Fuses

A. Fuses

1. Types of Circuit Protection

   a. Short circuit - One type of overcurrent condition – current flows outside of normal paths.

   b. Overload – Second type of overcurrent condition – current exceeds normal ratings but flow is confined to normal current paths.

   c. Selective Tripping – The fuse or circuit breaker closest to the fault opens, therefore minimizing circuit interruptions. This is accomplished by selectively using lower rated fuses/breakers closest to the load, and higher rated fuses/breakers closer to distribution loads

   d. Selective coordination - (same concept, different name) The act of isolating a faulted circuit from the remainder of the system, thereby eliminating unnecessary power outages. The faulted circuit is isolated by selective operation of only that over-circuit protective device closest to the overcurrent condition.

2. Fuse Ratings

   a. Voltage rating – the maximum voltage at which the fuse can suppress the arc created after the link melts.

      1) Unless prohibited by procedure, a fuse with a higher voltage rating may be used to replace a fuse of a lower voltage rating.

   b. Ampere rating – the current at which the fuse will blow (melt and open the circuit). It is not acceptable to use a fuse of higher current rating to replace a fuse of lower current rating.

   c. Interrupting rating – the maximum current at which the fuse will maintain its integrity while reacting to a fault.

1) The interrupt rating is sized to the circuit.

2) This allows for starting current and system characteristics such as circuit resistance, inductance and capacitance.

3. Fuses vs Circuit Breakers

a. Fuse Characteristics

1) No moving parts

2) No periodic maintenance required

3) Relatively high interrupt rating

4) High current limits (>200,000 to 500,000 amps)

5) Can be used only once

6) Relative inexpensive

b. Circuit Breaker Characteristics

1) Re-useable

2) Easy to verify open/close status

3) Control Circuits - interlocks, remote control, etc.

4) Expensive

c. Current Limiting Fuses

1) An UL listed, current-limiting fuse must clear a short circuit current in less than 1/2 cycle.

2) In its current limiting range, the fuse will melt in the first quarter cycle and prevent the fault from reaching the first peak of the asymmetrical waveform. This limits the total electrical energy delivered to the fault.

4. Types of Fuses

   a. Single Element Fuses

      1) Renewable vs Non-Renewable Fuses

         a) Renewable fuses require some maintenance.

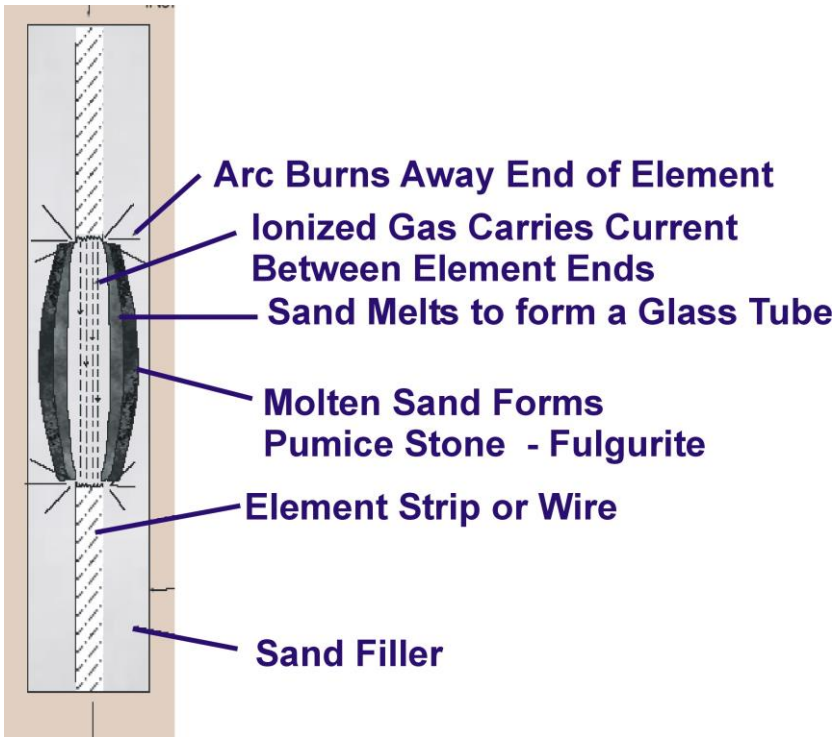
         b) Renewable fuses do not have a filler material to assist in arc suppression.

