as plumbing, heating, electrical, and general). In addition, bidders are told where and how the plans and specifications can be obtained prior to the preparation of the bid, how to make out the proposal form, where and when to deliver the proposal, the amount of any bid deposits required, any performance bonds required, and bidders' qualifications. Other specific instructions may be given, depending upon the particular job.

Proposal. The proposal is a form that is filled out by the contractor and submitted at the proper time and place. The proposal is the contractor's bid on a project. The form is the legal instrument that binds the contractor to the owner provided that the contractor completes the proposal properly, the contractor does not forfeit the bid bond, and the owner accepts the proposal and signs the agreement.

Unless the proposal is specifically marked as irrevocable, it may be revoked by the contractor without penalty at any time until the agreement has been signed by the owner.

If the owner fails to pay the contractor within the terms of the agreement, the contractor has a right to charge this as a lien against the property being upgraded. This type of lien is known as a "mechanic's lien." This means that the owner may not deal with the property, e.g., increase the mortgage or sell it, until the lien has been satisfactorily discharged or the amount in dispute has been paid into court pending settlement.

The proposal may show that alternate bids were requested by the owner. In this case, the electrician on the job should study the proposal and consult with the contractor to learn which of

the alternate bids has been accepted in order to determine the extent of the work to be completed.

On occasion, the proposal may include a specified time for the completion of the project. This information is important to the electrician on the job since the work must be scheduled to meet the completion date.

Agreement. If the proposal is acceptable to the owner, then a legally binding agreement must be executed between the parties. This agreement may be included as part of the proposal document. The contractor and the owner sign the agreement and the result is a legal contract. Once the agreement is signed, both parties are bound by the terms and conditions given in the specification.

General Conditions. The following items are normally included under the General Conditions heading of the *General Clauses and Conditions* section. A brief description is presented for each item.

- **General Note:** This item specifies that the general conditions are part of the contract documents.
- **Definition:** As used in the contract documents, this item defines the owner, contractor, architect, engineer, and other people and objects involved in the project.
- **Contract Documents:** This item lists the documents involved in the contract, including plans, specifications, and agreement.
- **Insurance:** This item specifies the insurance a contractor must carry on all employees and on the materials involved in the project.
- **Workmanship and Materials:** This item specifies that the work must be done by skilled workers and that the materials must be new and of good quality.
- **Substitutions:** Materials used must be as specified or equivalent materials must be shown to have the required properties.
- **Shop Drawings:** This item identifies the drawings that must be submitted by the contractor to show how the specific pieces of equipment are to be installed.

- **Payments:** This item specifies the method of paying the contractor during the construction.
- **Coordination of Work:** This item specifies that each contractor on the job must cooperate with every other contractor to ensure that the final product is complete and functional.
- **Correction of Work:** This section describes how work must be corrected, at no cost to the owner, if any part of the job is installed improperly by the contractor.
- **Guarantee:** In this item the contractor guarantees the work for a certain length of time, usually one year.
- **Compliance with All Laws and Regulations:** This section specifies that the contractor will perform all work in accordance with all required laws, ordinances, and codes, such as the *Canadian Electrical Code, Part I* and local codes.
- **Others:** These sections are added as necessary by the owner, architect, and engineer when the complexity of the job and other circumstances require them. None of the items listed in the General Conditions has precedence over another item in terms of its effect on the contractor or the electrician on the job. The electrician must study each of the items before taking a position and assuming responsibilities with respect to the job.

SUPPLEMENTARY GENERAL CONDITIONS

The second main section of the specification is titled *Supplementary General Conditions*. These conditions usually are more specific than the General Conditions. While the General Conditions can be applied to any job or project in almost any location with little change, the Supplementary General Conditions are rewritten for each project. The following list covers the items normally specified by the Supplementary General Conditions.

- The contractor must instruct all crews to exercise caution while digging; any utilities damaged during the digging must be replaced by the contractor responsible.
- The contractor must verify the existing conditions and measurements.
- The contractor must employ qualified individuals to lay out the worksite accurately. A registered land surveyor or engineer may be part of the crew responsible for the layout work.
- Job offices are to be maintained as specified on the site by the contractor; this office space may include space for owner representatives.
- The contractor may be required to provide telephones at the project site for use by the architect, engineer, subcontractor, or owner.
- Temporary toilet facilities and water are to be provided by the contractor for the construction personnel.
- **The contractor must supply an electrical service of a specified size to provide temporary light and power at the site.**
- It may be necessary for the contractor to supply a specified type of temporary heating to keep the temperature at the level specified for the structure.
- According to the terms of the guarantee, the contractor agrees to replace faulty equipment and correct construction errors for a period of one year.

The above list is by no means a complete catalogue of all of the items that can be included in Supplementary General Conditions.

Other titles may be applied to the Supplementary General Conditions section; these include Special Conditions and Special Requirements. Regardless of the title used, these sections contain the same types of information. All sections of the specifications must be read and studied by all of the construction trades involved. In other words, the electrician must study the heating, plumbing,

ventilating, air-conditioning, and general construction specifications to determine if there is any equipment furnished by the other trades that the contract specifies is to be installed and wired by the electrical contractor. The electrician must also study the general construction specifications, since the roughing in of the electrical system will depend on the types of construction that will be encountered in the building.

This overview of the General and Supplementary General Conditions of a specification is intended to show the student that the construction worker on the job is affected by parts of the specification other than the part designated for each particular trade.

Contractor Specification

In addition to the sections of the specification that apply to all contractors, there are separate sections for each of the contractors, such as the general contractor who constructs the building proper, the plumbing contractor who installs the water and sewage systems, the heating and air-conditioning contractor, and the electrical contractor. The contract documents do not usually make one contractor responsible for work specified in another section of the specifications. However, it is always considered good practice for each contractor to be aware of the responsibilities of each of the other contractors in the total job.

COMMERCIAL BUILDING PLANS

The construction plans for a building are usually called *blueprints*. This term is a carry-over from the days when the plans were blue with white lines. Today, a majority of the plans used have black lines on white since this combination is considered easier to read.

