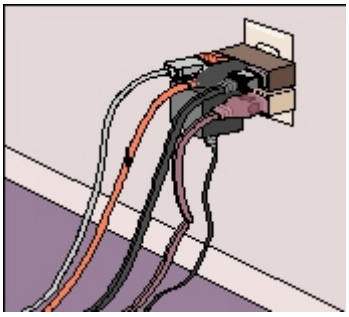
ELECTRICAL FIRES

Which came first, Chicken or the Egg?
Did the damage on the wire come from the fire?
Was the wire the ignition factor that caused the fire?

Voltage - (Electromotive force, EMF) is electrical pressure, or meaning the "pressure" of the electrons within the wire or electrical device. Voltage can be related to the PSI or pressure of water within a fire hose. For instance, a 120 volt line has ten times as much pressure as a 12 volt wire.

Current - (amperage) is the flow of electrons, or meaning the amount of electrons that pass through a given wire or device. Current can be related to the gallons per minute that flow out of a hose or nozzle.

Resistance - (impedance or ohms) is a measurement of the amount of energy that is held back or resisted through the limitations of the wire size, material composition or physical defects. Otherwise known as electrical friction. Ohms can be related to the amount of friction loss in a fire hose or increased ohms to the effect that placing a 1.5" reducer on a 2.5" hose.



For determining unknown factors

Voltage = Current x Resistance (E = I x R)

$$\text{Current} = \frac{\text{voltage}}{\text{Resistance}} \qquad (I = E / R)$$

$$\text{Resistance} = \frac{\text{voltage}}{\text{Current}} \qquad (R = E / I)$$

Electrical current *desribes the path or current of flow. The electrons must have an actual flow which requires the return to the source, or a complete loop.*

WIRE FACTS

1.Every 10 degrees centigrade increase over the rated insulation temperature of a wire will **half** it's life expectancy.

Rule of Thumb Example:

A 90 degree centigrade (194 degree F.) Rated insulated wire with a life expectancy of 40 years.
@ 90 degrees 40 years
@100 degrees 20 years
@110 degrees 10 years
@120 degrees 5 years
@130 degrees 2.5 years

2. In open air a *properly fused* wire will not exceed the temperature limits of the insulation and cause a fire.
3. ***Rolling and bundling wire*** will cause the inside wires to have a greater temperature than the outer wires. They will generally have to be overloaded to exceed the safe operating temperature.
4. Properly protected wires (via fuse or circuit breaker) will not fail due to overheating in insulated walls unless ***several wires are close*** to each other causing heat buildup in the insulation.
5. ***Wires in the attic with high "R" value blown insulation*** can fail due to heat buildup. Tests have shown that three #12 romex ran close together in a R 44 insulated attic will exceed their 90 degree cent. Rating in about 2 hours.

6. ***If a wire overheats due to excessive current*** then the damage should be ***uniforn throught the length of the wire*** with the only exception being areas that the wire has more insulation, such as a wall stud, carpet or materials stacked on top of the wire.
7. Installing a ***fuse or breaker with a higher amp rating*** does not increase the current flow unless the loads demands it.
8. An ***18 gauge extension cord*** will require about four times its 10 amperes rating to exceed the melting temperature of the insulation.
9. An unloaded 30 ampere circuit does not get any hotter than an unloaded 15 ampere circuit.
Refer to the "Plastics Chapter" for melting temp. and Ignition temps. of wire insulation, specifically PVC, polyethylene, and nylon.

OVERHEATING AT JUNCTIONS

Typically, if a fire is caused by overheating, then a large percentage of the time the problem can be traced to a junction. The abnormal resistance that can be produced at a junction usually can be related to age, corrosion, thermal cycling, dissimilar metals, conductors or improper preperation of the joint.

A. **Backwired, pushin connections in duplex receptacles** may loosen due to improper manufacturing or installation of the wire if it reseated. The fire will occur when the circuit is least loaded, causing current to flow through the poor connection, resulting in glowing.

B. Failure between the **plug blades of a duplex receptacle**. Usually occurs at moderate to heavy loads leaving melting on the blade of the plug. Improper finger tension is usually the cause.

