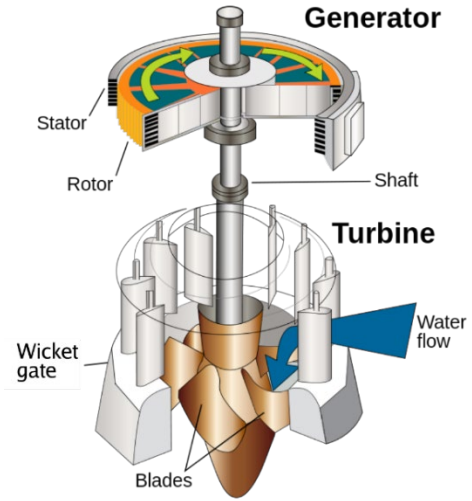
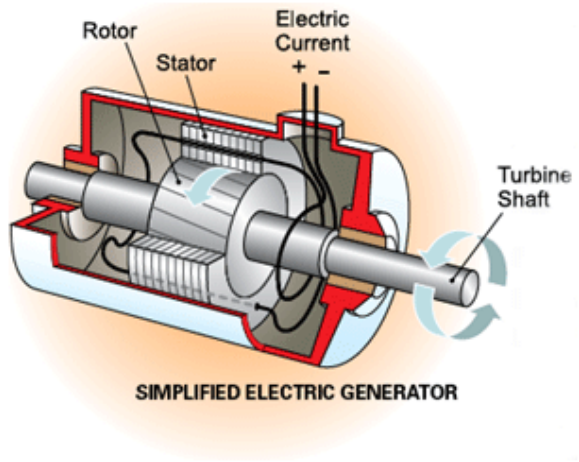
Power Distribution

Power Distribution

Power Generation

- ❑ Electricity generation is the process of generating electrical energy from other forms of energy.
- ❑ Almost all electrical power on Earth is generated with a turbine of some type.
- ❑ Turbines are commonly driven by wind, water, steam or burning gas.
- ❑ The turbine drives an electric generator.
- ❑ A generator converts mechanical energy into electricity by magnetic induction.

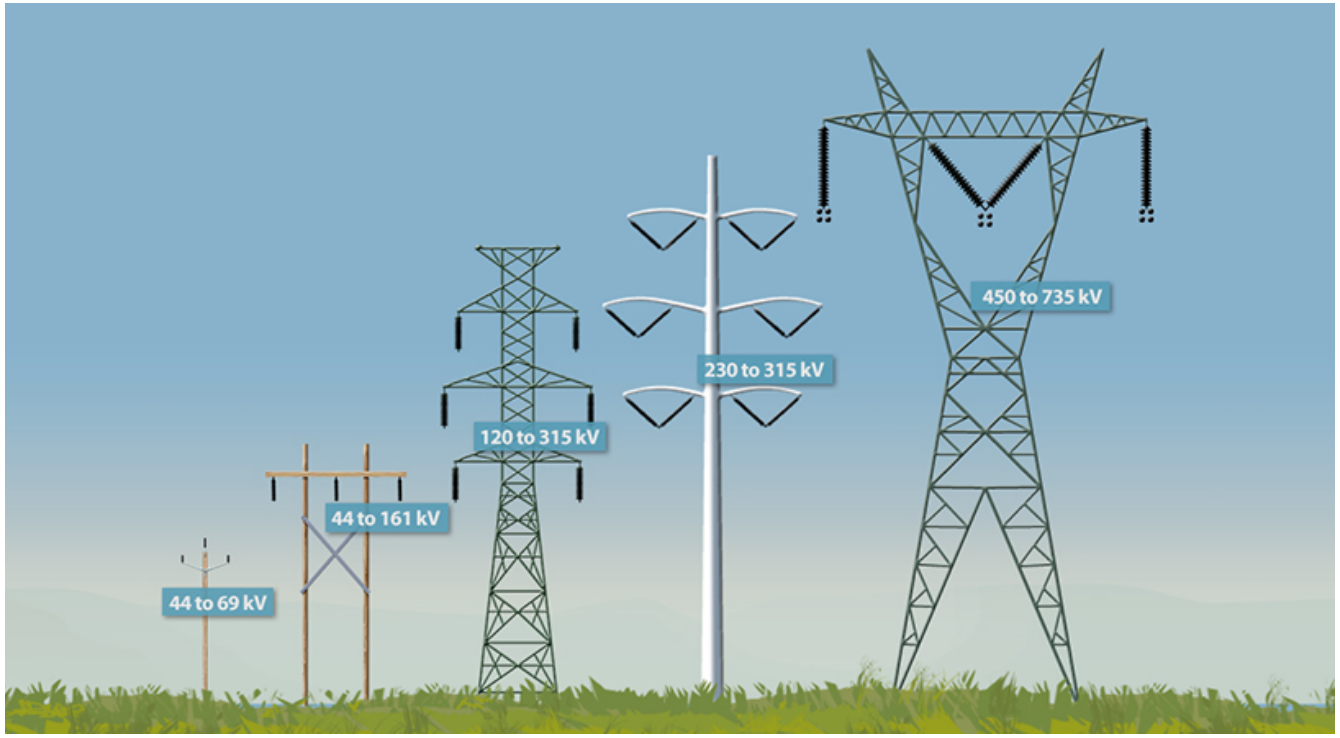




Power Distribution

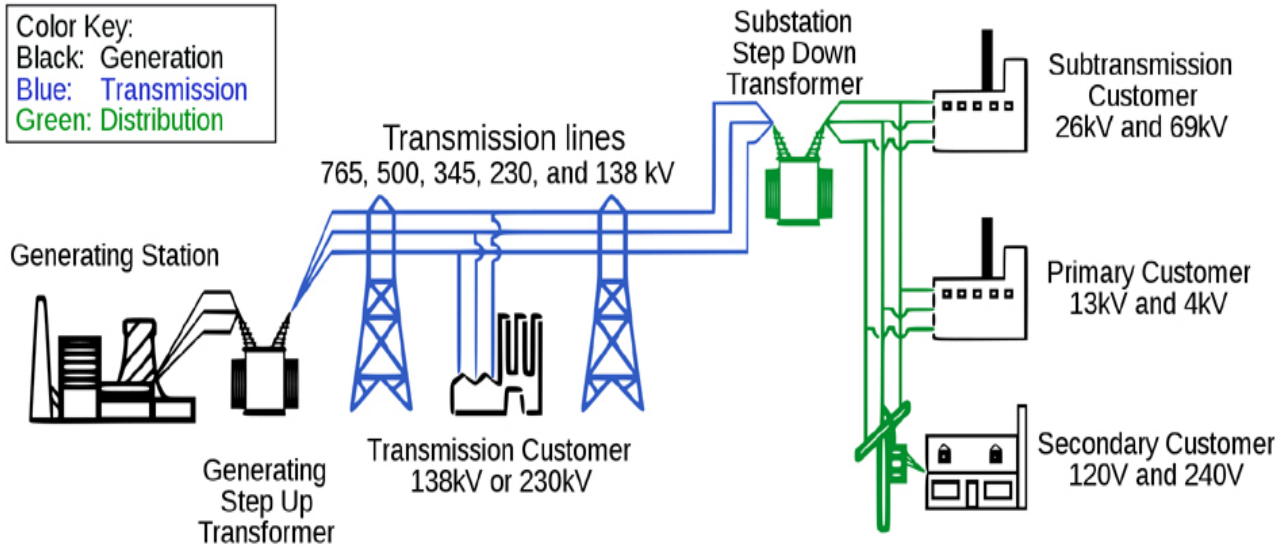
Power Transmission Lines

- Transmission lines are sets of wires, called conductors, that carry electric power from generating plants to the substations that deliver power to customers. At a generating plant, electric power is “stepped up” to several thousand volts by a transformer and delivered to the transmission line.



