Terminology and Symbols: Electricity and Electronics

Unit: Graphic Agility

Problem Area: Industrial Applications—Terminology Symbols

Lesson: Terminology and Symbols: Electricity and Electronics

Student Learning Objectives.

Instruction in this lesson should result in students achieving the following objectives:

1. **Review basic electrical systems.**
2. **Interpret electrical terminology and symbols.**

Resources.

The following resources may be useful in teaching this lesson:

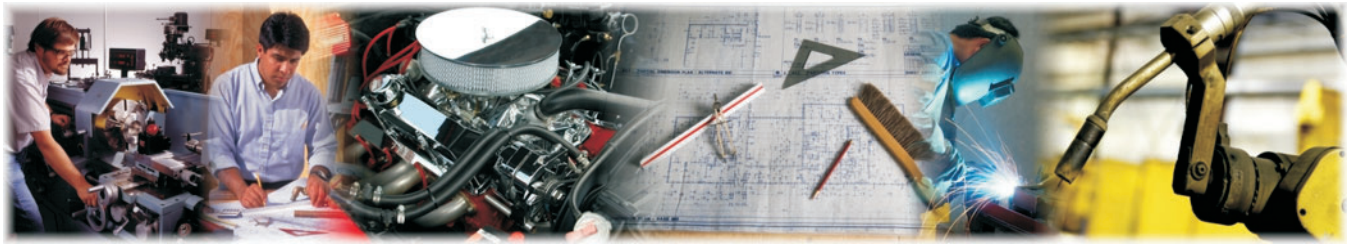
"Electrical Glossary," *1-800-any-tyme*. Accessed Aug. 26, 2012. http://electrical.1800anytyme.com/electrical-glossary.php.

The Engineering ToolBox. Accessed Aug. 28, 2012. http://www.engineeringtoolbox.com/electrical-systems-t_33.html.

Linsley, Trevor. *Basic Electrical Installation Work*, 6th ed. Elsevier, 2011.

Madsen, David A., and Alan Jefferis. *Print Reading for Architecture and Construction Technology,* 2nd ed. Delmar Cengage, 2004.

Young & Company. Accessed Aug. 28, 2012. http://www.youngco.com/young2.asp?ID=4&Type=3.



Equipment, Tools, Supplies, and Facilities

- ✓ Overhead or PowerPoint projector
- ✓ Visual(s) from accompanying master(s)
- ✓ Copies of sample test, lab sheet(s), and/or other items designed for duplication
- ✓ Materials listed on duplicated items
- ✓ Computers with printers and Internet access
- ✓ Classroom resource and reference materials

Key Terms.

The following terms are presented in this lesson (shown in bold italics):

- amperes
- amps
- circuit
- circuit breaker
- electric panel
- electrical connector
- EMT conduit
- four-way switch
- fuse
- ground
- home run
- junction
- receptacle
- Romex wiring
- switch
- switch-leg
- tag
- three-way switch
- two-gang
- wire gauge
- wire nuts

Interest Approach.

Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

> *Approach the topic of electrical terminology and symbols by helping the students understand what a useful resource this knowledge becomes on the job. These terms and symbols are a new code, a new language, or a type of industry shorthand. Explain that with this knowledge, a person can begin to understand how electrical systems work and how to effectively and clearly communicate with electrical engineers, technicians, installers/contractors, architects, and drafters.*

CONTENT SUMMARY AND TEACHING STRATEGIES

Objective 1: Review basic electrical systems.

Anticipated Problem: Which terms and symbols are used in basic electrical systems?

I. Basic electrical systems

A. Electrical systems for buildings and for equipment may include a large range of electrical devices and wiring. It is not practical to draw all of the devices and wires as they actually appear. It would require too much space on the plans and prints and is not necessary if people know the basic standard symbols developed to indicate each device and wire.

1. Electrical systems in a building require electric panels, junctions, receptacles, wiring, switches, light fixtures, and appliances.
   a. An ***electric panel*** (service panel) is the distribution box that sends the electric current through different circuits.
   b. ***Circuits*** are the complete path of electric current, including the electric energy source.
   c. A ***junction*** (junction box) is a metal or plastic container used to hold electrical connections.
   d. A ***receptacle*** (outlet) is a fitting in a wiring system where current is directed to operate electrical devices. The wiring diagram should show which lights are controlled by which switches. It is not necessary to show the wiring in its exact path. A line in the shape of an arc is drawn that connects the appropriate switch to its fixture.
2. The switches and outlets or receptacles are shown as symbols in their appropriate position. Electrical fixtures are also shown as symbols in their correct place. When an exact location is important, it will be dimensioned. The engineer draws most major appliances as they actually appear to make sure they fit. The same symbols and abbreviations drawn on plans are located in a schedule or legend. There they are defined, and more specific information is provided (e.g., type, color, and manufacturer).