            (1) Renewable fuses are not used at Nine Mile Point.

            (2) There is no guarantee proper link will be installed in fuse case.

      2) Single Element fuses are non-surging

      3) Single Element fuses are less expensive



Picture 1, Single Element Fuse

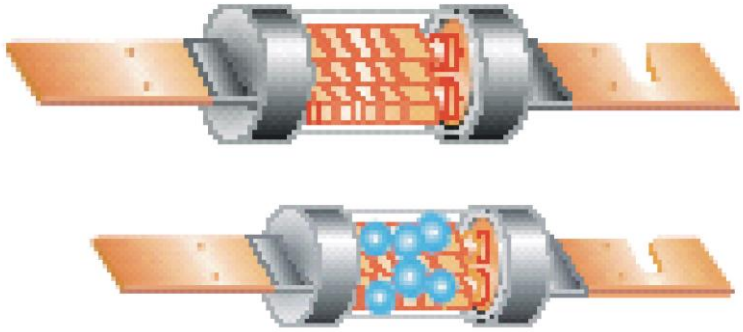
   b. Duel Element Fuses

1) Are typically used for overload and current limiting applications.

2) Typical protect motor overloads and transformers.

3) They provide motor overload, ground fault, and short-circuit protection.

4) They permit the use of smaller and less expensive switches.



Picture 2, Dual Element Fuses

5) They give a higher degree of short-circuit protection (greater current limitation) in circuits in which surge currents or temporary overloads occur.

6) They simplify and improve blackout prevention (when used with selective coordination/tripping).

7) The dual element fuse link employs a center section which does not require sand filling material. This is because the metal parts slow the temperature rise and allow free movement of these metal parts when clearing an overload.

5. Underwriters Laboratory Classifications for Low Voltage Fuses

a. Fuse dimensions are grouped by class.

b. They must withstand heavy short circuit current without exploding (interrupting capacity). They must operate at reasonably low temperatures.

c. They must operate at reasonable ambient temperatures, usually rated in deg. C.

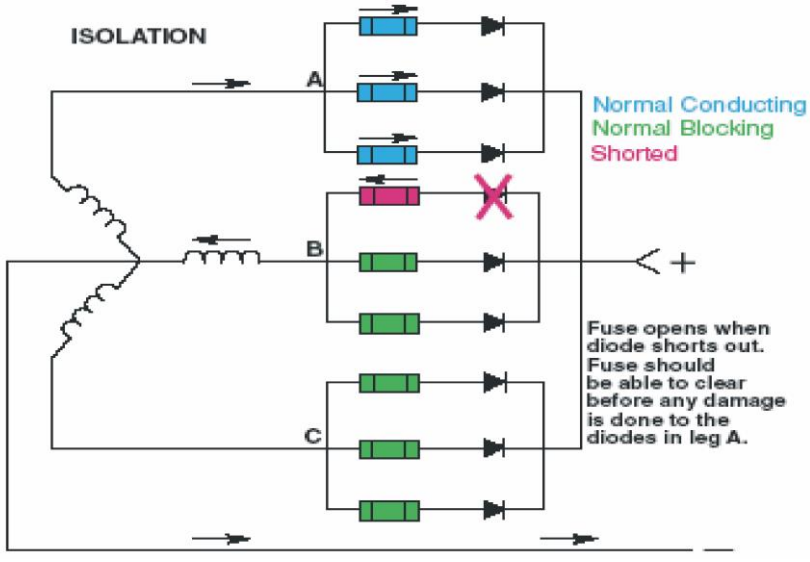
d. They must carry rated current (tested at 10% overload in open air).

e. They must blow promptly at overload conditions (tested at 35% overload in open air).

6. Semiconductor Fuses

a. Specially designed for solid state circuitry. Fast blow to protect delicate solid state devices from overcurrent conditions.

b. Delicate solid state components more susceptible to damage caused by overcurrent conditions. Require faster acting fuses to prevent overheating.