Power Distribution

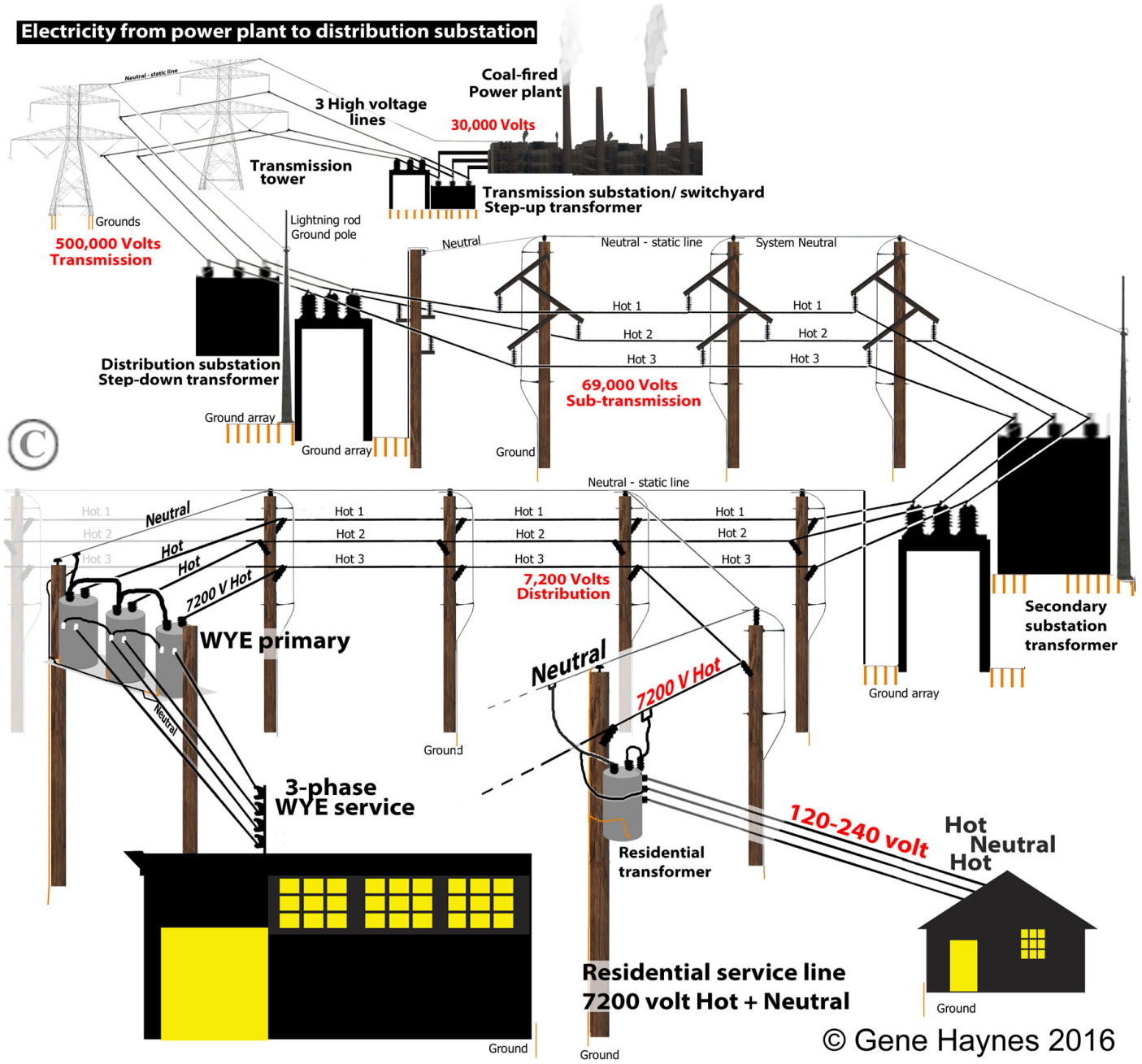
Power Generation and Transmission



The Grid

Substation

Power Distribution

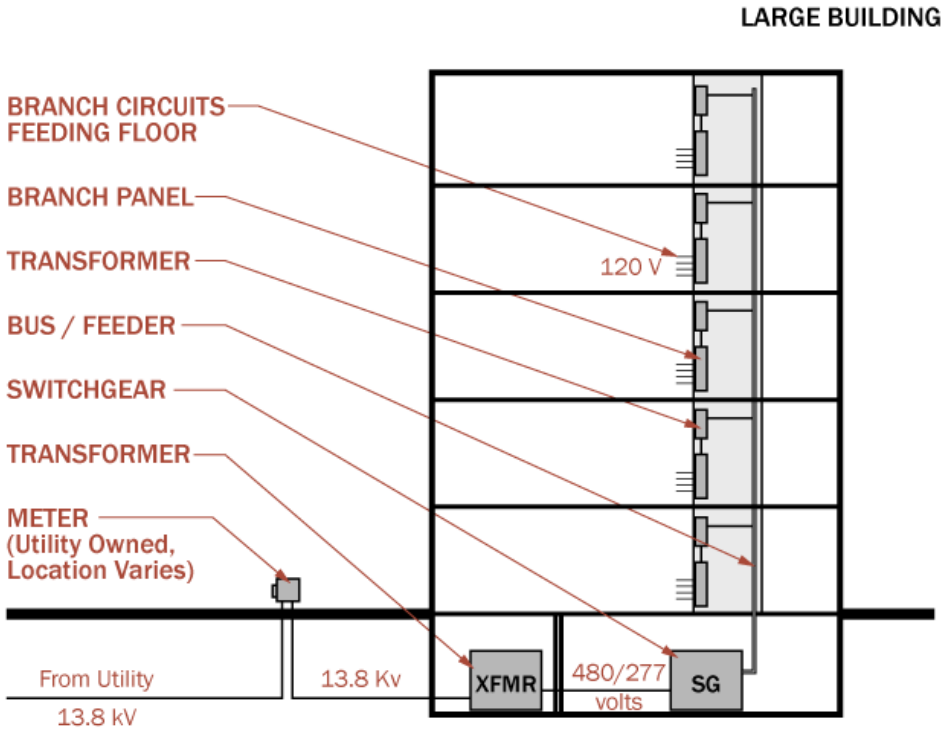


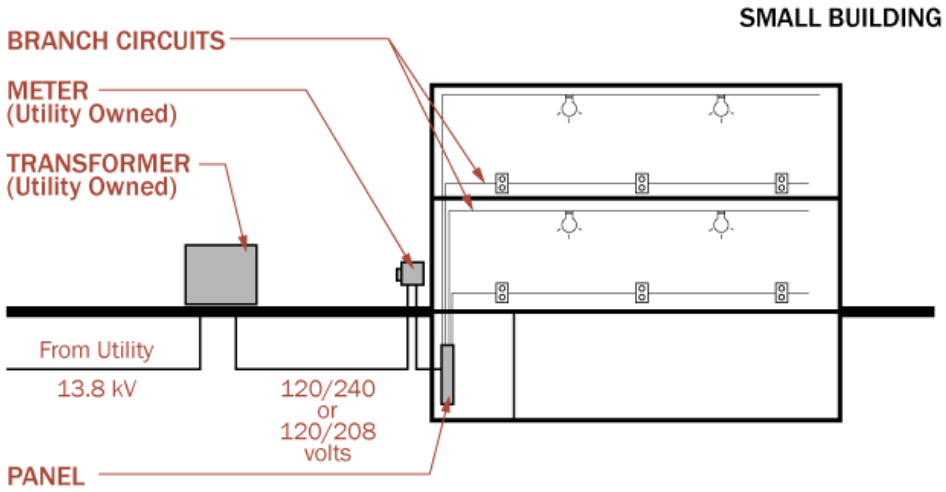
Power Distribution

Low Voltage Distribution Equipment

Table 4-1: Standard nominal three-phase system voltages per ANSI C84.1-1989

Voltage Class	Three-wire	Four-wire
Low Voltage		208 Y/120
	240	240/120
	480	480 Y/277
	600	
Medium Voltage	2,400	
	4,160	4,160 Y/2400
	4,800	
	6,900	
		8,320 Y/4800
		12,000 Y/6,930
		12,470 Y/7,200
		13,200 Y/7,620
	13,800	13,800 Y/7,970
		20,780 Y/12,000
		22,860 Y/13,200
	23,000	
		24,940 Y/14,400
	34,500	34,500 Y/19,920
	46,000	
	69,000	
High Voltage	115,000	
	138,000	
	161,000	
	230,000	
Extra-High Voltage	345,000	
	500,000	
	765,000	
Ultra-High Voltage	1,100,000	





Power Distribution

Service Equipment

NEC Article 100 Definitions

Service Equipment - The necessary equipment, usually consisting of circuit breakers or switches and fuses and their accessories, connected to the load end of service conductors to a building or other structure, or an otherwise designated area, and intended to constitute the main control and cutoff of the supply. Service equipment does not include the metering equipment, such as the meter and/or meter enclosures.

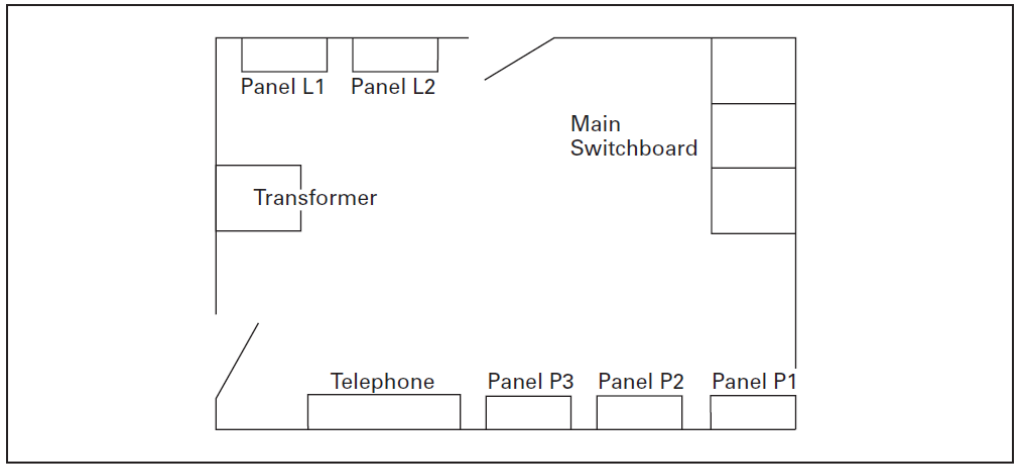
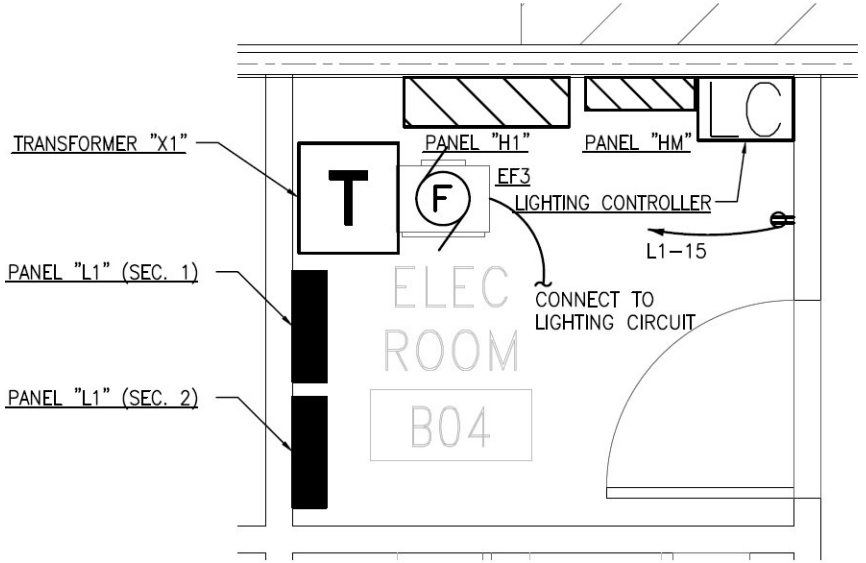