B. Symbols and terms are used to simplify and organize drawings. Knowing what each symbol and term means allows a person to interpret electrical documents. There is no mandated set of standard symbols, so some designers and engineers modify them. Therefore, it is important to understand the specific symbols being used on each project. To ensure accuracy, it is necessary to check the symbol legend to be certain of meanings.

1. Some electric symbols are generic and require an additional tag on the symbol. A ***tag*** may be a line through the symbol, a side shaded, a number, or a letter. A tag allows symbols to be more specific for different uses.

2. Abbreviations (e.g., those for receptacles or outlets) are drawn along with the electrical symbols. These abbreviations designate that the outlet is to be used for a specific appliance.
   a. A receptacle dedicated for a refrigerator would include the abbreviation "REF" next to the symbol.
   b. When a receptacle needs to be waterproof, it would have the abbreviation "WP" next to it.

Teaching Strategy: *Bring in a set of real electrical construction drawings, or use VM–A. Then have a class discussion about the ways in which the symbols and terms are used on the drawing.*

Objective 2: Interpret electrical terminology and symbols.

Anticipated Problem: What is the basic electrical terminology and symbols?

II. Electrical terminology and symbols have developed over the years. Although there is no specific set for every designer, engineer, builder, and fabricator, the following are common in the industry.

A. Electrical terminology

1. An ***electrical connector*** is a device used to tie electric lines to electrical boxes or junctions. It is used with Romex wiring and with EMT conduit.
2. ***Romex wiring*** (non-metallic sheathed cable) is a type of electrical wire covered with a non-metallic material; it has a plastic sheathing wrapped around several wires. The gauge and amount of wires within the plastic wrap ranges, depending on use.
3. ***EMT conduit*** (electrical metal tubing) is metal tubing with thin walls and is used to run electrical wiring. The wiring is pulled through the conduit after the conduit is properly located. The metal tubing protects the wiring and is fitted together with connectors.
4. A ***wire gauge*** is a measure of the thickness of the wire's diameter. The gauge determines how much electric current the wire can safely carry. A thicker wire can carry more current.
5. A breaker panel (circuit box) is the electrical box that distributes electricity entering the building to each branch circuit (each plug and switch). It is made up of ***circuit breakers***—safety devices that detect too much current in a circuit.
6. A ***fuse*** is an electrical safety device that limits the amount of current flow. Once the flow (measured in amps) reaches a certain amount, the fuse will melt and stop the electric flow.
7. ***Amperes*** is a measurement of the rate at which electricity flows through a wire, a piece of machinery, or an appliance. Another name for amperes is

amps. It is the measure (unit) of electric current passing a point in an electric circuit per unit of time (meter-kilogram-second system).

8. A ***ground*** is a direct electrical connection to the earth; it drains away any unwanted buildup of electrical charge. Grounding minimizes the effect of a lightning strike and eliminates electrostatic buildup in appliances, computer systems, and other electronic devices.
9. A ***home run*** is the main electrical line that runs from the electric panel to the first device on a circuit. It is the cable that carries power from the main circuit breaker panel to the first electrical box, plug, or switch in the circuit.
10. A ***switch*** is a device that makes, breaks, or changes the course of an electric circuit; it interrupts and manipulates current in circuits. A switch consists of a power wire and a switch leg.
11. A ***switch-leg*** is a control leg of the branch circuit. It is the part of a circuit that runs from a lighting outlet box to a light fixture or lamp holder down to an outlet box that contains the wall switch that turns the light or other load on or off.
12. A ***two-gang*** is a type of electrical box that can hold two switches, two receptacles, or one switch and one receptacle.
13. A ***three-way switch*** (a single-pole double-throw switch) is a light switch that has three terminals (screws, plus a ground screw); this allows a fixture to have multiple electricity sources. It is used to control a circuit from two locations.
14. A ***four-way switch*** is a light switch that has four terminals (screws, plus a ground screw); it allows a fixture to have multiple switches and one is able to turn a fixture on or off at three or more locations. Four-ways are used between two three-way switches to control a light from a third (or more) location(s).
15. ***Wire nuts*** are twist-on plastic connectors used to fasten two or more electrical conductors together; they connect bare wires.