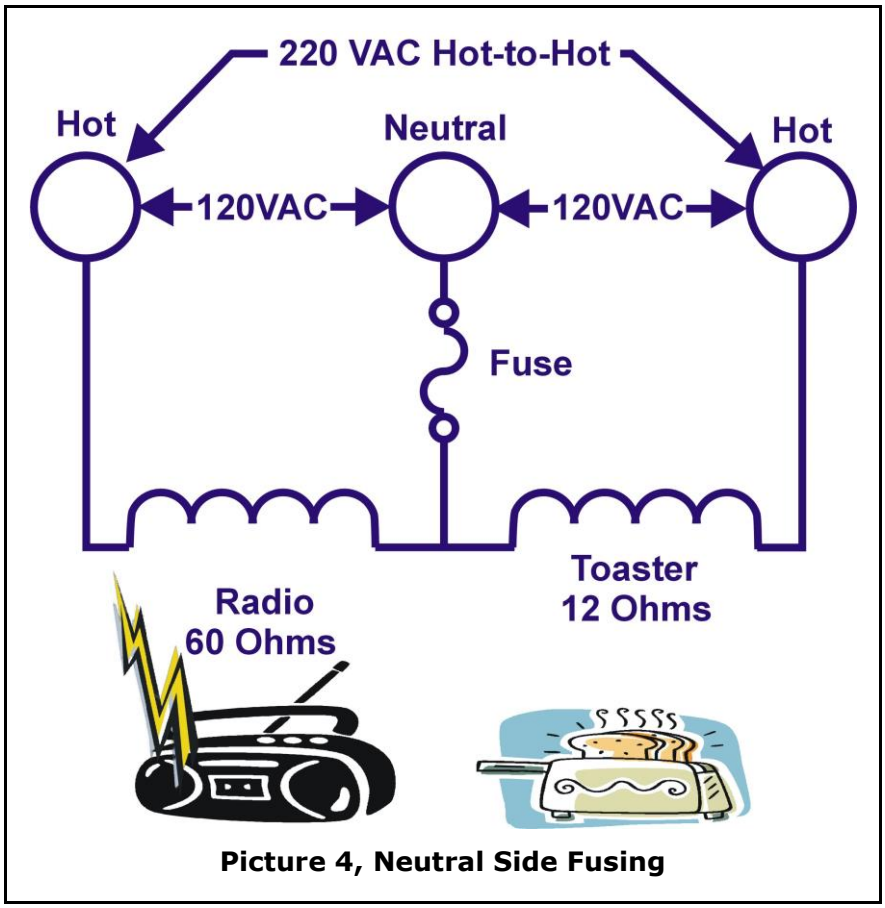
Picture 3, Semiconductor Fuses

7. AC and DC Circuit Fusing

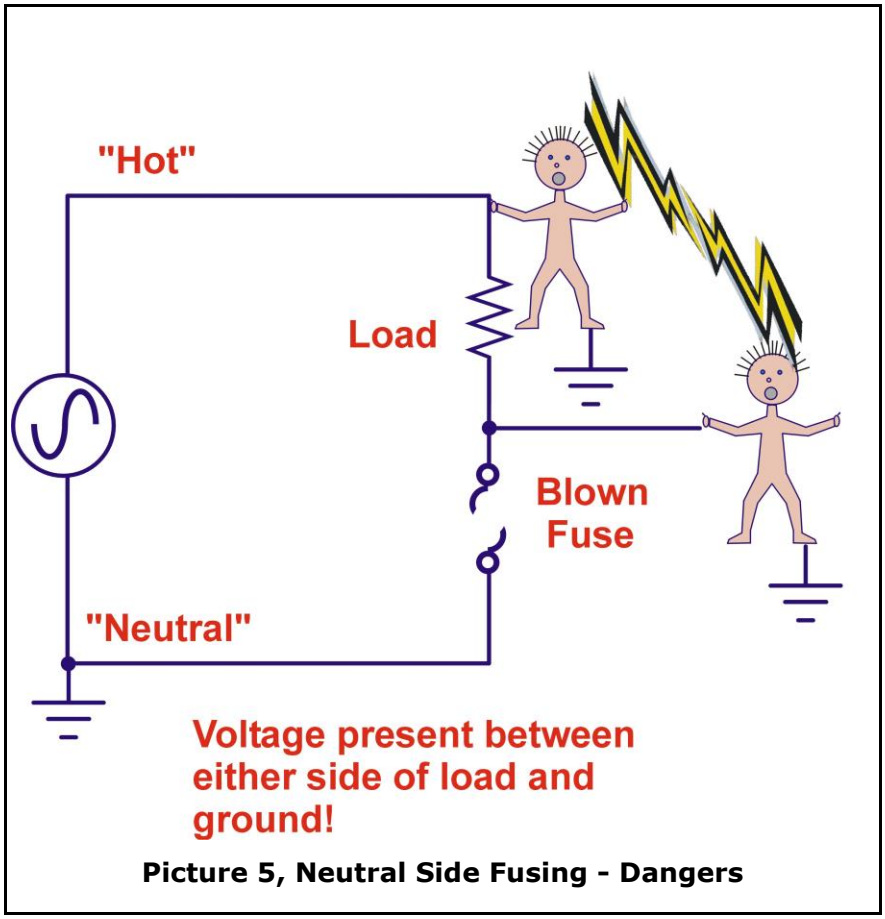
   a. AC "Hot Side" Fusing protects the circuit than neutral side fusing does.