Figure 21.6-1. Traditional Electrical Room—Plan View



PARTIAL PLAN - ELECTRICAL ROOM

SCALE: 1/2" = 1'–0"

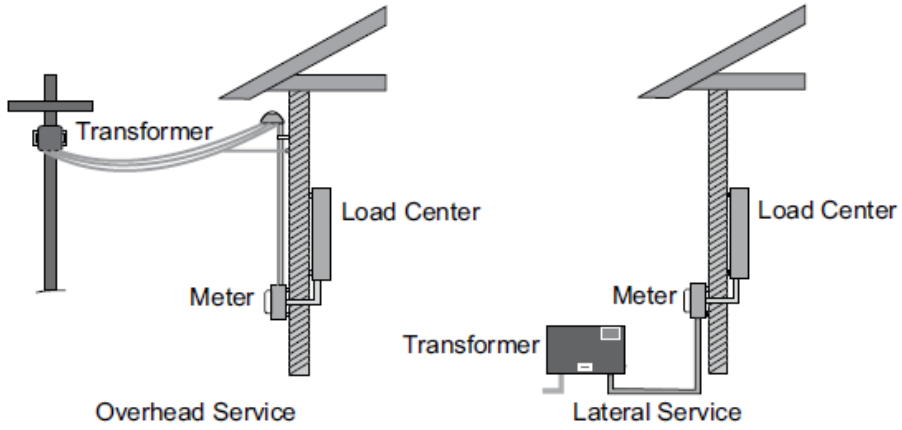
Power Distribution

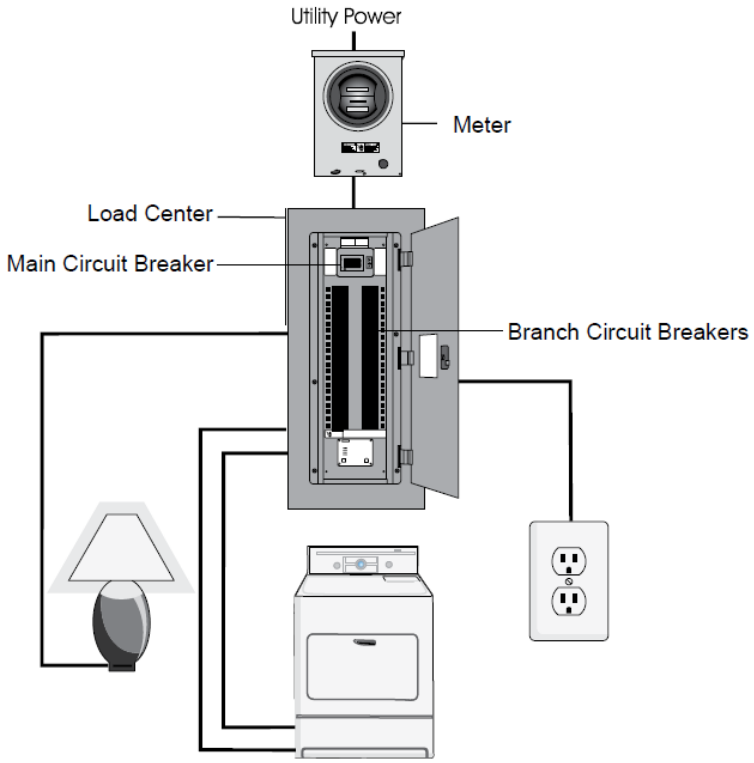
Incoming Service - Power

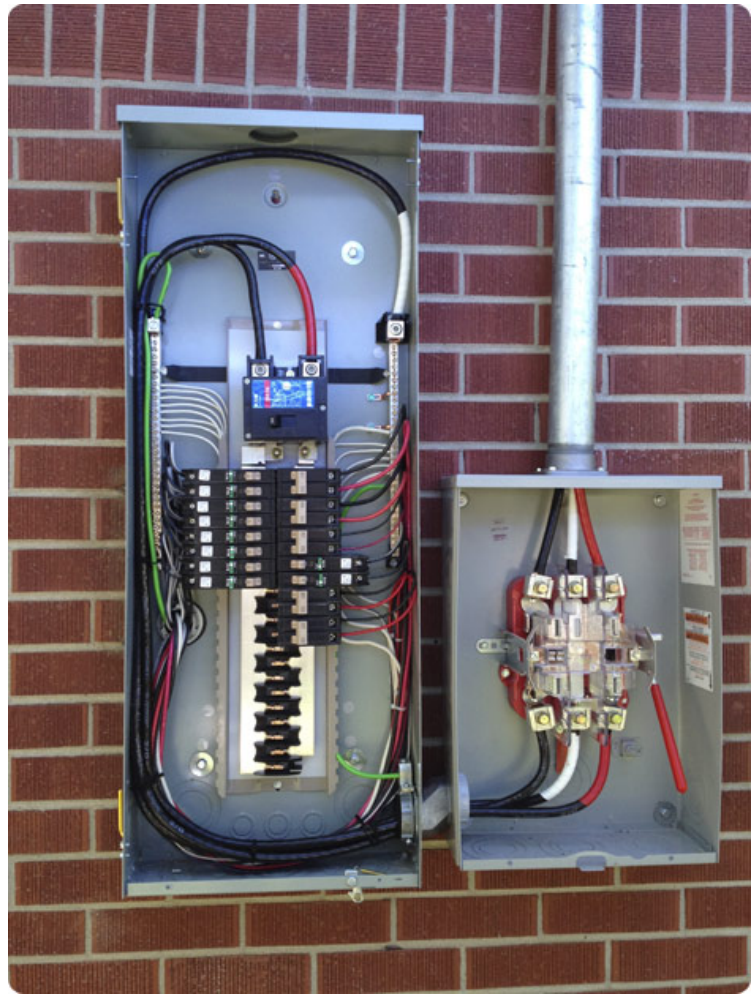
- ❑ All buildings have an electrical service.
- ❑ A utility transformer is installed outside the building on a pad (site drawing) or pole.
- ❑ Primary service (utility company) is shown on the One-line Diagram, Single-line Diagram, or Riser Diagram.

Power Distribution

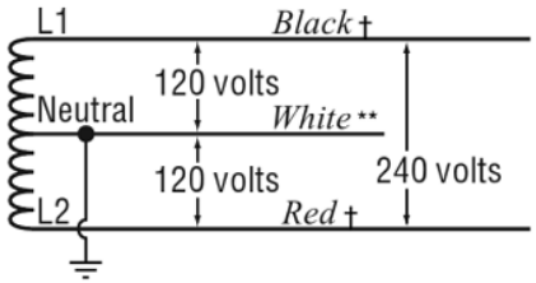
Common Electrical Distribution Systems
Residential







120/240-Volt, Single-Phase, Three-Wire System



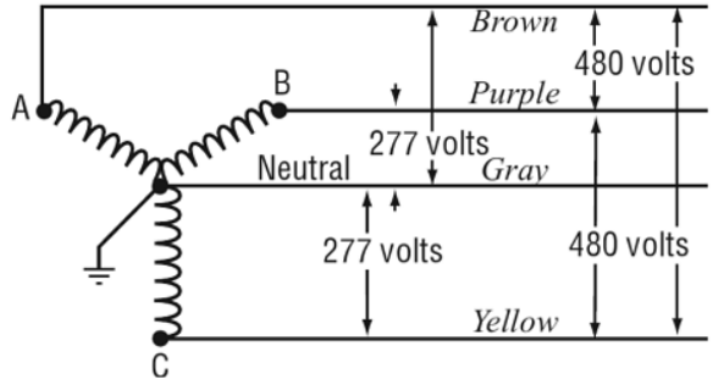
† • **Line one** ungrounded conductor colored **black**
† • **Line two** ungrounded conductor colored **red**
** • Grounded neutral conductor colored **white** or gray

Power Distribution

Commercial / Industrial
Incoming Service Voltage

- ❑ The most common commercial building electric service in North America is 120/208-Volt wye, which is used to power 120VAC plug loads, lighting, and smaller HVAC systems.
- ❑ In larger facilities the voltage is 277/480-Volt and used to power single phase 277VAC lighting and larger HVAC loads.