B. Electrical symbols and abbreviations

1. Symbols used in an electrical plan are not always the same as those used in elevation or section drawings. Typically, symbols are graphics that may contain letters or numbers. In elevation drawings, electrical elements or fixtures are often shown as they actually appear.
2. Symbols and graphic representations are used to designate the circuiting.
3. Electrical symbols and terms use a typical set of abbreviations next to the electrical symbols. They are used to represent and clarify specific switch types, receptacles, fixtures, etc. A full range of electrical symbols are used to represent receptacles.
4. Symbols for various electrical power equipment, remote controls, and motor types are common in the industry.
5. Electrical distribution and lighting fixture symbols are commonly used in drawings.

Teaching Strategy: *Use VM–B through VM–G to illustrate various electrical terms and symbols. Take a field trip to a local electrical engineer's office to get a firsthand*

look at how electrical symbols and terms are used in the profession. Have students prepare a list of questions prior to the visit. Assign LS–A, in which students use VM–H.

Review/Summary. Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions at the ends of chapters in the textbook may be used in the Review/Summary.

Application. Use the included visual master(s) and lab sheet(s) to apply the information presented in the lesson.

Evaluation. Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activities. A sample written test is provided.

Answers to Sample Test:

Part One: Matching

1. f
2. a
3. d
4. e
5. c
6. b

Part Two: True/False

1. T
2. F
3. T
4. F
5. T
6. F

Part Three: Short Answer

Answers will vary but should include four of the following: circuiting, switches, receptacles, light fixtures, power equipment, electric motors, and electric distribution.

