

BASIC ELECTRICITY 101

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Review some typical hazards associated with electricity and learn how to mitigate the hazards.

OBJECTIVES





In the United States,
electrical hazards are
ranked number 6
among all causes of
work-related deaths.

- ▶ The following drawing shows how circuit breakers access the incoming power:

SINGLE PHASE ELECTRIC PANEL

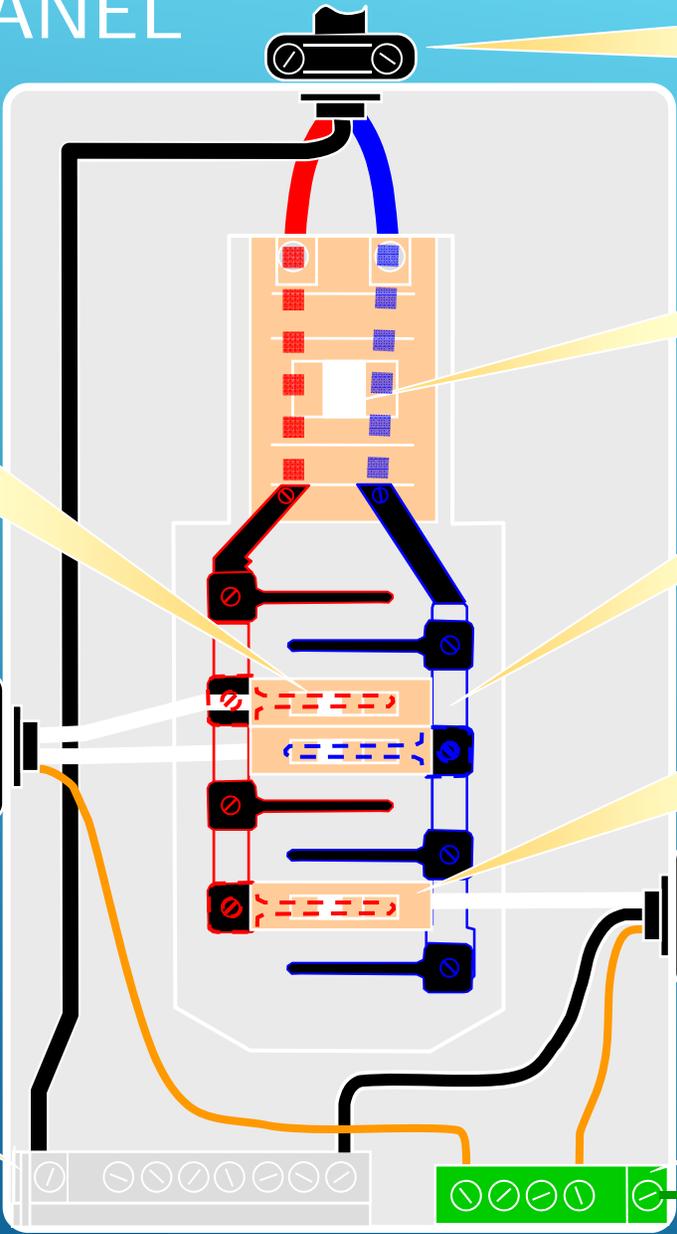
A decorative graphic consisting of several parallel white lines of varying lengths, slanted diagonally from the bottom right towards the top right, set against the blue background.

ELECTRIC PANEL

Double Pole
Circuit Breaker
240v

240v Circuit

Neutral



Main Power
240v / 120v -1Ø

Main Breaker

Bus Bars

Single Pole
Circuit Breaker
120v

120v Circuit

Ground

APPLIANCE	WATTAGE SELCTION BOXES	
	AVERAGE RUNNING WATTS	AVERAGE STARTING WATTS
AM/FM RADIO →	175	175
TELEVISION SET	300	300
(5) 100 W. LIGHT BULBS	500	500
(10) 100 W. LIGHT BULBS	1000	1000
REFRIGERATOR, 1/4 HP	600	1950
FREEZER, 1/4 HP	600	1200
1/3 HP FURNACE FAN	800	1600
1/3 HP SUMP PUMP, CODE G	800	1600
1/2 HP SUMP PUMP, CODE G	1200	3600
1/4 HP GARAGE DOOR OPERATOR	600	1200
MICROWAVE OVEN →	750	1500
ELECTRIC WATER HEATER	5000	5000
COMPUTER SYSTEM: CPU, MONITOR, LASER PRINTER →	1500	1500
DISHWASHER, 1/6 HP	500	1000
PORTABLE ELECTRIC HEATER →	1500	1500
UPS SYSTEM →	2000	2500
ELECTRIC FRY PAN	1400	1400
AIR CONDITIONER 12,000 BTU (1 HP ELECTRIC MOTOR)	1900	7600
AIR CONDITIONER 24,000 BTU (2 HP ELECTRIC MOTOR)	2800	11200
AIR CONDITIONER 32,000 BTU (2.5 HP ELECTRIC MOTOR)	3500	14000
AIR CONDITIONER 40,000 BTU (3 HP ELECTRIC MOTOR)	5000	20000
1 HP WATER PUMP, CODE G	1920	5760
2 HP WATER PUMP, CODE G	2500	7500
3/4 HP WATER PUMP, CODE L	1700	6800
1-1/2 HP WATER PUMP, CODE L	2400	9600
1/4 HP ATTIC FAN, CODE G	600	1200
ELECT. CLOTHES DRYER, 1/4 HP	6000	8000
GAS CLOTHES DRYER, 1/4 HP	750	2100
ELECTRIC RANGE 6" ELEMENT	1200	1200
ELECTRIC RANGE 8" ELEMENT	2000	2000
WASHING MACHINE WITH 1/3 HP MOTOR	800	1600