C. Failures in **duplex receptacles that have steel screws**. Underwriter's Laboratory has conducted tests that show failures can occur in steel/copper or steel/aluminum connections with as little as .3 amps.

D. Failures in **aluminum connections that have not been properly prepared**. Break down over time and require proper preperation by wire brushing the conductor, applying anti-oxide paste and applying the proper torque. These failures are usually found in service entrance lugs, circuit breakers and bus ducts and result in overheating.

E. Failure of **wiresplicing**. Made by twisting the wires together without the use of solder. These connections will loosen over time and will heat due to high resistance. Commonly found in "home handyman" projects.

F. Failure of **old "loom" style romex with paper or rubber insulation and a cloth covering** is usually due to movement, rebending, stepping on or different types of mechanical damage. It will fail at support staples or in re-insulated attics and can be heard to crackle when moved from it's original position.

G. Overheated wires require **excessive current**, **insulation** to contain the heat, a **fuel source** and **oxygen to start a fire.**

H. An electrical fire will usually result in a **single point of origin**, with the same fire patterns and magnitude as any other accidental heat source at that point.

General rules for arcing

✡A **short (bolted fault)** in a circuit will cause the fuse or circuit breaker to open quickly, leaving only **one point of beading** on the conductors.
✡**Several points of faulting**, as evidence by beading, indicates that the shorts were not of the magnitude to open the fuse or the circuit breaker. The multiple faulting circuit (in a properly protected circuit) is usually due to a **well developed fire impinging** on an energized circuit and causing arcing along the conductors **before a fire** originating from the wiring and also before the circuit breaker reacts.
✡**Holes blown in steel conduit** covering branch and feeder circuits are due to the heating of the conduit by an **external fire** that causes melting of the wire insulation. The melted insulation allows the conductors and conduit to arc. The heat from the arc and the fire cause the "blowholes". Service entrance conductors are not protected by fuses or breakers and the available current in residential may be up to 10,000 amperes and up to 200,000 in

commercial structures.

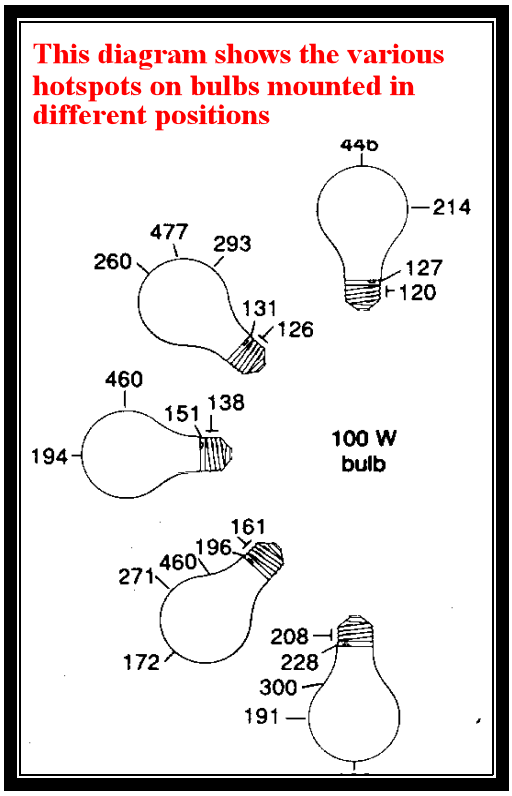
✡If a fire starts in the **service entrance conductors** then there **should not** be signs of electrical faulting downstream, in the branch or feeder circuits.