Sample Test

Name _____

Terminology and Symbols: Electricity and Electronics

Part One: Matching

Instructions: **Match the term with the correct definition.**

a. junction
b. fuse
c. switch-leg
d. wire gauge
e. amperes
f. electric panel

_____1. The distribution box that sends the electric current through different circuits

_____2. A metal or plastic container used to hold electrical connections

_____3. A measure of the thickness of the wire's diameter

_____4. A measurement of the rate at which electricity flows through a wire or a piece of machinery or an appliance

_____5. A control leg of the branch circuit

_____6. An electrical safety device that limits the amount of current flow

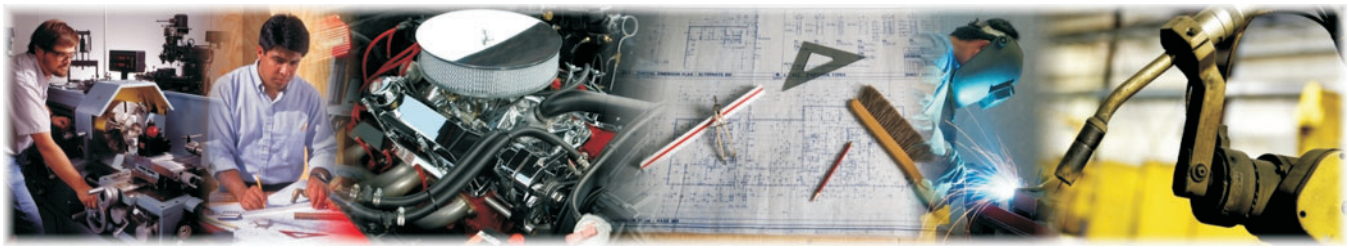
Part Two: True/False

Instructions: **Write *T* for true or *F* for false.**

_____1. Wire nuts are twist-on connectors used to fasten two or more electrical conductors together.

_____2. A three-way switch is a light switch that connects three light fixtures.

_____3. A two-gang is an electrical box that can hold two switches, two receptacles, or one switch and one receptacle.



_____4. Romex wiring is metal tubing with thin walls used to run electrical wiring.

_____5. A receptacle is a fitting in a wiring system where current is directed to operate electrical devices.

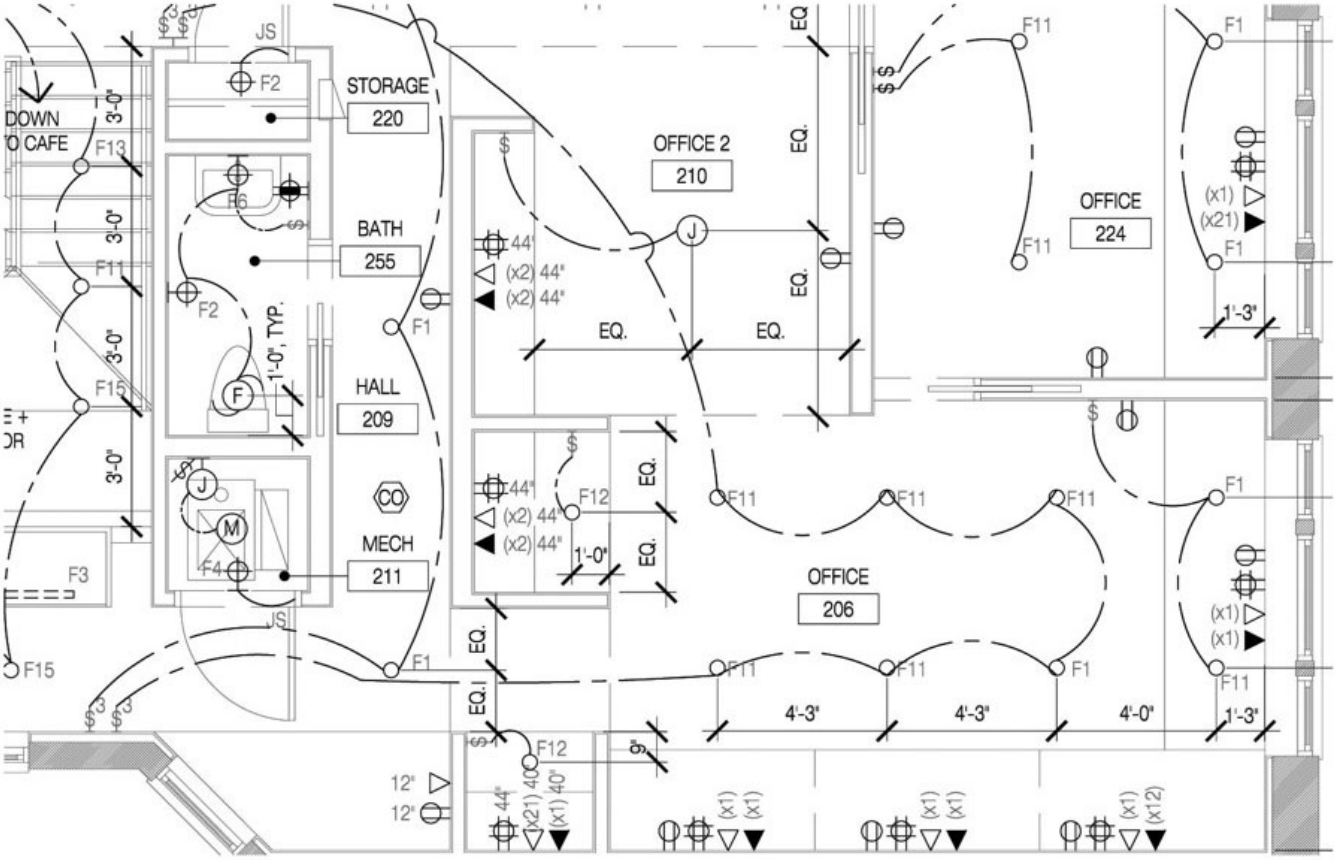
_____6. EMT conduit is a type of electrical wire that has a non-metallic sheath; it has a plastic sheathing wrapped around several wires.