So a 2000 watt UPS will draw how many amps?

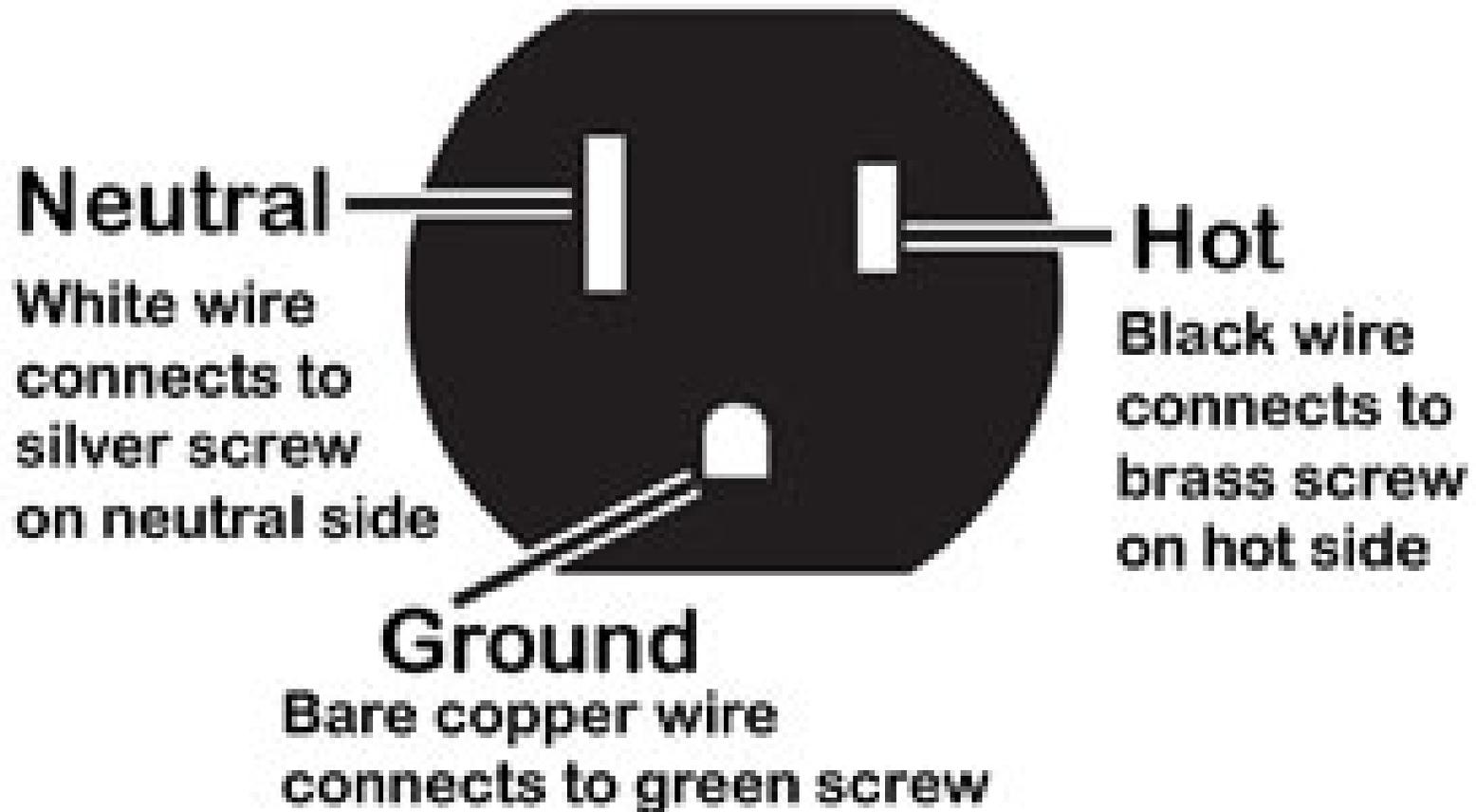
$$2000/120 = 16.66 \text{ amps}$$

A standard 20 amps outlet is designed to carry 80%, that would be 16 amps.