   b. High voltages and currents may be seen if the neutral wire is opened.

   c. Greater protection than neutral wire fusing.



Picture 4, Neutral Side Fusing



Picture 5, Neutral Side Fusing - Dangers

d. DC Fuses - SER 33-86

1) During a refueling outage, power was lost to all four Intermediate Range Neutron Flux Monitors in one reactor protection system division. This occurred when fuses in the monitors' DC power supplies blew during a voltage transient.

2) Replacement of the fuses in the positive side cleared the associated control room annunciator alarms. Intermediate Range indication also appeared to be restored to normal. It was later discovered that the fuses on the negative side of the power supplies had also blown. This condition rendered these Intermediate Range Monitors inoperable even though they appeared to be functioning properly.

3) It is wise to check all monitors.

e. Fuse Testing - De-energized

1) Verify that the circuit is de-energized (dead).

2) Verify no circuits are in parallel with the fuse or remove fuse from the circuit (the latter is recommended). Use the proper fuse puller to remove the fuse.

3) Use the resistance scale on a multimeter to measure the resistance of the fuse.

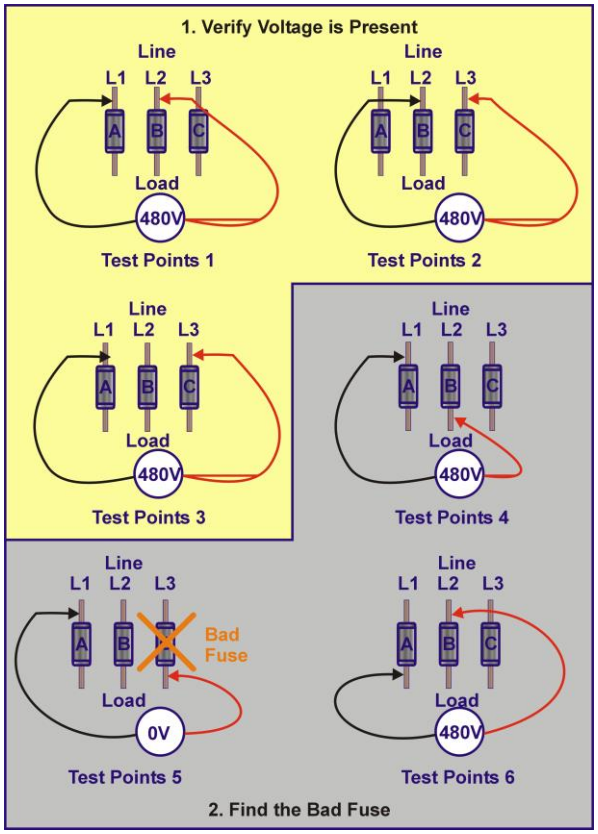
4) There should read very low resistance (near zero ohms) in both directions.

f. Fuse Testing - Energized

1) Be sure to use proper PPE and take required safety precautions.

2) Use a multimeter to check for voltage across fuse.

3) There should be 0 volts across the fuse. It any voltage is measured across the fuse, the fuse is bad.



Picture 6, Testing Fuses -The Energized Approach

PRACTICE:

1. When is it good practice to fuse the neutral side of a circuit?

2. Name two methods of testing fuses.