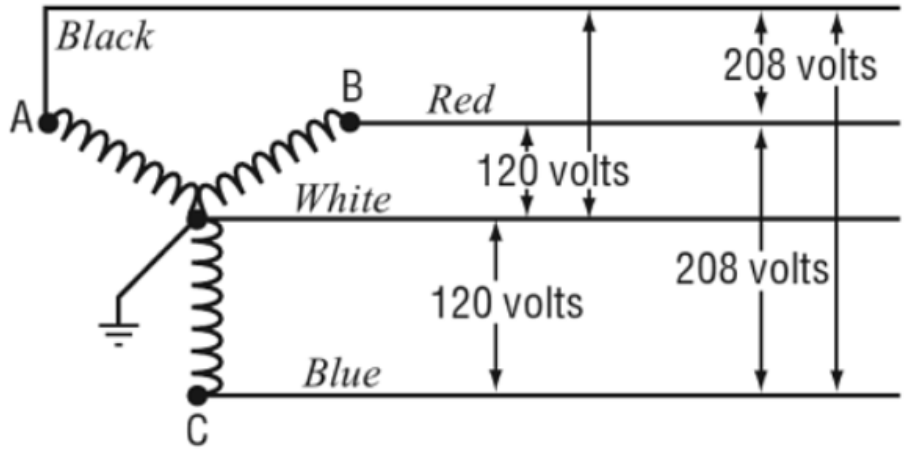
277/480-Volt, Three-Phase, Four-Wire System (Wye Connected)



† • **A** phase ungrounded conductor colored **brown**
† • **B** phase ungrounded conductor colored **purple**
† • **C** phase ungrounded conductor colored **yellow**
** • Grounded neutral conductor colored **gray**

** Grounded conductors are required to be white or gray or three white stripes. See *NEC* 200.6(A).
* B phase of high leg delta must be orange or tagged.
† Ungrounded conductor colors may be other than shown; see local ordinances or specifications.

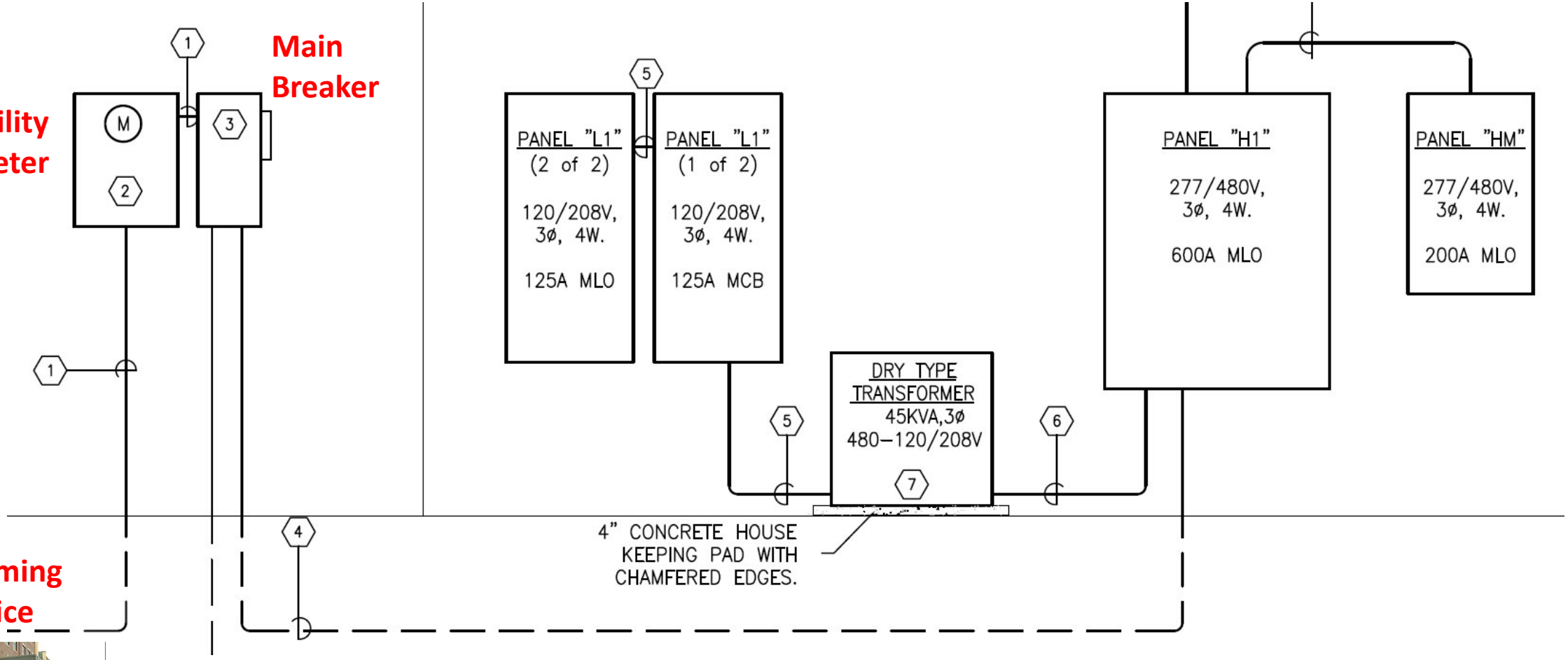
120/208-Volt, Three-Phase, Four-Wire System (Wye Connected)



† • **A** phase ungrounded conductor colored **black**
† • **B** phase ungrounded conductor colored **red**
† • **C** phase ungrounded conductor colored **blue**
** • Grounded neutral conductor colored **white** or gray

Power Distribution

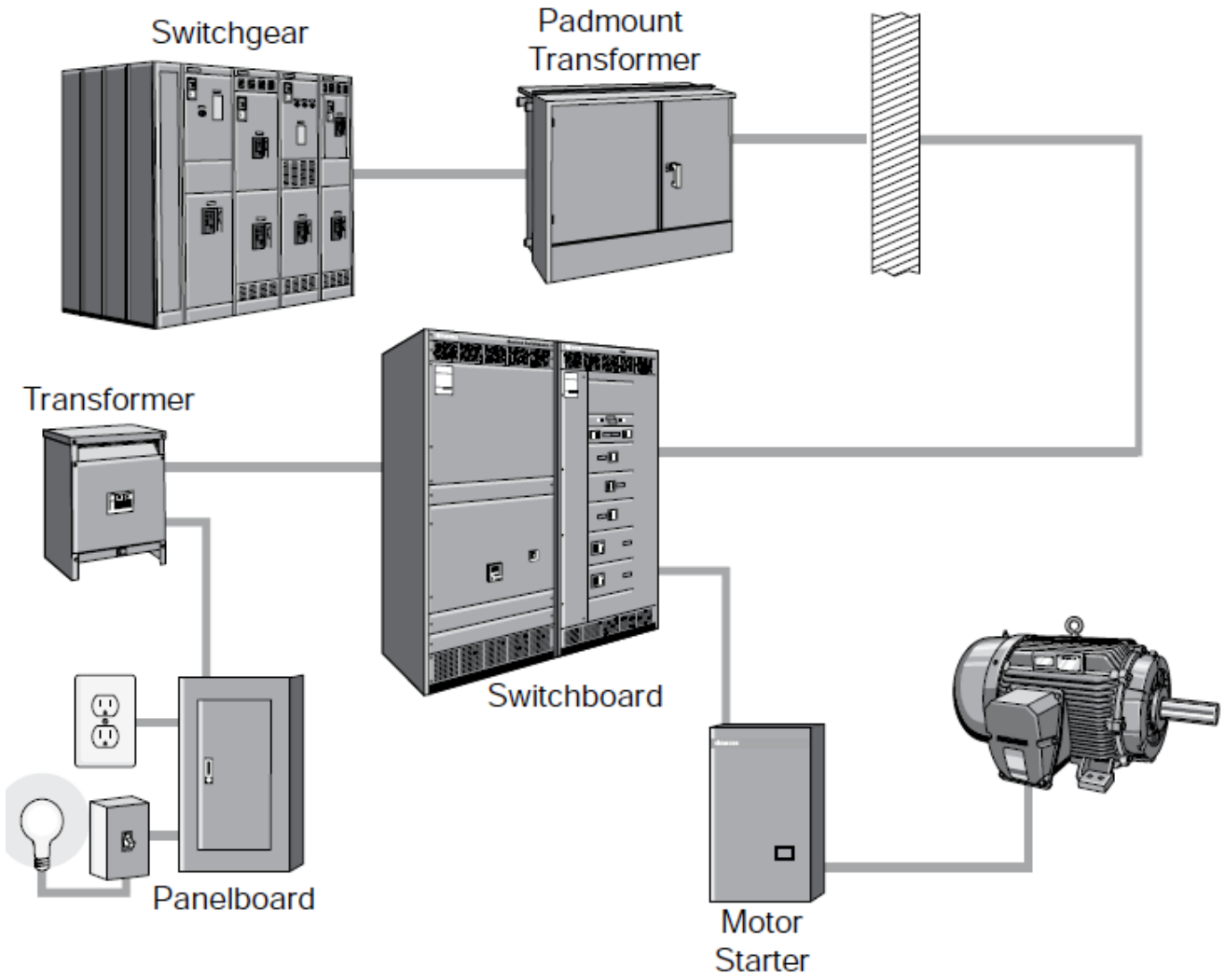
Commercial / Industrial Incoming Service Voltage



Single-Line Diagram (Partial)

Power Distribution

Commercial and Industrial Power Distribution Equipment



Switchgear may or may not be part of the distribution system.

It is typically present if the incoming power provided by the utility company is at a much higher voltage level than the commonly supplied 277/480-volt.

The owner purchases a higher voltage level (5kV, 13.8kV, 15kV) and purchases and maintains the switchgear and step-down transformer(s).

Switchboards are generally for voltages less than 600 volts. They are free standing and intended to be accessible from the front and rear.