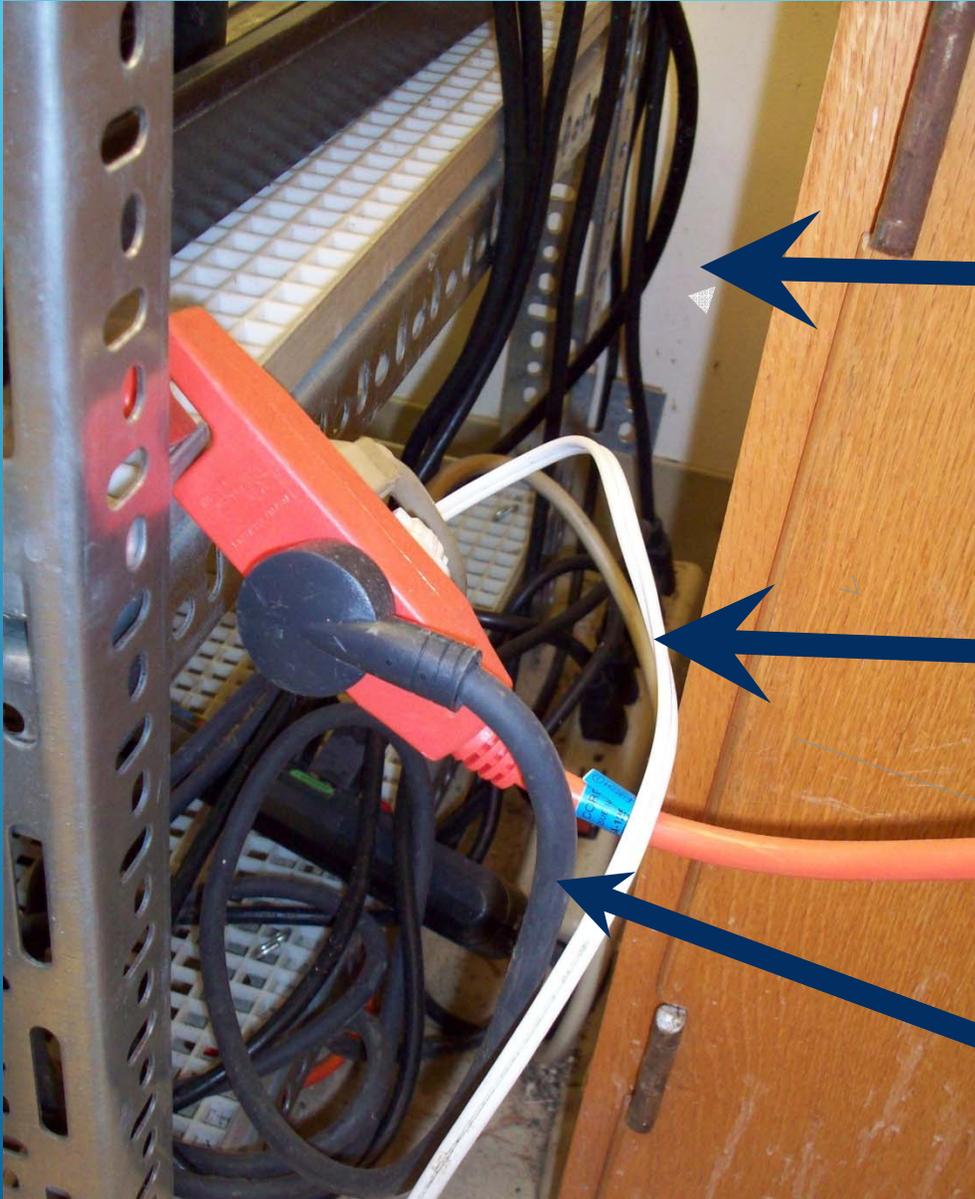
How much additional load will this circuit handle?

$$I = V/R$$

Outlet polarity







Venting

Rated ?