A set of fourteen plan sheets is included at the back of the text showing the general and electrical portions of the work specified.

- *Sheet A1—Plot Plan, East Elevation, West Elevation, Index to Drawings:* The plot plan

shows the location of the commercial building and gives needed elevations. The east elevation is the street view of the building and the west elevation is the back of the building. The index lists the content of all of the plan sheets.

- *Sheet A2—Architectural Floor Plan: Basement.*
- *Sheet A3—Architectural Floor Plan: First Floor.*
- *Sheet A4—Architectural Floor Plan: Second Floor.*

The architectural floor plans give the wall and partition details for the building. These sheets are dimensioned; the electrician can find exact locations by referring to these sheets. The electrician should also check the plans for the material used in the general construction, since these will affect when and how the system will be installed.

Sheet A5—Elevations; North and South: The electrician must study the elevation dimensions, which are given in feet and hundredths of a foot above sea level. For example, the finished second floor, which is shown at 218.33', is 218 feet 4 inches above sea level.

Sheets A6 and A7—Sections; Longitudinal, Transverse: These sheets give detailed drawings of the more important sections of the building. The locations of the sections are indicated on the floor plans. When looking at a section, imagine that you are looking in the direction of the arrows at a building that is cut in two at the place indicated. You should see the section exactly as you view the imaginary building from this point.

- *Sheet E2—Electrical Floor Plan: Basement, Owner—Emergency Panelboard Schedule, Telephone Riser Diagram.*
- *Sheet E3—Electrical Floor Plan: First Floor, Drugstore Panelboard Schedule, Bakery Panelboard Schedule.*
- *Sheet E4—Electrical Floor Plan: Second Floor, Insurance Office Panelboard Schedule, Beauty Salon Panelboard Schedule, Doctor's Office Panelboard Schedule.*

- *Sheets E5, E6, and E7 are layout sheets for students to do their own conduit and wire layout.*

Sheets E2 to E4 show the detailed electrical work on an outline of the building. Since dimensions usually are not shown on the electrical plans, the electrician must consult the other sheets for this information. It is recommended that the electrician refer frequently to the other plan sheets to ensure that the electrical installation does not conflict with the work of the other construction trades.

- *Sheet E1—Luminaire–Lamp Schedule, Electrical Symbol Schedule, Electrical Power Distribution Diagram, Detail of Typical Roof-Type Cooling System Unit, Panelboard Summary.*

To assist the electrician in recognizing components used by other construction trades, the following illustrations are included: Fig. 1–1, Architectural drafting symbols; Fig. 1–2, Standard symbols for plumbing, piping, and valves; Fig. 1–3, Sheet metal ductwork symbols; and Fig. 1–4, Generic symbols for electrical plans. However, the electrician should be aware that variations of these symbols may be used and the specification and/or plans for a specific project must always be consulted.

CODES AND ORGANIZATIONS

Local Codes

Many organizations, such as cities and power companies, develop electrical codes that they enforce within their areas of influence. These codes generally are concerned with the design and installation of electrical systems. In all cases, the latest *Canadian Electrical Code* is used as the basis for the local code. It is always advisable to consult these organizations before work is started on any project. The local codes may contain special requirements that apply to specific and particular installations. Additionally, the contractor may be required to obtain special permits and/or licences before construction work can begin.