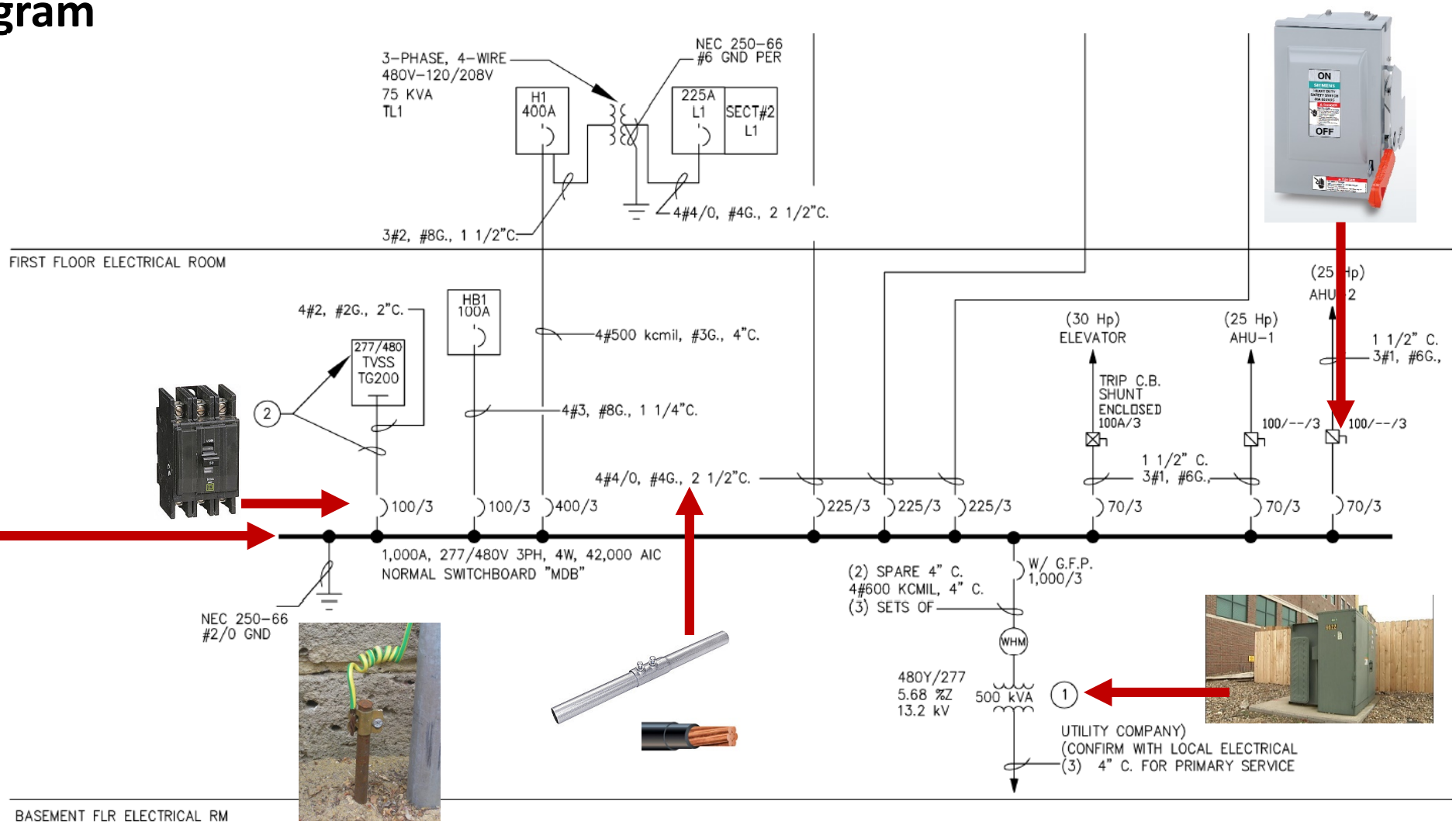
Power Distribution

Electrical One-Line Diagram

Single-Line Diagram

One-Line Diagram

Electrical Riser Diagram



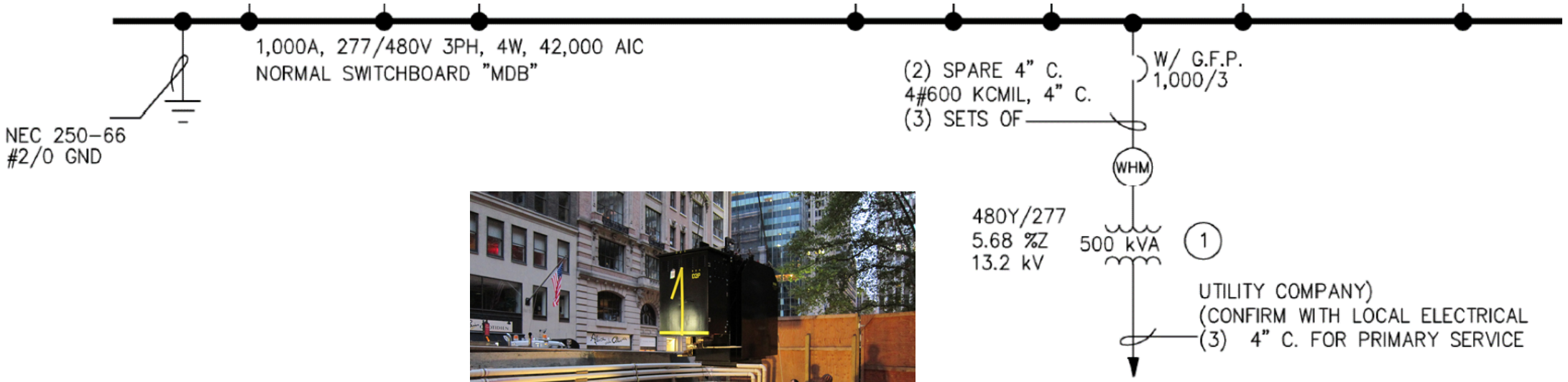
ELECTRICAL ONE-LINE DIAGRAM

NO SCALE

Power Distribution

Utility Primary Transformer

The power provided to a building all starts at the utility primary transformer. The secondary of the transformer is connected to the switchgear, switchboard, or a panel. The power company "owns" and connects the primary service. The EC connects the secondary to the building distribution.

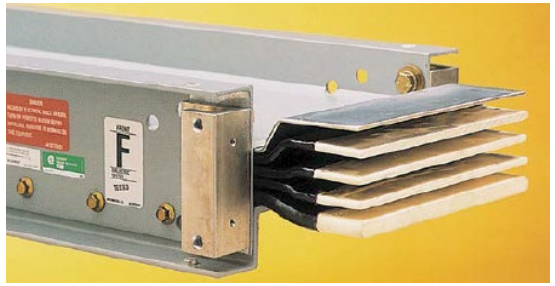


Power Distribution

In-Coming Service – Power

Power Distribution

Power Distribution System Equipment

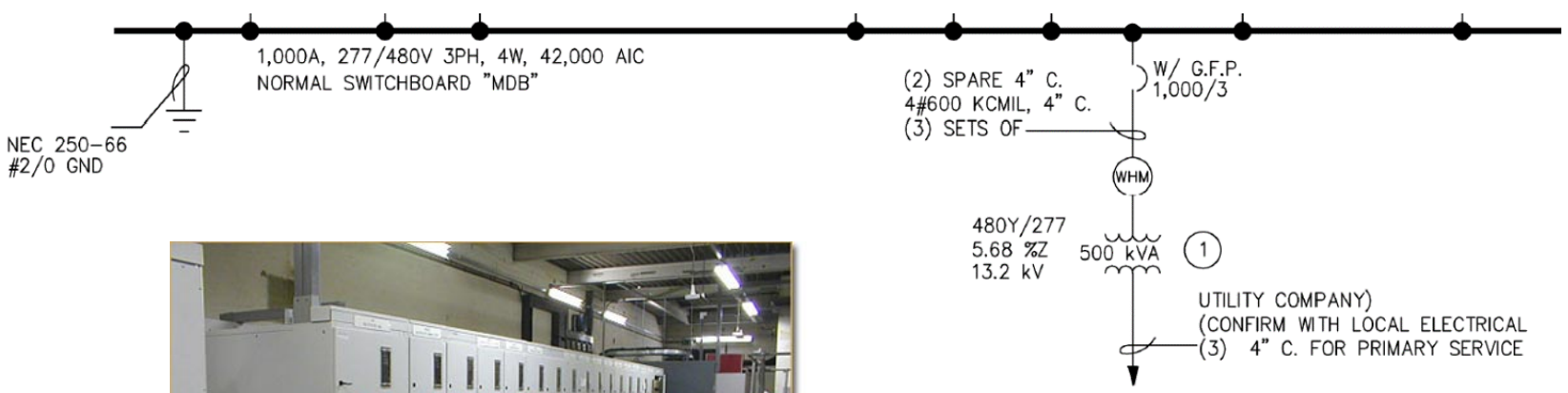


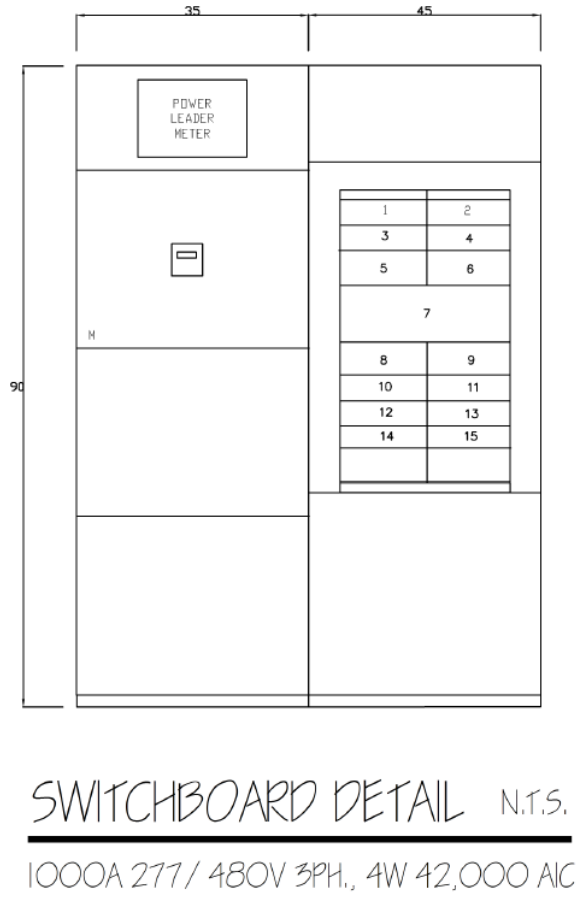
Power Distribution

Switchboard

Main Distribution Board (MDB)

Main Switchboard (MSB)





SWITCHBOARD DETAIL N.T.S.