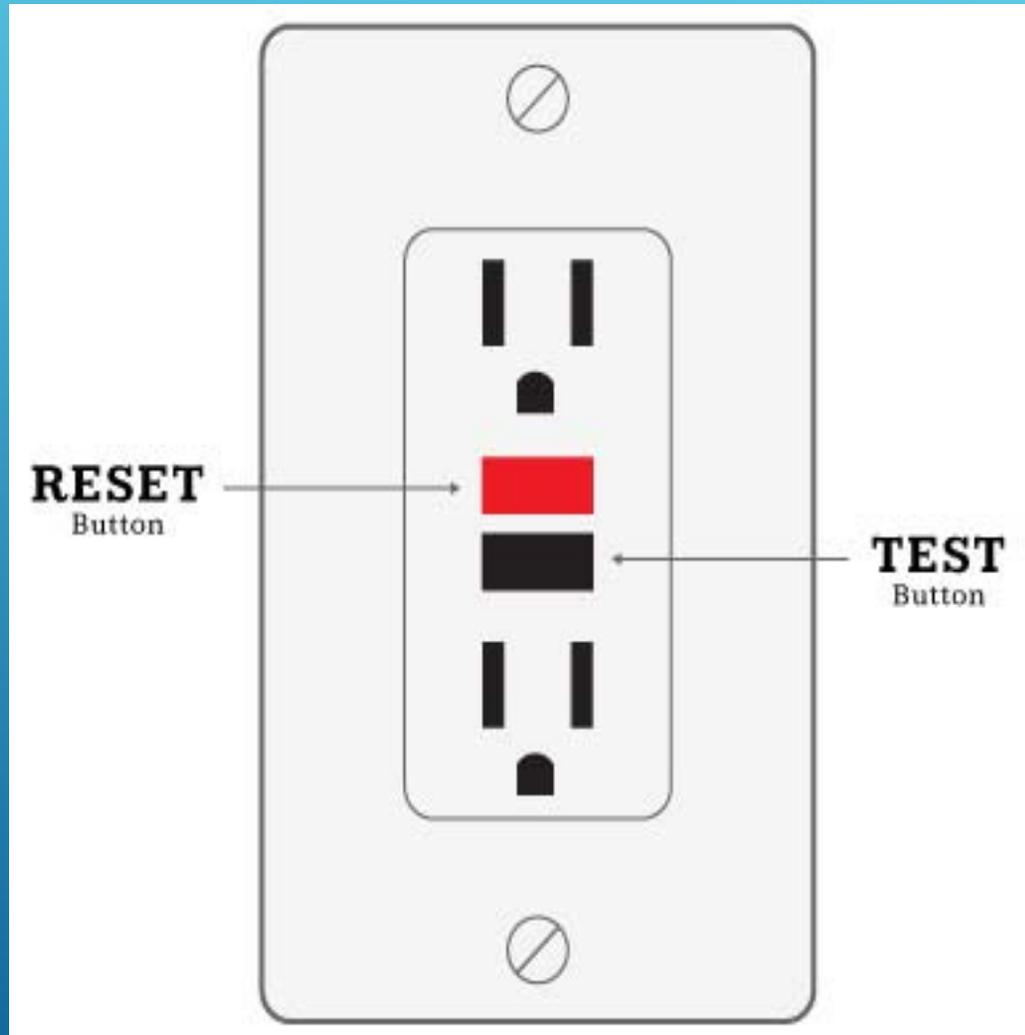
Listed

NEC 110.13. Mounting and Cooling of Equipment.

This requirement is always in dispute, it seems. Cramming equipment into an overcrowded arrangement to maximize revenue per square foot sounds like a really good idea until that equipment starts failing left and right, or the whole place just burns down.

NATIONAL ELECTRICAL CODE

A decorative graphic consisting of several parallel white lines of varying lengths, slanted diagonally from the bottom right towards the top right, set against the blue background.





Do YOU push the test button
on GFCIs and AFCIs monthly?

It's HARD to remember
without calendaring the task!

NEC 110.3. Examination, Identification, and Use of Equipment. This section gives 8 requirements for examination in part (A). In (B), it says "Listed or Labeled equipment shall be installed and used in accordance with any instructions included in the Listing or Labeling."

In other words, use the product as intended. Unauthorized modifications void the Listing and expose the modifier to civil, and potentially criminal, litigation and liability.

Back in 2005 the CPSC (Consumer Product Safety Commission) went to the electrical manufacturers of GFCI's and asked them to develop self testing devices.

The original scope was that the device would shut down if it did not pass the self test and hence create the safety that these devices are there to provide.