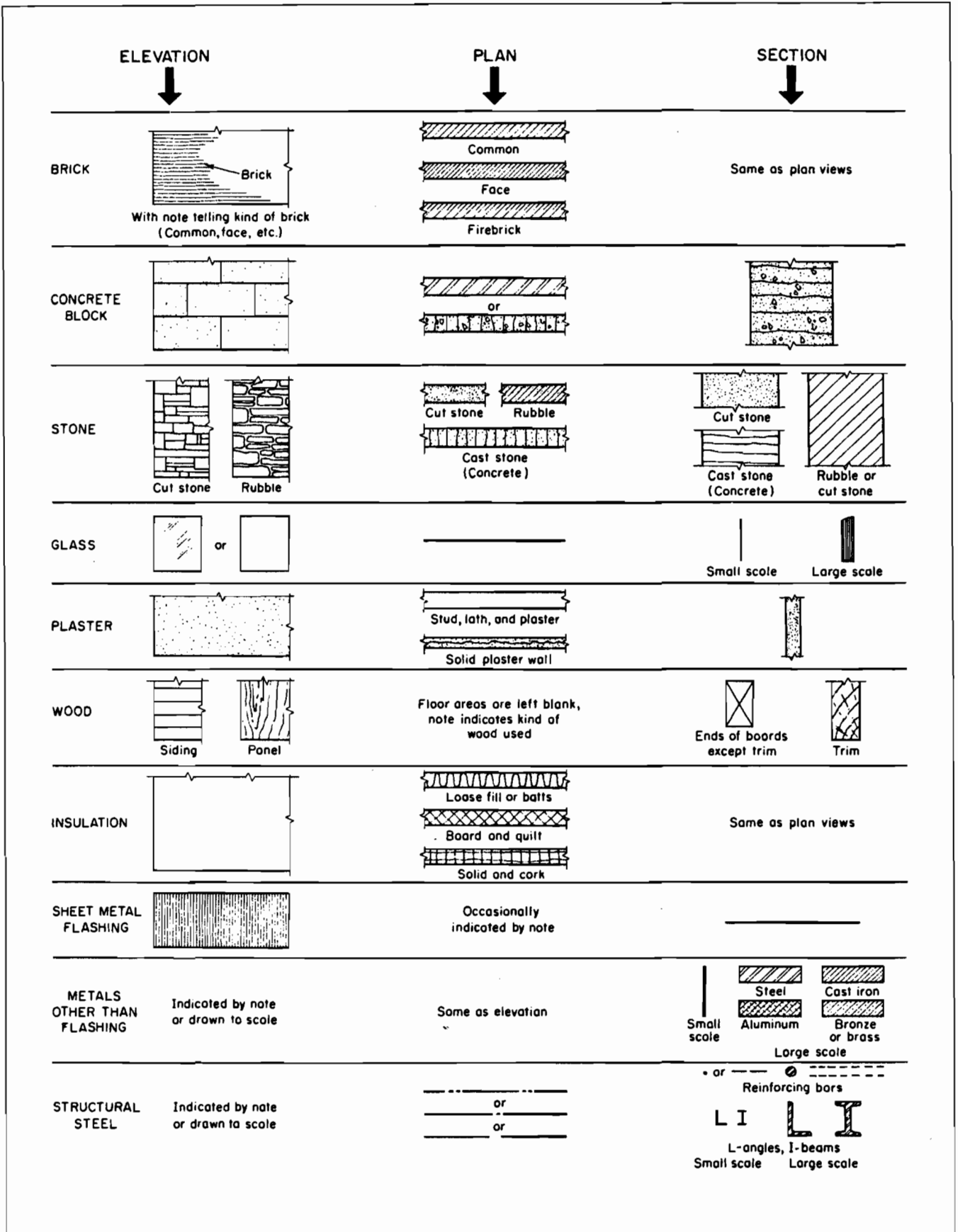


Fig. 1-1 Architectural drafting symbols.

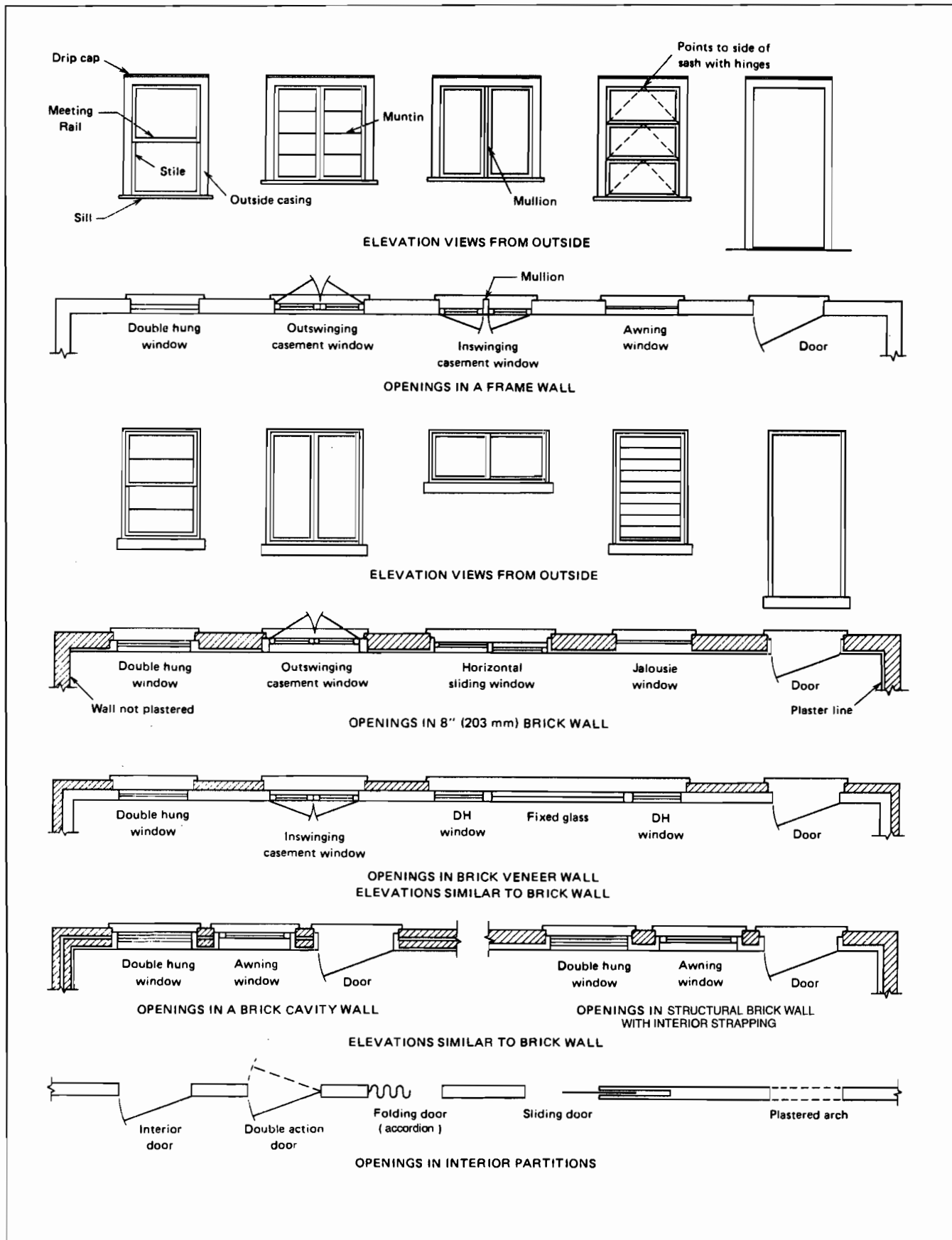


Fig. 1-1 Architectural drafting symbols (continued).