Part Three: Short Answer

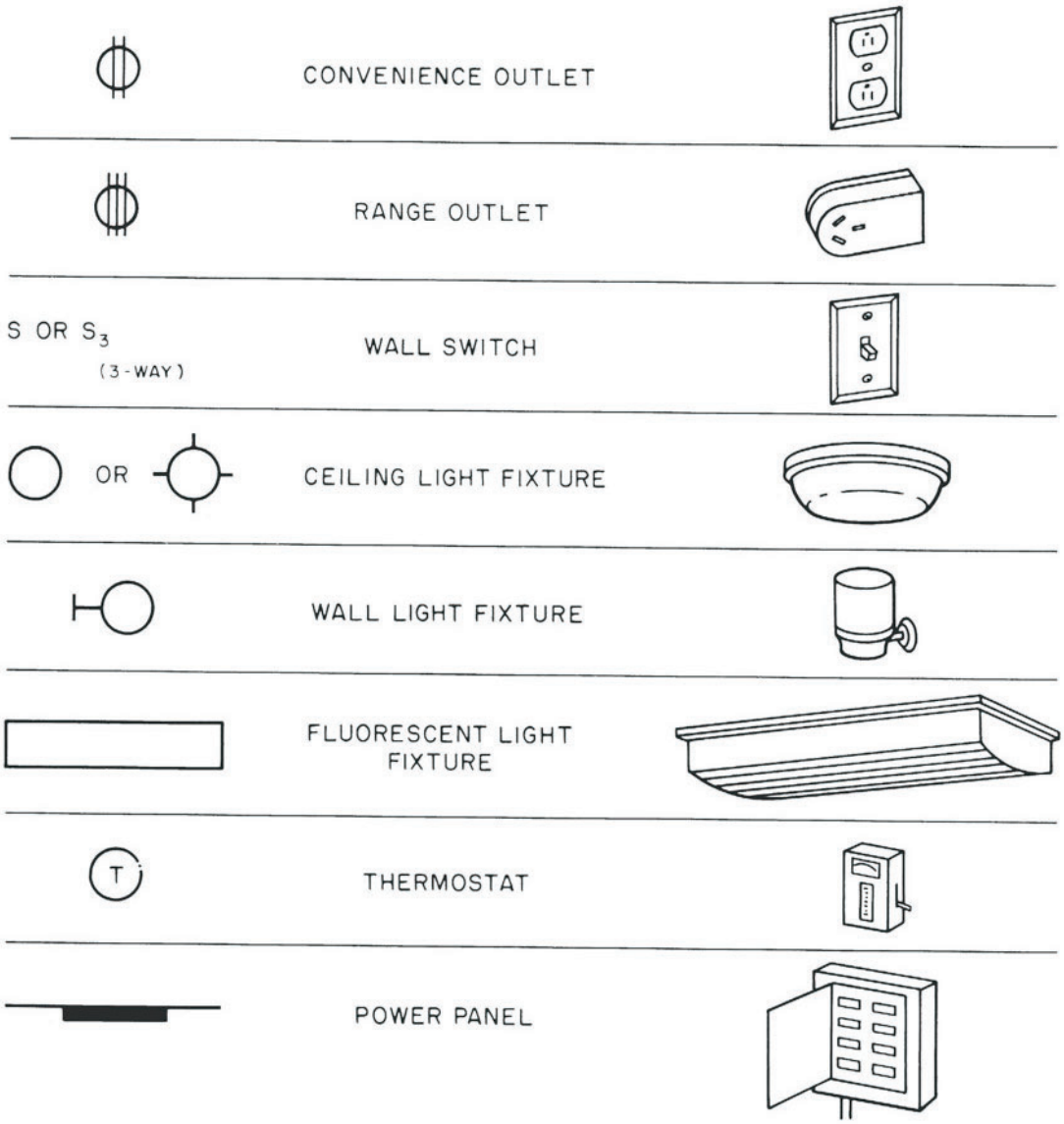
Instructions: **Answer the following.**

List four electrical features on a drawing that are represented with symbols.

ELECTRICAL PLAN

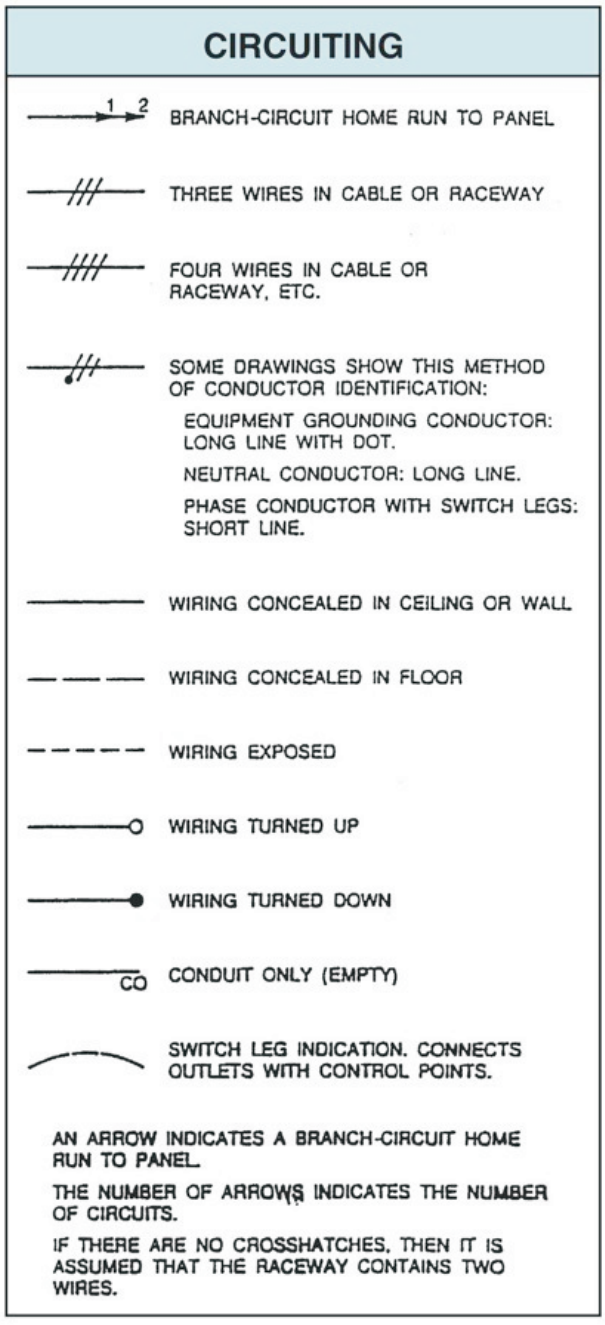


ELECTRICAL SYMBOLS, TERMS, AND IMAGES: OUTLETS, FIXTURES, THERMOSTAT, AND POWER PANEL



(Courtesy, Shanghai Jiao Tong University, Shanghai, China)