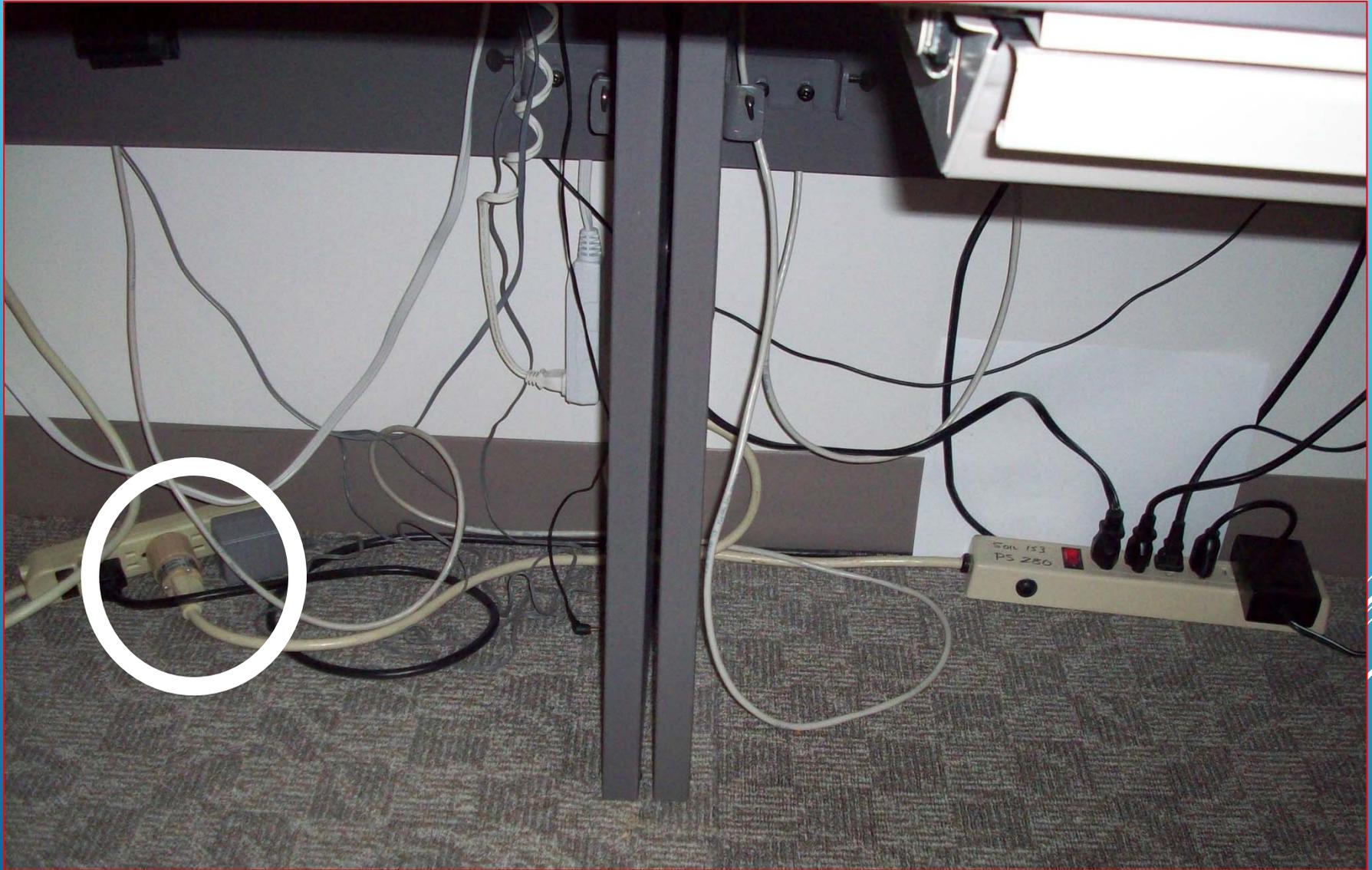
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Section 1926.416(e)(1) provides that "worn or frayed electrical cords or cables shall not be used." Superficial nicks or abrasions — those that only slightly penetrate the outer jacket of a flexible cord, and do not permit the cord to bend more in that area than in the rest of the cord — do not normally render a cord "worn or frayed." Therefore, there is no need to repair or replace such a cord.