Unit 1 Commercial Building Plans and Specifications

PIPING			PIPE FITTINGS (continued)			PLUMBING (continued)		
Piping, in general (Lettered with name of material conveyed)			For welded or soldered fittings, use joint indication shown below			Plain kitchen sink		
Non-intersecting pipes			Screwed			Kitchen sink, R & L drain board		
Steam			Bell and spigot			Kitchen sink, L H drain board		
Condensate			Lateral			Combination sink & dishwasher		
Cold water			Expansion joint flanged			Combination sink & laundry tray		
Hot water			VALVES			Service sink		
Air						For welded or soldered fittings, use joint indication shown below		
Vacuum			Screwed			Wash sink		
Gas			Bell and spigot			Laundry tray		
Refrigerant			Gate valve			Water closet (Low tank)		
Oil			Globe valve			Water closet (No tank)		
PIPE FITTINGS			Angle globe valve			Urinal (Pedestal type)		
			Angle gate valve			Urinal (Wall type)		
For welded or soldered fittings, use joint indication shown below			Check valve			Urinal (Corner type)		
Screwed			Angle check valve			Urinal (Stall type)		
Bell and spigot			Stop cock			Urinal (Trough type)		
Joint			Safety valve			Drinking fountain (Pedestal type)		
Elbow - 90 deg			Quick opening valve			Drinking fountain (Wall type)		
Elbow - 45 deg			Float opening valve			Drinking fountain (Trough type)		
Elbow - turned up			Motor operated gate valve			Hot water tank		
Elbow - turned down			PLUMBING			Water heater		
Elbow - long radius						Corner bath		
Side outlet elbow - outlet down			Recessed bath			Hose rack		
Side outlet elbow - outlet up			Roll rim bath			Hose bibb		
Base elbow			Sitz bath			Gas outlet		
Double branch elbow			Foot bath			Vacuum outlet		
Single sweep tee			Bidet			Drain		
Double sweep tee			Shower stall			Grease separator		
Reducing elbow			Shower head			Oil separator		
Tee			Shower head (Plan/Elev)			Cleanout		
Tee - outlet up			Overhead gang shower (Plan/Elev)			Garage drain		
Tee - outlet down			Pedestal lavatory			Floor drain with backwater valve		
Side outlet tee outlet up			Wall lavatory			Roof sump		
Side outlet tee outlet down			Corner lavatory					
Crass			Manicure lavatory					
Reducer			Medical lavatory					
Eccentric reducer			Dental lavatory					

Types of joints



Fig. 1-2 Standard symbols for plumbing, piping, and valves.

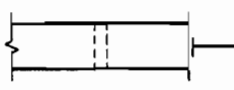
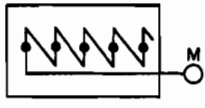
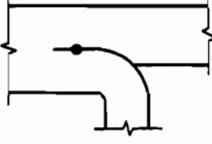
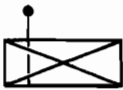
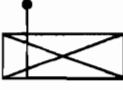
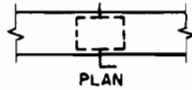

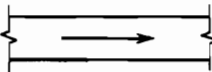
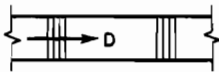
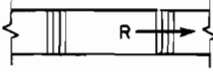
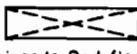
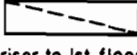
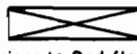
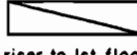

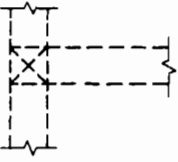
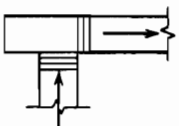
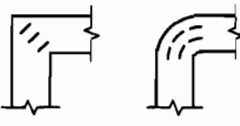
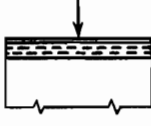








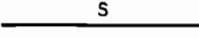

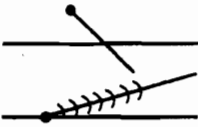

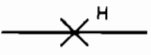
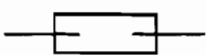
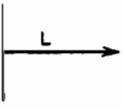
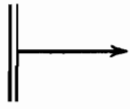
<p>Blank Off. adjustable</p> 	<p>Damper automatic</p> 	<p>Damper deflecting</p> 	<p>Damper deflecting up</p> 
<p>Damper deflecting down</p> 	<p>Damper volume</p> <p>PLAN</p>  <p>ELEVATION</p> 	<p>Duct flow direction</p> 	<p>Duct inclined drop</p> 
<p>Duct inclined rise</p> 	<p>Duct section exhaust, return</p>  <p>riser to 2nd floor</p>  <p>riser to 1st floor</p>	<p>Duct section supply</p>  <p>riser to 2nd floor</p>  <p>riser to 1st floor</p>	<p>Duct section notation</p>  <p>type exhaust</p> <p>place kitchen</p>
<p>Duct connection below joist</p> 	<p>Fan flexible connection</p> 	<p>Vanes</p> 	<p>Louver & screen air intake</p> 
<p>Ventilator, cowl</p> <p>PLAN</p>  <p>ELEVATION</p> 	<p>Ventilator, gooseneck</p> <p>PLAN</p>  <p>ELEVATION</p> 	<p>Ventilator, rainproof</p> <p>PLAN</p>  <p>ELEVATION</p> 	<p>Ventilator, standard</p> <p>PLAN</p>  <p>ELEVATION</p> 
<p>SINGLE LINE REPRESENTATION</p>			
<p>Supply</p> <p>S</p> 	<p>Return</p> <p>R</p> 	<p>Damper & retractor</p> 	<p>Anchor</p> <p>PA.</p> 
<p>Hanger</p> <p>H</p> 	<p>Expansion joint</p> 	<p>Louver opening</p> <p>L</p> 	<p>Register or grille</p> 

Fig. 1-3 Sheet metal ductwork symbols.