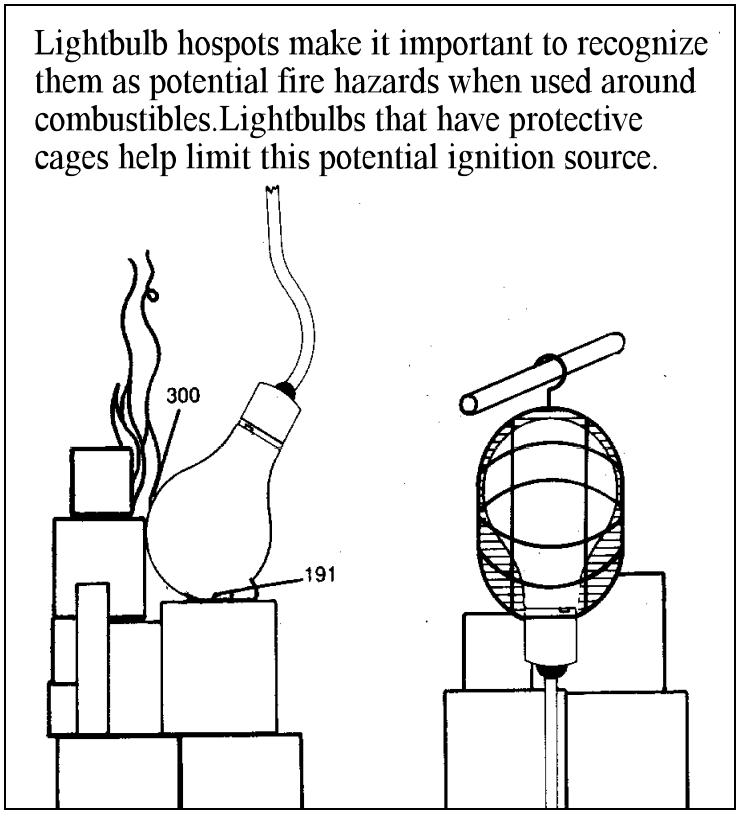
✡**Plastic jacketed romex** cable will not break down in **midrun** unless there is some type of abuse.

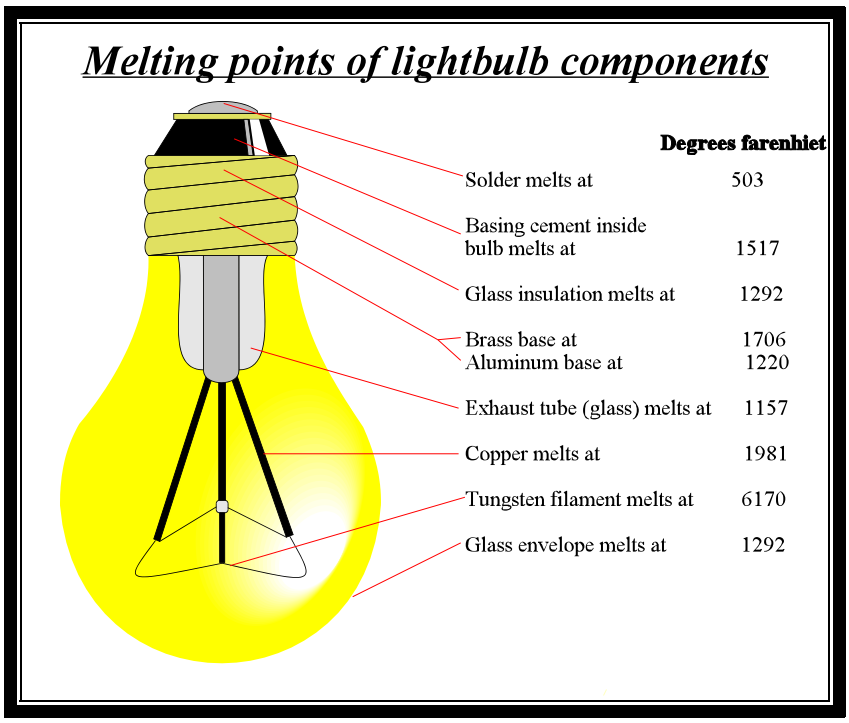
✡An **electric arc** has a temperature in the neighborhood of **5000 to 7000 degrees F**. It can start a fire if the duration and energy level are long enough and high enough.

✡**A static spark**, such as that from a doorknob, also has a temperature rating of **5000 - 7000 degrees F**, but it's duration is so short and it's energy so low that it typically will not even damage the skin.

A **Lightning Bolt** has enough duration and energy to ignite combustibles. Lightning can cause multiple faults in ci rcuit s.







Incandescent lamp temperatures*

Wattage	*Bare bultemp.F*
25 watts	110
40	252
60	260
100	261
200	307
300	374
500	389

Figures are with the bulb mounted base up

Filament temperatures F.

40-100 watts	4424-4676
150-200 watts	4712-4730
300-500 watts	4784-4838