OSHA STANDARDS

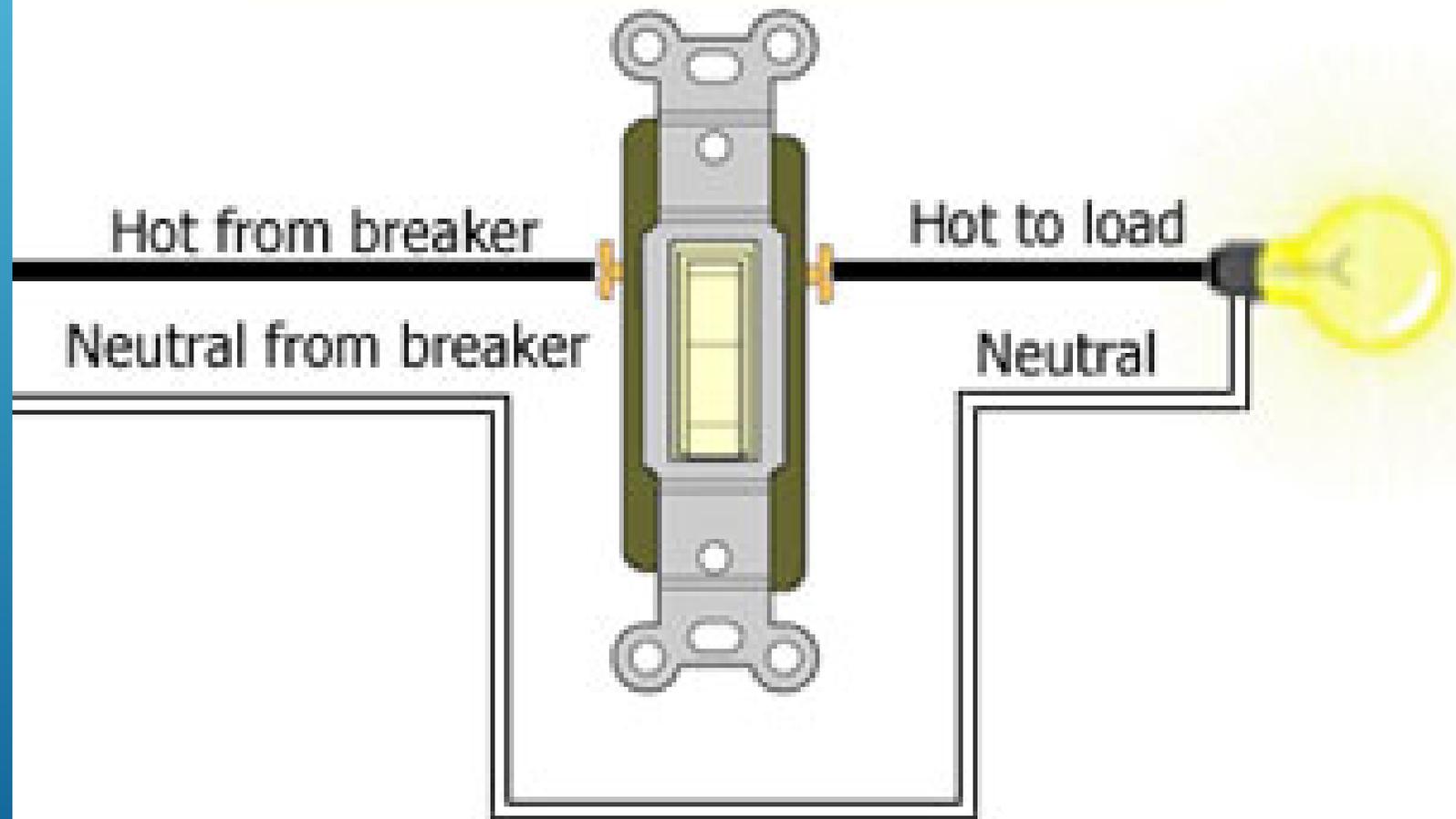




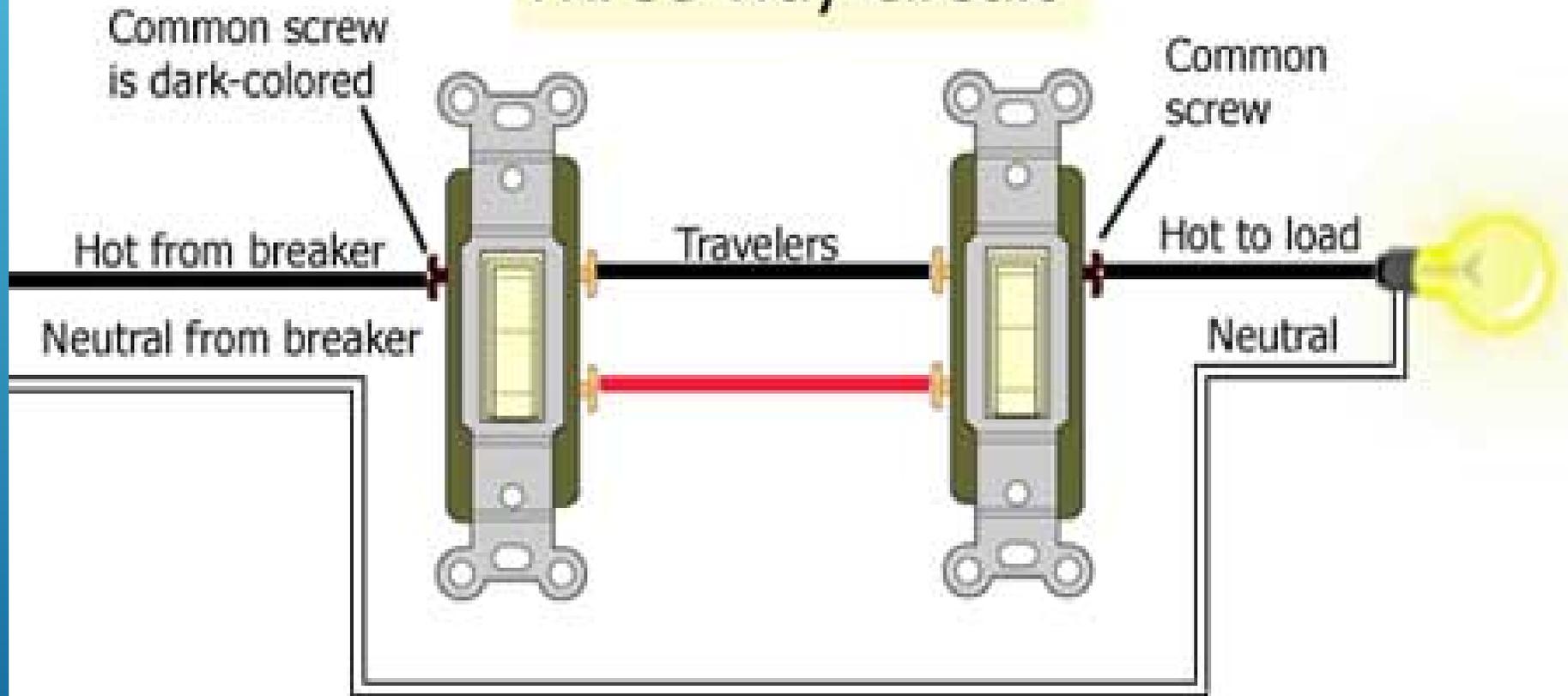
Stapled through cord!