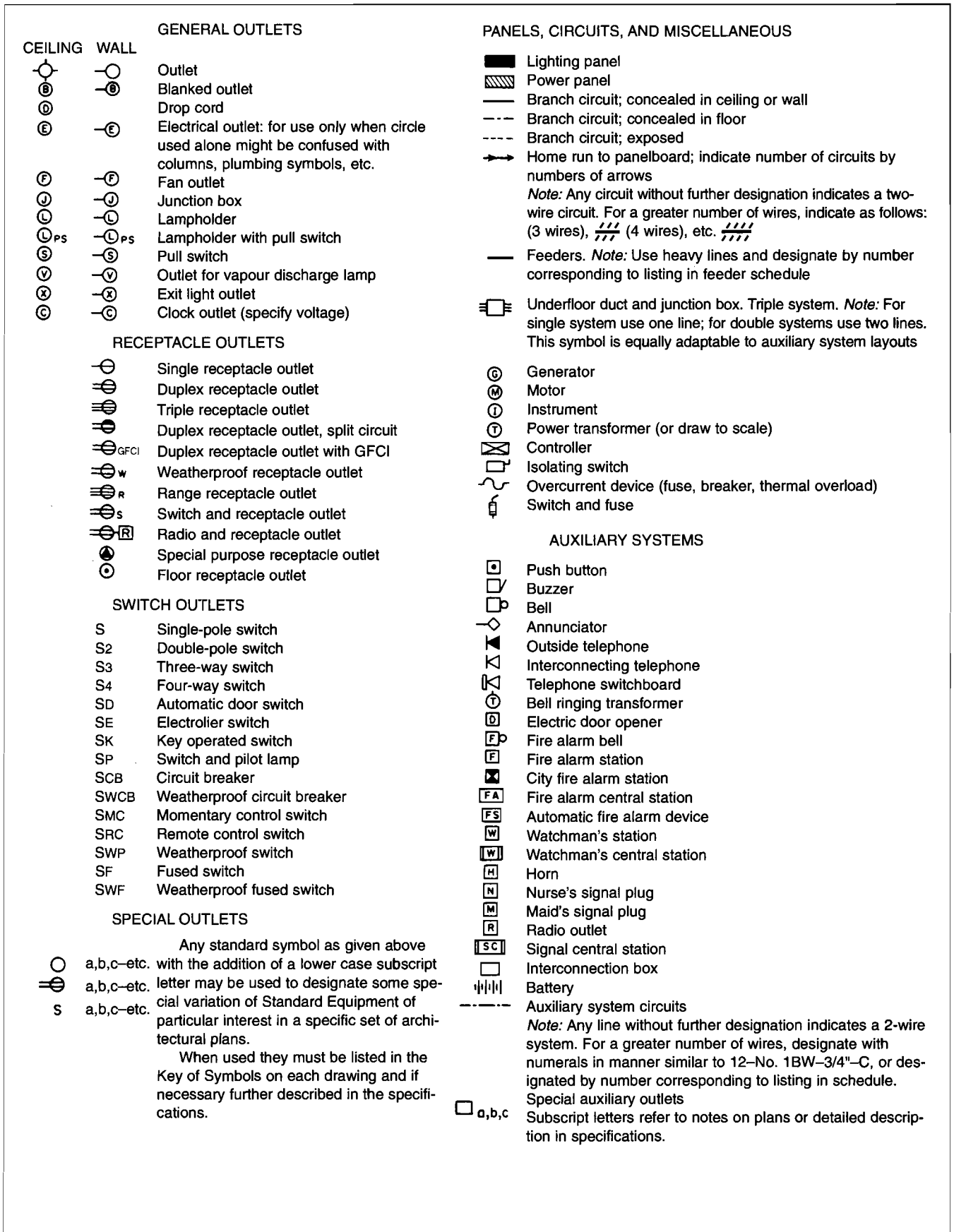


Fig. 1-4 Generic symbols for electrical plans.

Canadian Standards Association (CSA)



The **Canadian Standards Association (CSA)** is a nonprofit organization that was formed in 1919 to develop standards for a variety of organizations and disciplines. These standards are the cornerstone for product certification, and are subsequently approved by provincial and federal government authorities to become recognized throughout the country.

Thousands of manufacturers work directly with the CSA on the certification process and the CSA mark appears on many new products every year. The *Canadian Electrical Code* is one of the many standards that are developed by the CSA. This code is then adopted by provincial authorities to become law in the various provinces.

For more information please write to:

Canadian Standards Association
Customer Service Department
178 Rexdale Boulevard
Etobicoke, ON M9W 1R3
Tel: (416) 747-4000
1-800-463-6727
Fax: (416) 747-4149

National Fire Protection Association

Organized in 1896, the National Fire Protection Association (NFPA) is an international, nonprofit organization dedicated to the twin goals of promoting the science of fire protection and improving fire protection methods. **The NFPA publishes an 11-volume series covering the national fire codes of the United States.** The *National Electrical Code® (NEC®)* is a part of volume 3 of this series. This covers the electrical requirements for installations in the United States of America. The purpose and scope of the *NEC®* are discussed in *Article 90* of the *Code*.

The terms *National Electrical Code®* and *NEC®* are registered trademarks of the National Fire Protection Association, Inc., Quincy, MA.

Although the NFPA is an advisory organization, the recommended practices contained in its published codes are widely used as a basis for local codes. Additional information concerning the publications of the NFPA and membership in the organization can be obtained by writing to:

National Fire Protection Association, Inc.
Batterymarch Park
Quincy, MA 02269
USA

Canadian Electrical Code

The original *Canadian Electrical Code* was developed in 1920 and was finalized in June 1927. At this time the revised draft was formally approved and printed as the ***Canadian Electrical Code, Part I. The purpose of the C.E.C., Part I*** is to prevent fire and shock, *Section 0*.

The *C.E.C., Part I* is the basic standard for the layout and construction of all electrical systems in Canada. However, some provincial and local codes contain specific amendments that must be adhered to in all electrical wiring installations under their jurisdiction. The authors encourage the reader to develop a detailed knowledge of the layout and content of the latest edition of the *C.E.C., Part I*. Also, refer to Table 1-1.

The *C.E.C., Part I* is divided into numbered sections, with each covering a major topic. These sections are further divided into numbered rules, subrules, paragraphs, and subparagraphs; related rules are often grouped together under a subsection heading. All references in the text are to the *Section* or to the *Section and rule number*. For example, *Rule 8-200(1)(a)(i)* in the text, refers to *Section 8, rule 200, subrule 1, paragraph a, subparagraph i*. Occasionally, a Section reference will include a clause. See Table 1-1. It is hoped that this explanation will assist the student in locating *C.E.C., Part I* references in the text.