1000A 277/480V 3PH., 4W 42,000 AIC

Power Distribution

Sections of a Switchboard

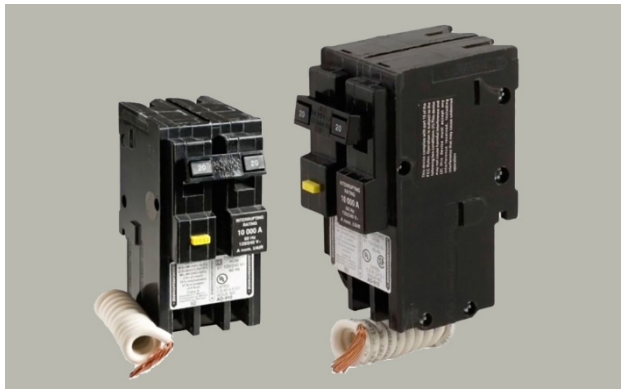
- ❑ Incoming Section
- ❑ Meter Main Section
- ❑ Distribution Section
  - Circuit Breakers (CB)
  - Fusible Switches
- ❑ Grounding
- ❑ Bonding

Power Distribution

Circuit Breakers

- A circuit breaker is a switch that automatically interrupts electrical flow in a circuit in case of an overload or short.
- The three types of circuit breakers:

standard



GFCI

AFCI

3-Pole CB

The 3-pole circuit breaker is used for three-phase circuits where there is L1, L2, L3 and N wire.

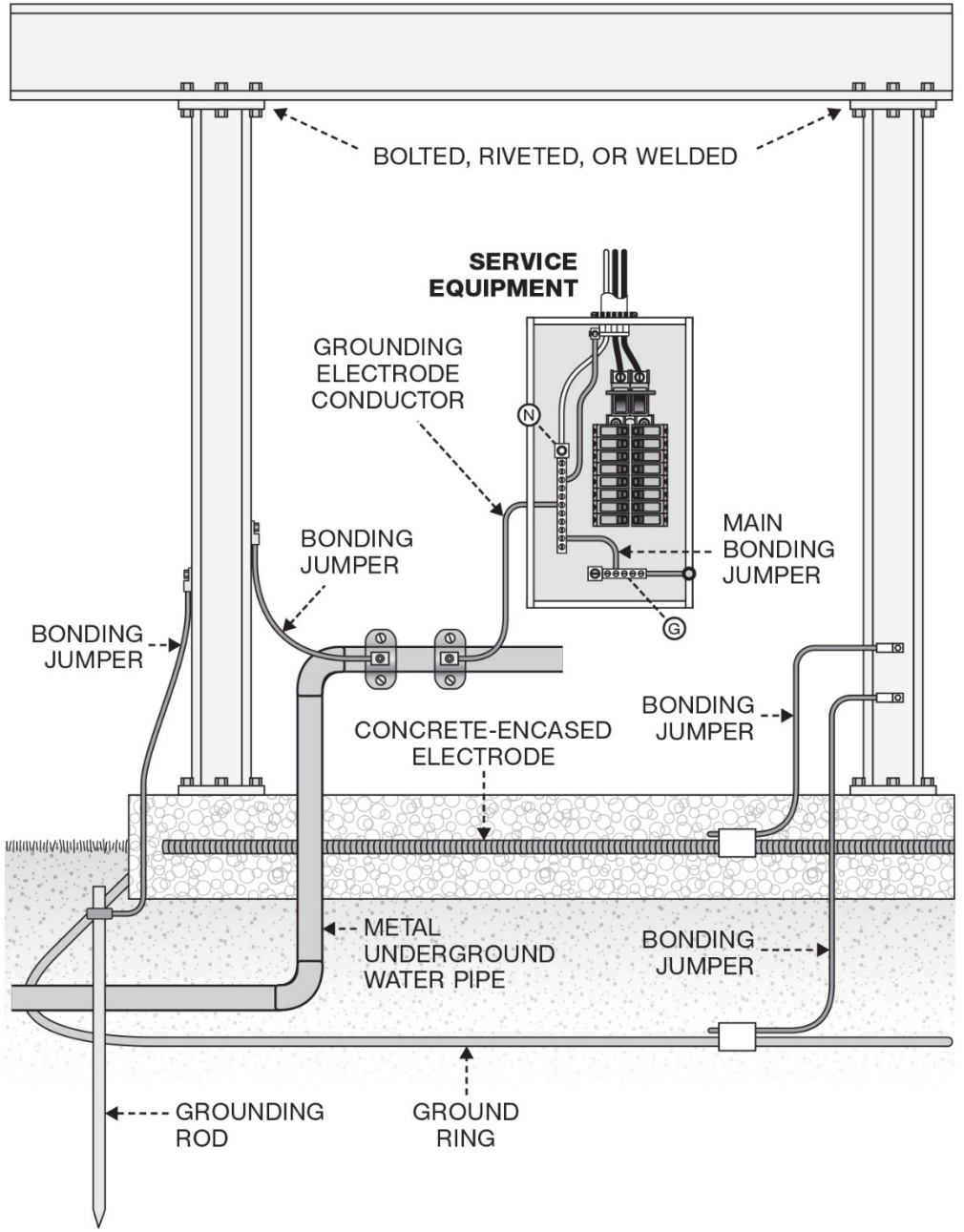
Power Distribution

Grounding

Article 100 of the NEC defines grounding as, "Establishing a connection, whether intentional or accidental, between an electrical circuit or equipment and the earth or to some conducting body that serves in place of the earth.“

Bonding

The NEC defines bonding as, "The permanent joining of metallic parts to form an electrically conductive path that ensures electrical continuity and the capacity to conduct safely any current likely to be imposed."

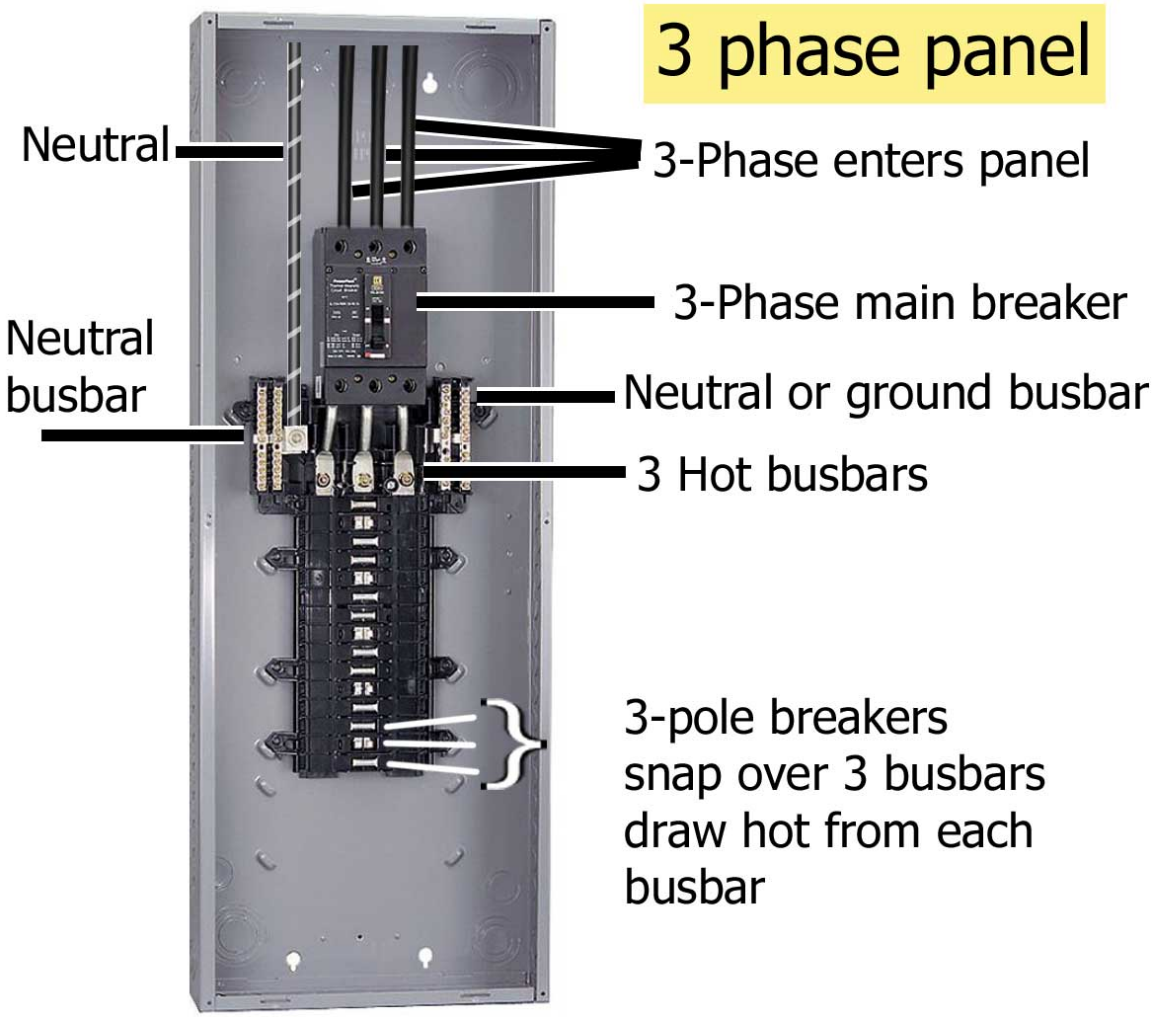


Power Distribution

Panelboard

NEC® definition, panelboards are:

- ❑ Used to control light, heat, or power circuits
- ❑ Placed in a cabinet or cutout box
- ❑ Mounted in or against a wall
- ❑ Accessible only from the front

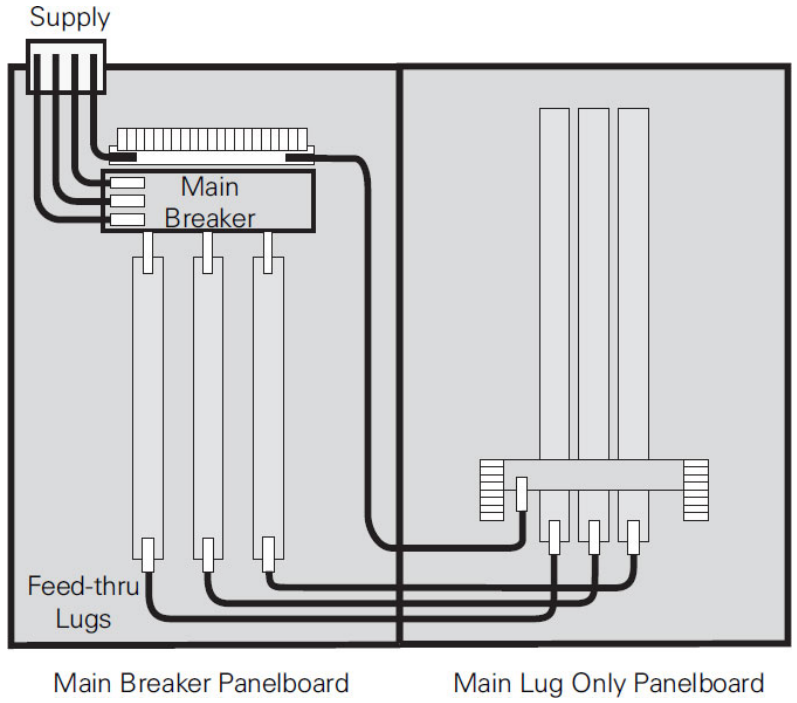


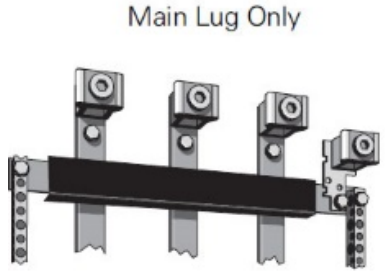
Power Distribution

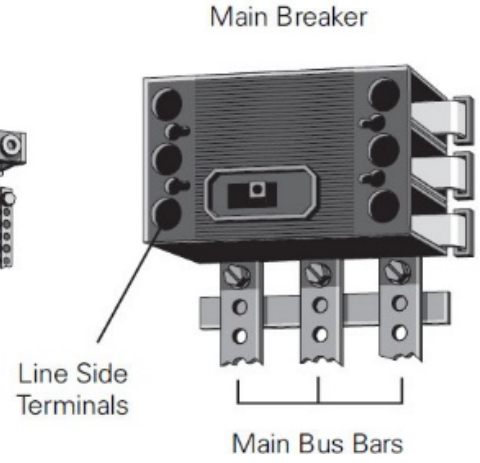
Panelboard

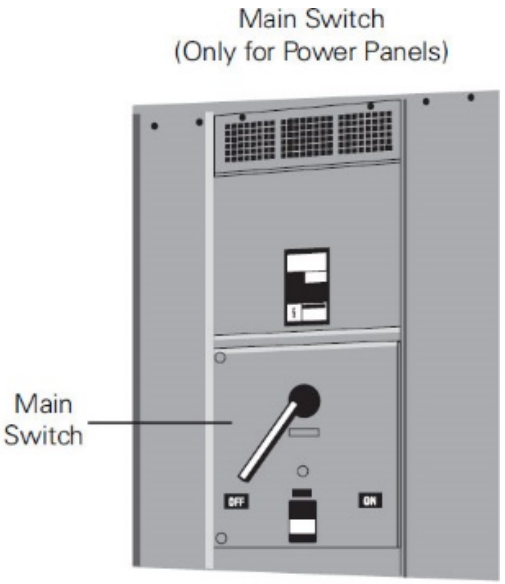
National Electrical Code® Article 408, Switchboards and Panelboards. Panelboards are frequently divided into two categories:

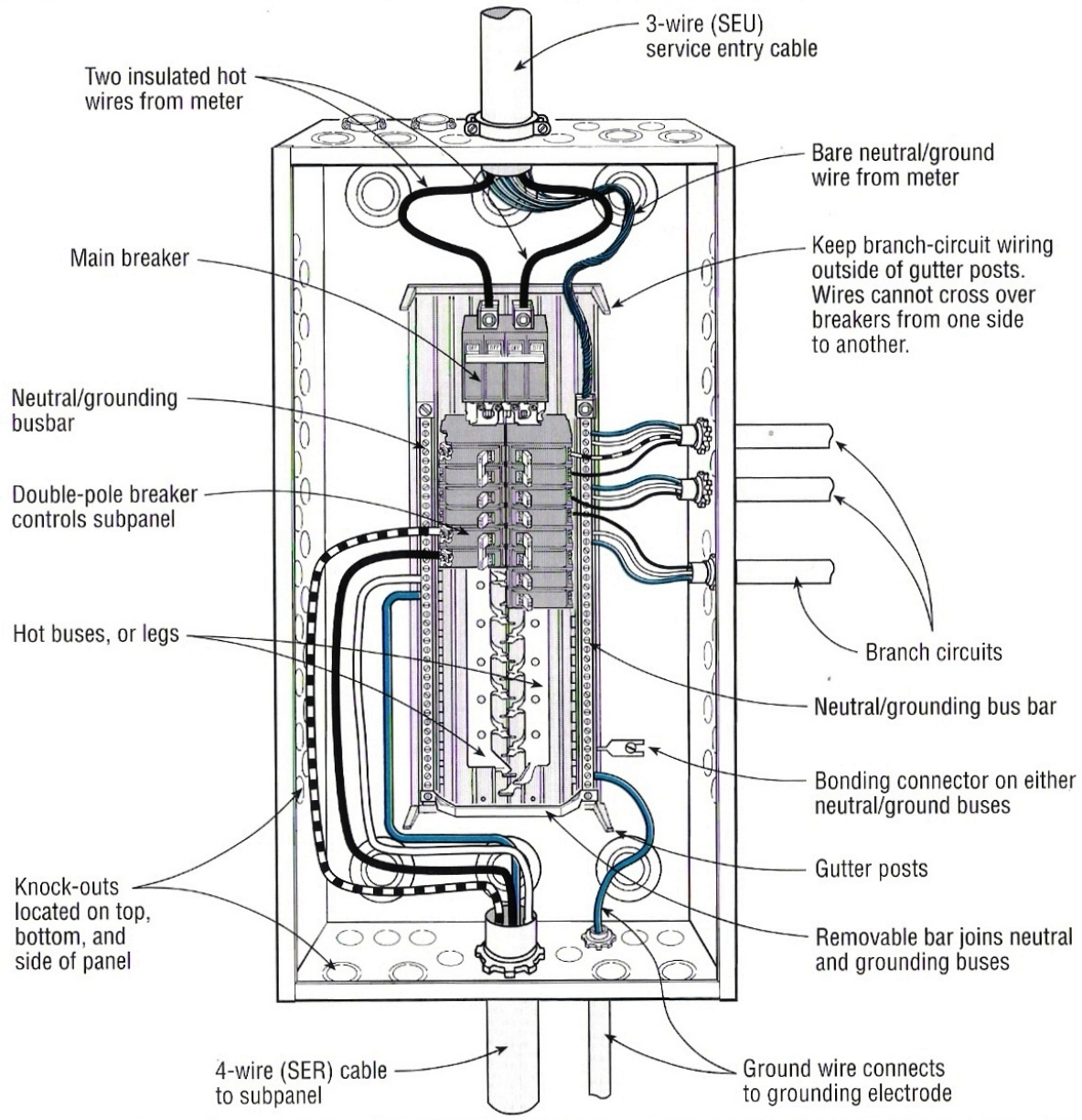
- ❑ Lighting and appliance branch-circuit panelboards
- ❑ Power panelboards (also called distribution panelboards)