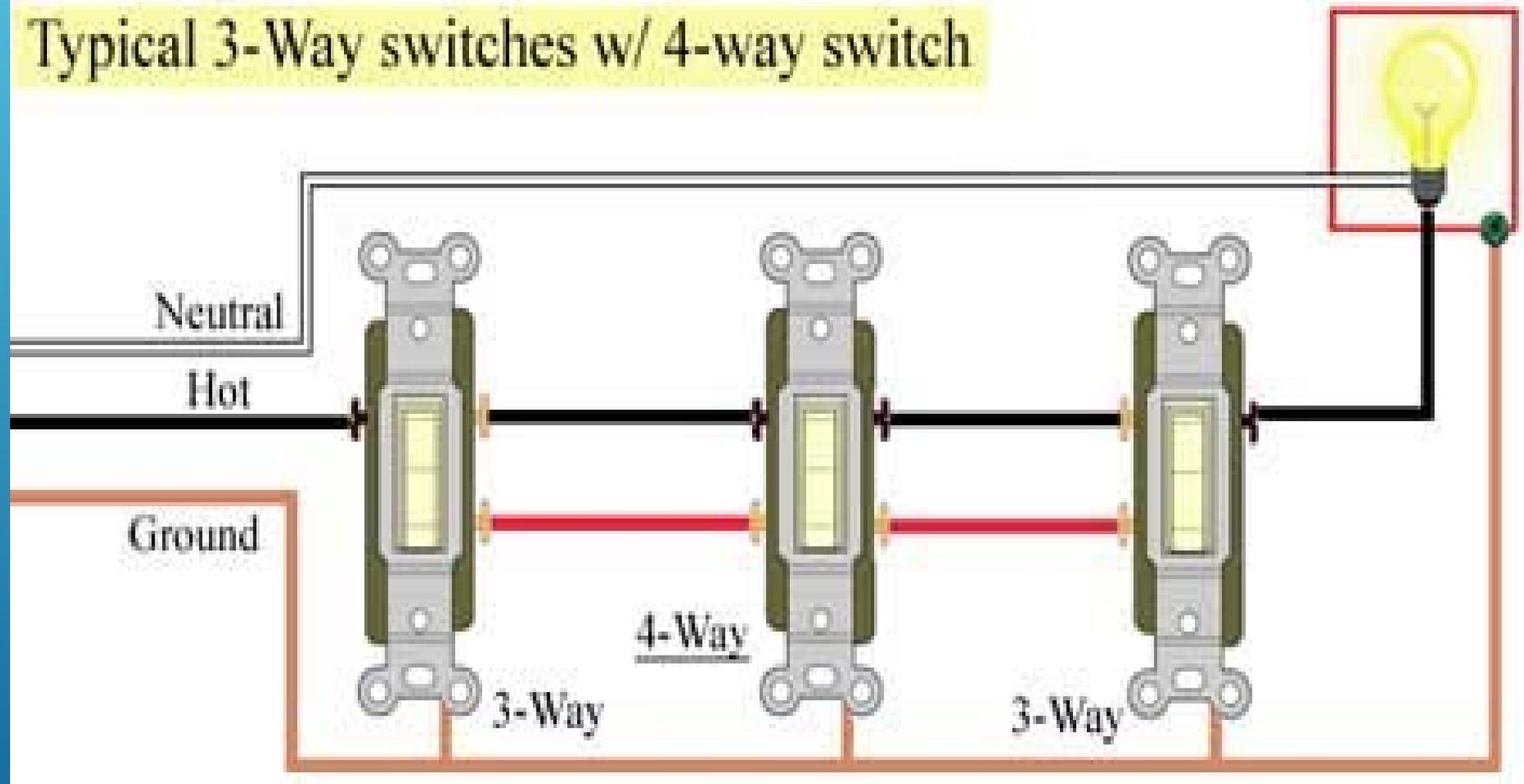
Single-pole circuit



Three-way circuit



Typical 3-Way switches w/ 4-way switch



AMPACITY AND WIRE INSULATION

Wire Size AWG	Ampacity for Type TW & UF	Ampacity for Type THHN	Maximum Amp Ratings*
#14	20	25	15*
#12	25	30	20*
#10	30	40	30*