To help the user of this text, relevant *C.E.C., Part I* sections are paraphrased where appropriate. However, the *C.E.C., Part I* must be consulted before any decision related to electrical installation is made.

Enforcement of the *C.E.C., Part I* is generally under the jurisdiction of the utility company providing electrical power in the particular province. In Ontario, for instance, electrical inspection is conducted by field inspectors employed by Ontario Hydro.

The *C.E.C., Part I* is revised and updated every four years.

Code Terms. The following terms are used throughout the *C.E.C., Part I*. It is important to understand the meanings of these terms.

Approved (as applied to electrical equipment): equipment has been submitted for examination and testing to an accredited certification organization and that the equipment conforms to appropriate Canadian Standards Association (CSA) standards.

Shall: Indicates a mandatory requirement.

Notwithstanding: In spite of.

Practicable: Feasible, possible.

Citing Code References

Every time that an electrician makes a decision concerning the electrical wiring, the decision should be checked by reference to the *C.E.C., Part I*. Usually this is done from memory. If there is any doubt in the electrician's mind, then the *C.E.C., Part I* should be referenced directly—just to make sure. It is a good idea to record the *C.E.C., Part I* location of the information—this is referred to as citing the reference. There is a very exact way that the location of an item is to be cited. The various levels of *C.E.C., Part I* referencing are shown in Table 1–1. Starting at the top of the table, each step becomes a more specific reference. A reference to *Section 2* includes all the information and requirements that are set forth in several pages. Citing a specific rule or exception narrows the reference to a few sentences or perhaps even a few words.

Table 1–1 Citing the *C.E.C., Part I*.

Division	Designation	Example
Section	0–84	Section 8
Rule	Even numbers	8–212
Subrule	Numbered sequence	8–106(1)
Paragraph	a–z	8–108(1)(d)
Subparagraph	Lower case/Roman numerals	8–204(2)(a)(i)
Clause	Capital A–Z	8–204(2)(b)(ii)(B)

Underwriters Laboratories, Inc.

Founded in 1894, Underwriters Laboratories, Inc. (UL) is a nonprofit organization that operates laboratories to investigate materials, devices, products, equipment, and construction methods and systems to define any hazards that may affect life and property. The organization provides a listing service to manufacturers, Fig. 1–5. Any product authorized to carry an Underwriters' listing has been evaluated with respect to all reasonable foreseeable hazards to life and property, and it has been determined that the product provides safeguards against these hazards to an acceptable degree. Approved products have a UL label attached.

Useful Underwriters Laboratories publications are:

- *Electrical Construction Materials Directory* (Green Book)
- *Electrical Appliances and Utilization Equipment Directory* (Orange Book)
- *Hazardous Location Equipment Directory* (Red Book)
- *General Information for Electrical Construction, Hazardous Location, and Electrical Heating and Air Conditioning Equipment* (White Book)
- *Recognized Component Directories* (Yellow Books)

Since the implementation of the Canada/U.S.A. Free Trade Agreement, the UL logo is more common in Canada than ever before. Check with your local inspection authority to ensure that any UL-listed products meet Canadian standards.

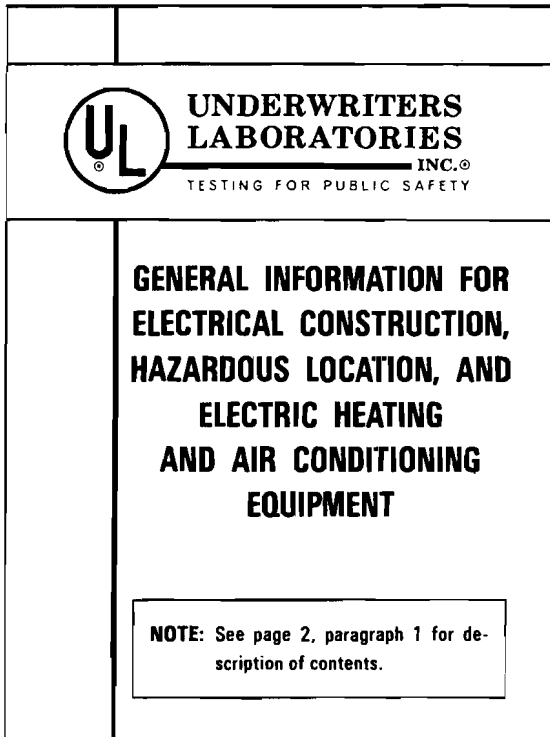


Fig. 1-5 Underwriters Laboratories' White Book.

If approval cannot be obtained the products may not be used in Canada.

An index of publications and information concerning the Underwriters Laboratories can be obtained by writing to:

Public Information
Underwriters Laboratories, Inc.
333 Pfingsten Road
Northbrook, IL 60062
USA
Tel: (847) 272-8800
<http://www.ul.com>

National Electrical Manufacturers Association

The National Electrical Manufacturers Association (NEMA) is a nonprofit organization supported by the manufacturers of electrical equipment and supplies. NEMA develops standards that are designed to assist the purchaser in selecting and obtaining the correct product for specific applications, Fig. 1-6.

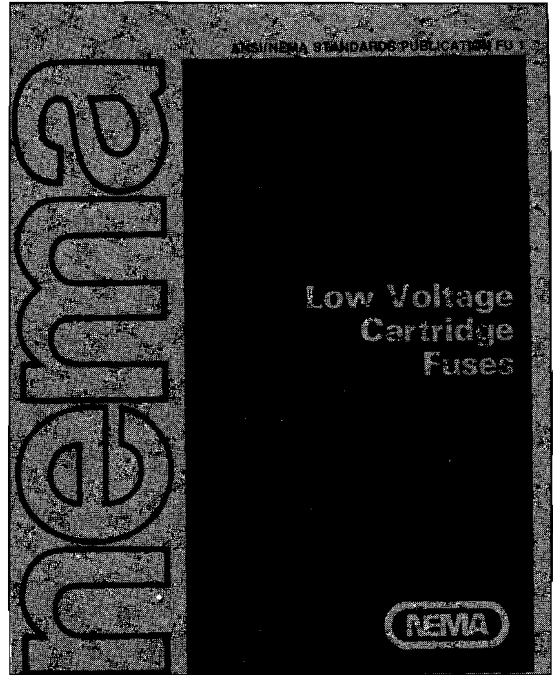


Fig. 1-6 National Electrical Manufacturers Association. (This material is reproduced by permission of the National Electrical Manufacturers Association from NEMA Standards Publication No. FU1, *Low Voltage Cartridge Fuses*, copyright by NEMA.)