ELECTRICAL SYMBOLS, TERMS, AND IMAGES: CIRCUITING



(Courtesy, Shanghai Jiao Tong University, Shanghai, China)

ELECTRICAL SYMBOLS, TERMS, AND IMAGES: ABBREVIATIONS WITH SYMBOLS

ELECTRICAL ABBREVIATIONS (Apply only when adjacent to an electrical symbol.)	
Central Switch Panel	CSP
Dimmer Control Panel	DCP
Dust Tight	DT
Emergency Switch Panel	ESP
Empty	MT
Explosion Proof	EP
Grounded	G
Night Light	NL
Pull Chain	PC
Rain Tight	RT
Recessed	R
Transfer	XFER
Transformer	XFRMR
Vapor Tight	VT
Water Tight	WT
Weather Proof	WP

ELECTRICAL SYMBOLS	
Switch Outlets	
Single-Pole Switch	S
Double-Pole Switch	S_2
Three-Way Switch	S_3
Four-Way Switch	S_4
Key-Operated Switch	S_K
Switch and Fusestat Holder	S_{FH}
Switch and Pilot Lamp	S_P
Fan Switch	S_F
Switch for Low-Voltage Switching System	S_L
Master Switch for Low-Voltage Switching System	S_{LM}
Switch and Single Receptacle	
Switch and Duplex Receptacle	
Door Switch	S_D
Time Switch	S_T
Momentary Contact Switch	S_{MC}
Ceiling Pull Switch	
"Hand-Off-Auto" Control Switch	
Multi-Speed Control Switch	
Push Button	

ELECTRICAL SYMBOLS, TERMS, AND IMAGES: RECEPTACLE OUTLETS

Receptacle Outlets

Where weather proof, explosion proof, or other specific types of devices are to be required, use the upper-case subscript letters. For example, weather proof single or duplex receptacles would have the uppercase WP subscript letters noted alongside of the symbol. All outlets should be grounded.

Single Receptacle Outlet

Duplex Receptacle Outlet

Triplex Receptacle Outlet

Quadruplex Receptacle Outlet

Duplex Receptacle Outlet (Split Wired)

Triplex Receptacle Outlet (Split Wired)

250-V Receptacle Single Phase. Use Subscript Letter to Indicate Function (DW—Dishwasher, RA—Range, CD—Clothes Dryer) or Numeral (with explanation in symbol schedule).

250-V Receptacle Three Phase

Clock Receptacle

Fan Receptacle

Floor Single Receptacle Outlet

Floor Duplex Receptacle Outlet

Floor Special-Purpose Outlet *

Floor Telephone Outlet (Public)

Floor Telephone Outlet (Private)

Example of the use of several floor outlet symbols to identify a 2, 3, or more gang flow outlet.

Underfloor duct and junction box for triple, double, or single duct system as indicated by the number of parallel lines.

Example of use of various symbols to identify location of different types of outlets or connections for underfloor duct or cellular floor systems.

Cellular Floor Header Duct

*Use numeral keyed to explanation in drawing list of symbols to indicate usage.

(Courtesy, Shanghai Jiao Tong University, Shanghai, China)

ELECTRICAL SYMBOLS, TERMS, AND IMAGES: POWER EQUIPMENT, REMOTES AND MOTOR TYPES

Power Equipment

Electric Motor (hp As Indicated)	1/4
Power Transformer	
Pothead (Cable Termination)	
Circuit Element (e.g., Circuit Breaker)	CB
Circuit Breaker	
Fusible Element	
Single-Throw Knife Switch	
Double-Throw Knife Switch	
Ground	
Battery	
Contactor	C
Photoeletric Cell	PE
Voltage Cycles, Phase	Ex: 480/60/3
Relay	R
Equipment Connection (As Noted)	▲