*According to the electrical code, the overcurrent protection shall not exceed 15A for #14, 20A for #12, or 30A for #10

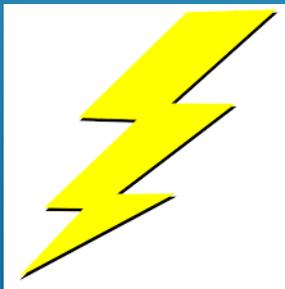
(However, insulation is a factor in locations above 86° F)

WIRE AND CIRCUIT BREAKER SIZING FOR MOTOR LOADS

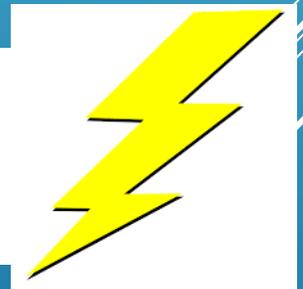
Total Unit Amps	Circuit Breaker Amps	Wire Size
0 - 12	15	#14
13 - 16	20	#12
17 - 24	30	#10
25 - 31	40	#8
33 - 48	60	#6

HAZARDS and RISKS

when working with



ELECTRICITY



What is the **BEST** WAY TO
PREVENT THE HAZARDS
of electricity?

AVOID energized
circuits - the safest way!



THINK
before taking
Action

THINK

about the

Risks and Hazards

OPTIONS

Do you have options like:

LOTO (Lockout/Tagout)

PROTECTION

Are you wearing PPE?
(Personal Protective
Equipment)

WHAT are the **HAZARDS** and **RISKS**?

1. Shock
2. Arc Flash & Arc Blast
3. Fire Ignition

SHOCK AND ITS EFFECTS

Immediate:

1. Muscle contraction
2. Vital organs damaged
3. Tingling
4. Pain
5. Breathing
6. Disorientation
7. Dizziness
8. Possible death

SHOCK AND ITS EFFECTS

Long Term:

1. Memory Loss
2. Nervous disorders
3. Chemical imbalances
4. Damage to vital organs
5. Sometimes fatal

EFFECT OF CURRENT ON THE BODY

MEN

- ▶ **Perception Threshold**
0.001 Amps (1 mA)
- ▶ **Painful Shock**
0.009 Amps (9 mA)
- ▶ **Cannot Let-Go Level**
0.010 Amps (10 mA)
- ▶ **Ventricular Fibrillation**
.100 Amps (100 mA)
- ▶ **Heart Failure**
0.5 Amps (500 mA)
- ▶ **Organ Burn**
1.5 Amps (1500 mA)

WOMEN

- ▶ Perception Threshold
0.0007 Amps (0.7 mA)
- ▶ **Painful Shock**
0.006 Amps (6 mA)
- ▶ **Cannot Let-Go Level**
0.010 Amps (10 mA)
- ▶ **Ventricular Fibrillation**
.100 Amps (100 mA)
- ▶ **Heart Failure**
0.5 Amps (500 mA)
- ▶ **Organ Burn**
1.5 Amps (1500 mA)

TWO TYPES OF BURNS FROM SHOCK

Surface Burns:

- Caused by entrance and exit of electrical currents through the body
- Can be caused by a very small amount of current
- 1st degree to 3rd degree



ARC FLASH & BLAST

RELATIVE TO THE HUMAN BODY:

- A **2nd** degree burn threshold, or a 'just curable burn threshold,' is skin temperature raised to 175°F for 0.1 second.
- A **3rd** degree burn threshold, or 'incurable burn threshold,' is skin temperature raised to 200°F for 0.1 second.
- Eardrum damage > 720 psf
- Lung damage > 1728 psf

TWO TYPES OF BURNS

FROM SHOCK

Internal Tissue Burns:

- Caused by current flowing through organs of the body
- Caused by currents in excess of 1.5 amps
- 4th degree (internal)
- Internal organs
- Typically Fatal

PROTECTION FROM ABNORMAL CONDITIONS

- NFPA 70E
- OSHA
- Electrical Safety Procedures Manual
- Electrical Safety Training

Equipment Labeling



DANGER

**Arc Flash Hazard
Appropriate PPE Required**

Do not operate controls or open covers without appropriate personal protection equipment.
Failure to comply may result in injury or death!



Refer to NFPA 70E for minimum PPE requirements.

 BRADY® #99453 Y4103145



Equipment Labeling



WARNING

ARC FLASH & SHOCK HAZARD

**Appropriate personal protection equipment
required**

Incident Energy (cal/cm²) _____

Hazard Category _____

 **BRADY® #121133 BRADYID.COM**

Questions?





NSED

Nebraska Electrical Division