Information concerning NEMA standards may be obtained by writing to:

NEMA
1300 North 17th Street
Suite 1847
Rosslyn, Virginia 22209
USA

American National Standards Institute, Inc.

Various working groups in the American National Standards Institute, Inc. (ANSI) study the numerous codes and standards. An American National Standard implies "a consensus of those concerned with its scope and provisions." *The National Electrical Code®* is approved by ANSI and is numbered ANSI/NFPA 70-1993. ANSI's address is:

American National Standards Institute
11 West 42nd Street
New York, New York 10036
USA
Telephone: (212) 642-4900
Fax: (212) 398-0023

Canadian Electricity Association

The Canadian Electricity Association (CEA), founded in 1891, is the national forum and voice of the evolving electricity business in Canada. It contributes to the regional, national, and international success of its members through the delivery of quality value-added services.

At the heart of the CEA is a core of corporate utility member companies accounting for about 95 percent of Canada's installed generating capacity. In addition, major electrical manufacturers, corporate consulting companies, and several hundred other company and individual members are grouped within CEA's broad structure. Additional information concerning the CEA may be obtained from:

Canadian Electricity Association
(Head office)
1155, rue Metcalfe, bureau 1120
Montréal, QC H3B 2V6
Telephone: (514) 866-6121
Fax: (514) 866-1880
e-mail: info@canelect.ca

International Association of Electrical Inspectors

The International Association of Electrical Inspectors (IAEI) is a nonprofit organization. **The IAEI membership consists of electrical inspectors, electricians, contractors, and manufacturers throughout the United States and Canada.** One goal of the IAEI is to improve the understanding of the *Canadian Electrical Code*. Representatives of this organization serve as members of the various panels of the *Canadian Electrical Code* Committee and share equally with other members in the task of reviewing and revising the *Canadian Electrical Code*. The IAEI publishes a bimonthly magazine, *IAEI News*. Additional information concerning the organization may be obtained by writing to:

International Association of
Electrical Inspectors
901 Waterfall Way, Suite 602
Richardson, TX 75080-7702
USA

Illuminating Engineering Society of North America

The Illuminating Engineering Society of North America (IESNA) was formed more than 65 years ago. Its objective is to communicate information about all facets of good lighting practice to its members and to consumers. The IESNA produces numerous publications that are concerned with illumination.

The *IESNA Lighting Handbooks* are regarded as the standard for the illumination industry and contain essential information about light, lighting, and luminaires. Information about publications or membership may be obtained by writing to:

IESNA
120 Wall Street, Floor 17
New York, NY 10005-4001
USA
Tel: (212) 248-5000

Registered Professional Engineer (PEng)

Although the requirements may vary slightly in different jurisdictions, the general statement can be made that a registered professional engineer has demonstrated his or her competence by graduating from college or university and passing a difficult licensing examination. Following the successful completion of the examination, the engineer is authorized to practise engineering under the laws of the province.

It is usually required that a registered professional engineer must supervise the design of any building to be used by the public. The engineer must indicate approval of the design by affixing a seal to the plans.

Information concerning the procedure for becoming a registered professional engineer and a definition of the duties of the professional engineer can be obtained by writing to the provincial government department that supervises licensing and registration.

Underwriters' Laboratories of Canada



Underwriters' Laboratories of Canada (ULC) is a nonprofit organization that operates laboratories and maintains a certification service for the testing and classification of devices, constructions, materials, and systems to determine their relation to life, fire, and property hazards.

ULC also publishes standards, specifications, and classification for products used in connection with on fire, accident, and property hazards.

For more information please write to:

Underwriters' Laboratories of Canada

7 Crouse Road

Scarborough, ON M1R 3A9

Tel: (416) 757-3611

1-800-INFO-ULC

Fax: (416) 757-9540

<http://www.ulc.ca>

e-mail: ulcinfo@ulc.ca

Standards Council of Canada (SCC)



The objective of the Standards Council of Canada is to promote efficient and effective voluntary standardization as a means of advancing the national economy, and benefiting the health, safety, and welfare of the public.

The Council fulfills its mandate by accrediting organizations engaged in standard development, certification, testing and quality, and environmental registration. It is also responsible

for approving National Standards of Canada (NSC).

The Council represents Canada on international standards bodies or agencies and accredits Canadian technical experts to international standards committees. The Council also offers a comprehensive family of information, products and services dealing with standards, regulations, and conformity assessment procedures. Through these activities the Council facilitates Canadian and international trade, protects consumers, and promotes international standards cooperation.

For more information please write to:

Standards Council of Canada

1200-45 O'Conner Street

Ottawa, ON K1P 6N7

Tel: (613) 238-3222

<http://www.scc.ca>

***C.E.C., Part I* Use of SI (Metric) Measurements**

The 1998 *C.E.C., Part I* includes both imperial and metric measurements. The metric system is known as the International System of Units (SI). Fig. 1-7 provides a list of SI units and symbols, as well conversion factors for previously used units.

The 1998 edition of the *C.E.C. Part I* indicates conduit sizes and box capacity in metric units. Conduit sizes are specified by the traditional imperial trade size followed by the metric designator in parentheses. Usable space and capacity of boxes are indicated in millilitres or cubic centimetres followed by the cubic inch value in parentheses. It is important to note that one millilitre is equal to one cubic centimetre.

A metric (SI) measurement is not shown for box size, wire size, horsepower designation for motors, and other "trade sizes" that are nominal rather than exact measurements.