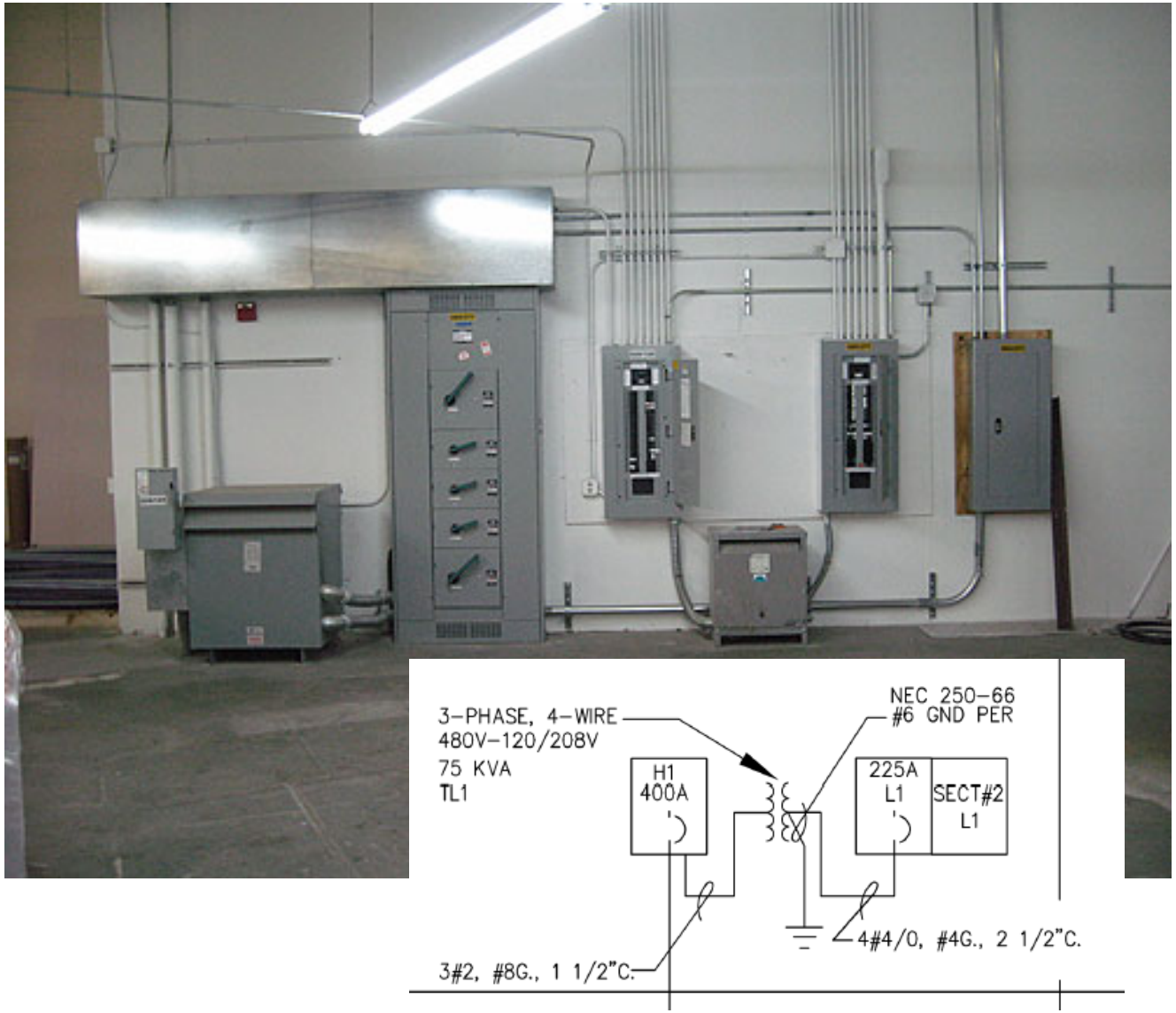





3-wire (SEU)
service entry cable
Two insulated hot
wires from meter
Bare neutral/ground
wire from meter
Main breaker
Keep branch-circuit wiring
outside of gutter posts.
Wires cannot cross over
breakers from one side
to another.
Neutral/grounding
busbar
Double-pole breaker
controls subpanel
Hot buses, or legs
Branch circuits
Neutral/grounding bus bar
Bonding connector on either
neutral/ground buses
Gutter posts
Knock-outs
located on top,
bottom, and
side of panel
Removable bar joins neutral
and grounding buses
4-wire (SER) cable
to subpanel
Ground wire connects
to grounding electrode


PELIGRO
DANGER
SIEMENS
Handyman

Power Distribution



Power Distribution

Safety Switch - Disconnect Switch

Fusible or Non-Fusible

250V or 600V

2 Pole or 3 Pole

30A

60A

100A

200A

400A

600A

800A

1200A

4 & 6-Pole Heavy Duty Safety Switches

Two-speed, two-winding motors

4-pole switches are also used in 3-phase, 4-wire circuits when a switching neutral is required.

Power Distribution

Electrical Drawings

The drawings (plans) that are most important for understanding the scope of work for the project's electrical distribution system are:

- ❑ Single-Line Diagram (One-Line Diagram, Electrical Riser Diagram)
- ❑ Panel Schedules
- ❑ Equipment Schedules and HVAC Schedules
- ❑ Lighting Control

Example Project – Broward Northside, Climate Controlled Storage

<u>Drawings</u>

E – 02 [Electrical Room, Elevator Equipment Room]

E – 03 [Single-Line Diagram, Exterior Lighting Control]

E – 04 [Panel Schedules, HVAC Equipment Schedules]

Power Distribution

Electrical Drawings

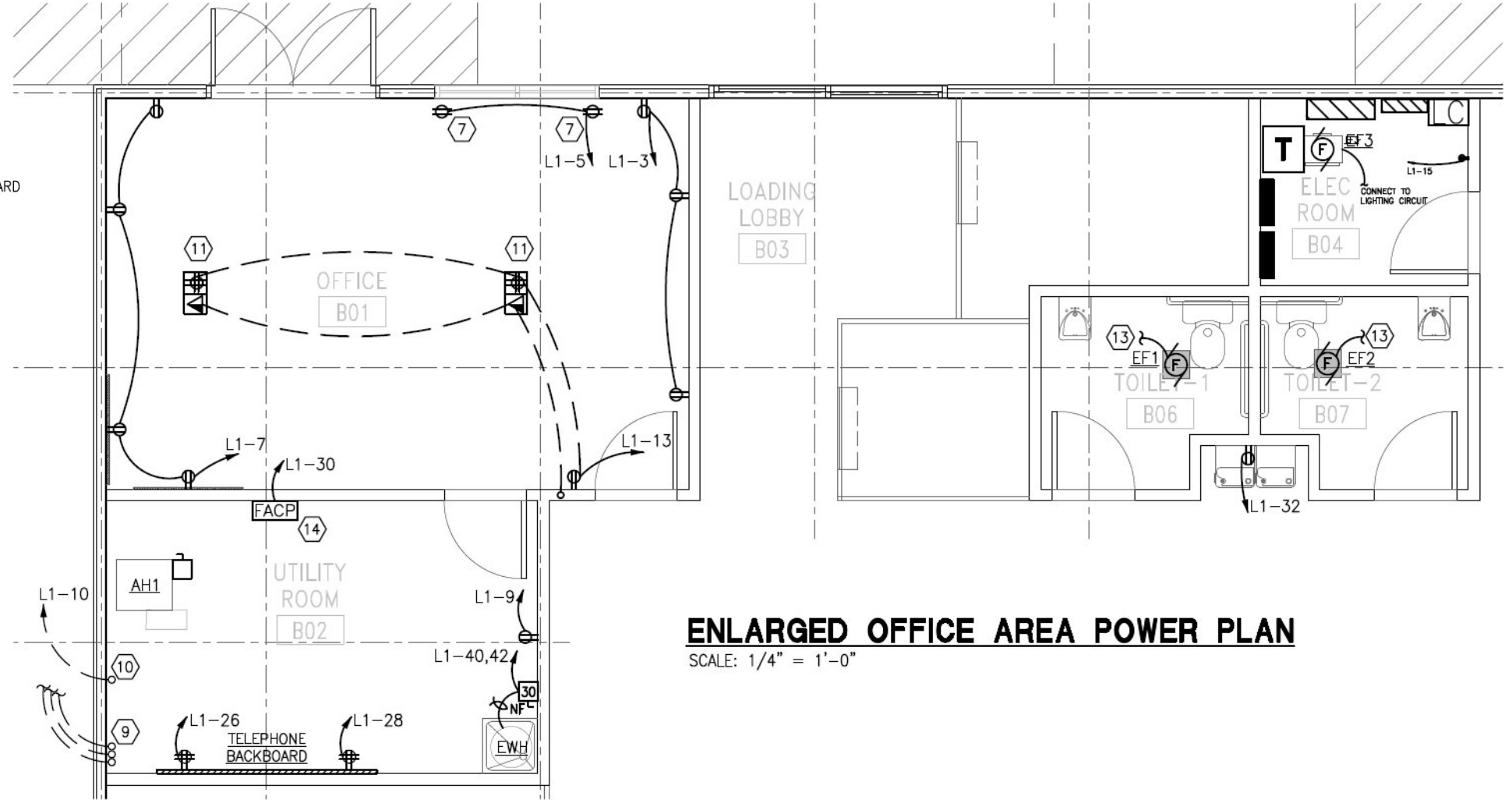
Electrical Legend (Partial)
Drawing E - 01

480 VOLT PANELBOARD

208/120 VOLT LIGHTING AND APPLIANCE TYPE PANELBOARD

MOTOR

FUSIBLE DISCONNECT SWITCH; NF IS NONFUSED



ENLARGED OFFICE AREA POWER PLAN
SCALE: 1/4" = 1'-0"

Drawing E-1 Lower Level Electrical Plan