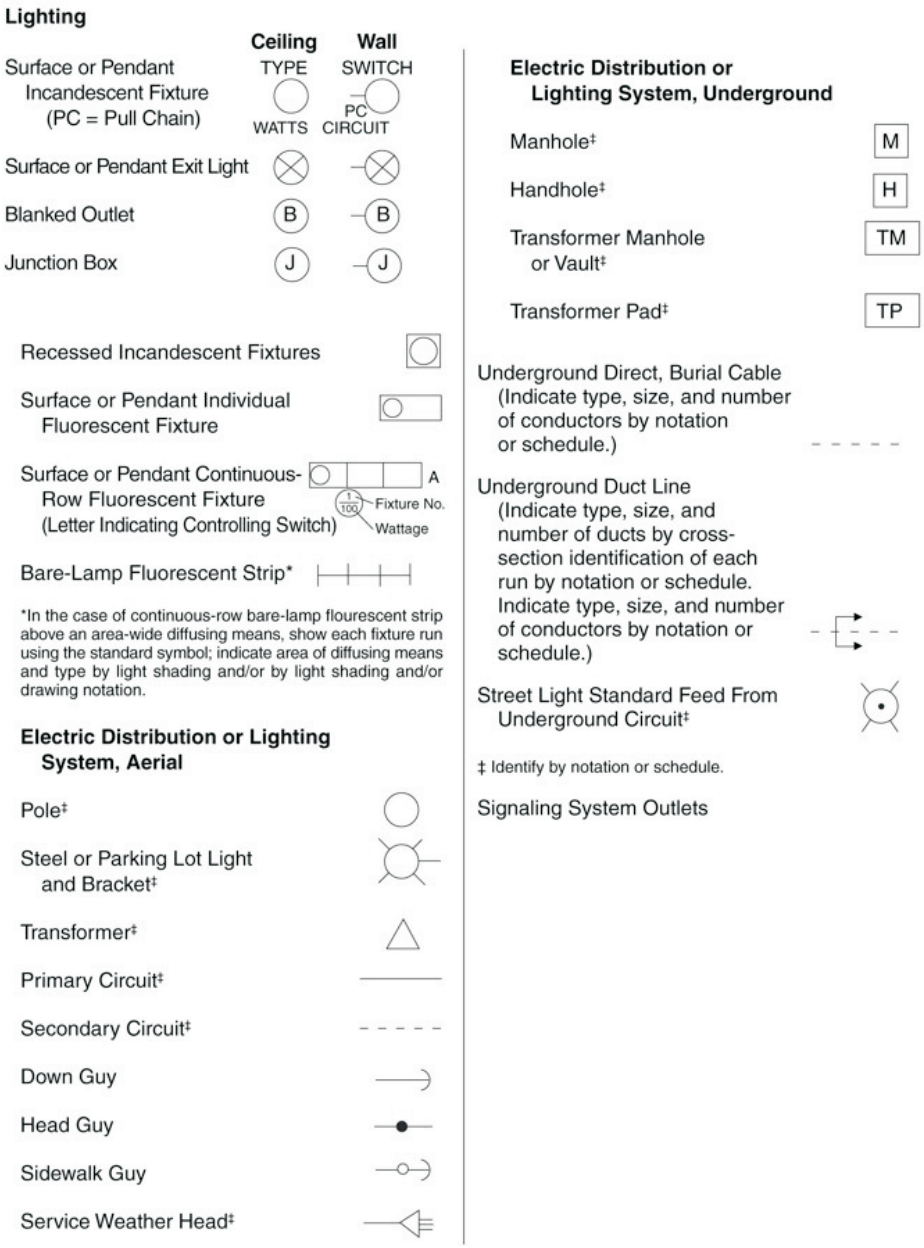
*Note: Use heavy weight line to identify service and leaders. Indicate empty conduit by notation CO (conduit only).
‡ Note: any circuit without further identification indicates two-wire circuit for a greater number of wires, indicate with cross lines, e.g.:

Neutral wire may be shown longer. Unless indicated otherwise, the wire size of the circuit is the minimum size required by the specification. Identify different functions of wiring system, e.g. signaling system by notation or other means.
‡ Identify by notation or schedule.