This system is international and many compromises were made to accommodate regional practice. In Canada and the U.S. the practice is to use the period as the decimal marker and the comma to separate a string of numbers into groups of three for easier reading. In many coun-

tries, the comma is used as the decimal marker and spaces are left to separate the string of numbers into groups of three. The SI system, taking something from both, uses the period as the decimal marker and the space to separate a string of numbers into groups of three starting from the decimal point and counting in either direction (e.g., 12 345.789 99). The only exception to this occurs when there are four numbers on either side of the decimal point in the string. In this case, the third and fourth numbers from the decimal point are not separated (e.g., 2015.1415).

In the SI system, the units increase or decrease in multiples of 10, 100, 1000, and so on. For instance, one megawatt (1 000 000 watts) is 1000 times greater than one kilowatt (1000 watts).

The metric prefixes indicate the factor by which the basic unit is multiplied. For example,

adding the prefix kilo to watt forms the new name kilowatt, meaning 1000 watts. Refer to Fig. 1–8 for prefixes used in the SI system.

Certain of the prefixes shown in Fig. 1–8 have a preference in usage. These prefixes are mega, kilo, centi, milli, micro, and nano. Thus commonly used multiples of a metre are a kilometre (1000 metres), a centimetre (0.01 metre), and a millimetre (0.001 metre).

The advantage of the SI system is that the prefixes allow measurements to be written with few zeros, which lessens the possibility of confusion. For example, a four-foot lamp is approximately 1200 millimeters, or 1.2 metres.

Some common measurements of length in the imperial system are shown with their SI equivalents in Fig. 1–9.

Symbol	SI Unit	Multiplying Factor for Conversion to Previously Used Unit	Previously Used Unit
A	ampere	1	ampere
cm ³	cubic centimetr	0.061	cubic inch
°	degree (angle)	1	degree
°C	degree Celsius (temperature)	1.8 plus 32	degree Fahrenheit
h	hour(s)	1	hour(s) (time)
min	minute (time)	1	minute
Hz	hertz	1	cycle per second
MHz	megahertz	1	megacycles per second
J	joule	0.7376	foot-pound
kg	kilogram	2.205	pound
kJ	kilojoule	737.6	foot-pound
km	kilometre	0.621	mile
kPa	kilopascal	0.295	inch of mercury
		0.334	foot of water
		0.145	pound per square inch (psi)
lx	lux	0.093	foot-candle
L	litre	0.220	gallon
m	metre	3.281	feet
m ²	square metre	10.764	square feet
m ³	cubic metre	35.315	cubic feet
mm	millimetre	0.03937	inch
mm ²	square millimetre	0.00155	square inch
Pa	pascal	0.000295	inch of mercury
		0.000334	foot of water
		0.000145	pound per square inch (psi)
Ω	ohm	1	ohm
V	volt	1	volt
W	watt	1	watt
μF	microfarad	1	microfarad

Fig. 1–7 Symbols for SI units.

mega	1 000 000	(one million)
kilo	1 000	(one thousand)
hecto	100	(one hundred)
deka	10	(ten)
	1	(one)
deci	0.1	(one-tenth) (1/10)
centi	0.01	(one-hundredth) (1/100)
milli	0.001	(one-thousandth) (1/1 000)
micro	0.000 001	(one-millionth) (1/1 000 000)
nano	0.000 000 001	(one-billionth) (1/1 000 000 000)


Fig. 1-8 SI prefixes and their values.

one inch	=	2.54	centimetres
	=	25.4	millimetres
	=	0.025 4	metre
one foot	=	12	inches
	=	0.304 8	metre
	=	30.48	centimetres
	=	304.8	millimetres
one yard	=	3	feet
	=	36	inches
	=	0.914 4	metre
	=	914.4	millimetres
one metre	=	100	centimetres
	=	1 000	millimetres
	=	1.093	yards
	=	3.281	feet
	=	39.370	inches


Fig. 1-9 Conversion factors for some common measurements of length.

REVIEW


Note: Refer to the *Canadian Electrical Code, Part I* or the plans where necessary.

- 

1. What section of the specification contains a list of contract documents?

- 

2. The requirement for temporary light and power at the job site will be found in what portion of the specification?

- 

3. The electrician uses the Schedule of Drawings for what purpose?



Complete the following items by indicating the letter(s) designating the correct source(s) of information for:

- | | | |
|---------------------------------|-------|-------------------------------|
| 4. Room width | _____ | a. Site plan |
| 5. Grading elevations | _____ | b. Architectural floor plan |
| 6. Ceiling height | _____ | c. Elevations |
| 7. Panelboard schedules | _____ | d. Details |
| 8. Exterior wall finishes | _____ | e. Electrical layout drawings |
| 9. View of interior wall | _____ | f. Specification |
| 10. Electrical outlet location | _____ | g. Sections |
| 11. Electrical receptacle style | _____ | h. Electrical symbol schedule |
| 12. Swing of door | _____ | |



Match the acronyms on the left with the phrase or word that best relates to that organization, document, or person.

- | | | |
|------------|-------|-----------------------------|
| 13. NFPA | _____ | a. Lighting handbooks |
| 14. C.E.C. | _____ | b. Seal |
| 15. ULC | _____ | c. Manufacturers' standards |
| 16. NEMA | _____ | d. Eleven-volume fire code |
| 17. IAEI | _____ | e. Listing service |
| 18. PE | _____ | f. Electrical inspectors |
| 19. IESNA | _____ | g. Electrical code |
| 20. CSA | _____ | |



Write the appropriate letters (*a*, *b*, or *c*) to indicate the proper interpretation of the *C.E.C., Part I*.

- | | | |
|---------------------------|-------|-----------------------|
| 21. Must be done | _____ | a. shall |
| 22. May be done | _____ | b. special permission |
| 23. Up to the electrician | _____ | c. not allowed |
| 24. Is required | _____ | d. allowed |
| 25. Is allowed | _____ | |