Remote Control Stations for Motors or Other Equipment

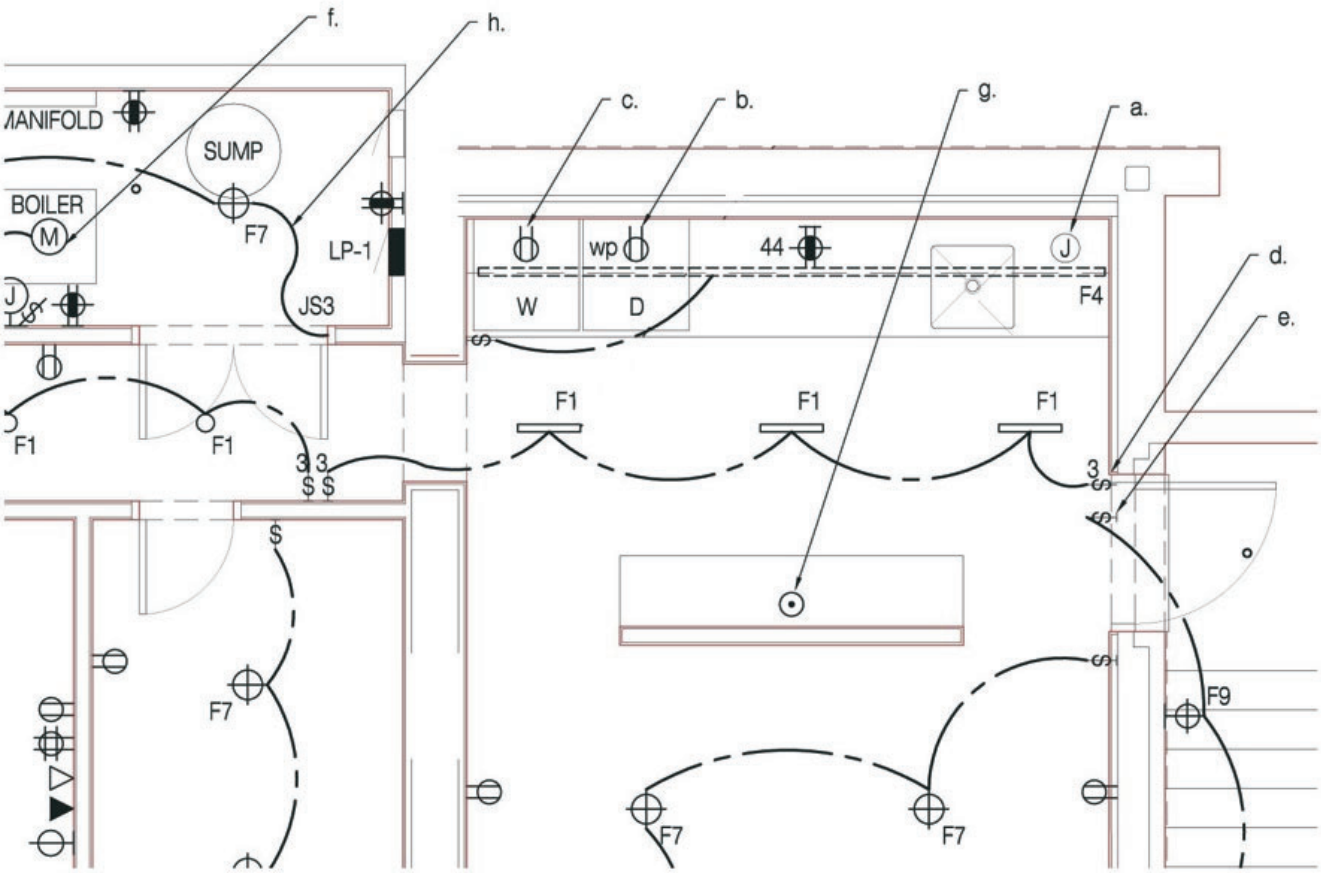
Push Button Station	PB
Float Switch (Mechanical)	F
Limit Switch (Mechanical)	L
Pneumatic Switch (Mechanical)	P
Electric Eye (Beam Source)	
Electric Eye (Relay)	
Temperature Control Relay Connection (3 Denotes Quantity.)	R 3
Solenoid Control Valve Connection	S
Pressure Switch Connection	P
Aquastat Connection	A
Vacuum Switch Connection	V
Gas Solenoid Valve Connection	G
Flow Switch Connection	F
Timer Connection	T
Limit Switch Connection	L

ELECTRICAL SYMBOLS, TERMS, AND IMAGES: LIGHTING AND DISTRIBUTION



(Courtesy, Shanghai Jiao Tong University, Shanghai, China)

ELECTRICAL PLAN



LS–A

Name _____

Use Electrical Symbols and Terms

Purpose

The purpose of this activity is to interpret abbreviations and symbols on an electrical plan.

Objectives

1. Read an electrical plan.
2. Identify electrical symbols and abbreviations on an electrical plan.

Materials

- VM–H (one copy per student or a projected image)
- writing utensil

Procedure

1. Work independently to complete this lab sheet.
2. The electrical plan (VM–H) includes eight symbols and abbreviations for you to identify. An arrow and a leader line (a line with a letter at the end) indicate which symbols and terms you need to identify.
3. List the electrical abbreviation and/or what each symbol represents in the spaces provided below.

   a.
   b.
   c.
   d.
   e.
   f.
   g.
   h.

4. Optional: Label other abbreviations and symbols shown on the electrical plan using a leader line.
5. Turn in your completed lab sheet to your instructor.