

<b>PPPL</b>	PRINCETON PLASMA PHYSICS LABORATORY ES&H DIRECTIVES	
	ES&HD 5008 SECTION 2, CHAPTER 12 <b>Resistors</b>	
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## CHAPTER 12 RESISTORS

### 12.1 DESCRIPTION

This section covers resistors used in the following applications to:

- A. Carry pulsed currents exceeding their steady-state ratings.
- B. Perform safety functions such as grounding.
- C. Absorb the discharge of stored energy.
- D. Provide a means of connecting instruments to a high-voltage circuit, as in a voltage divider.

### 12.2 TYPES OF HAZARDS

- A. Resistors used in discharge circuits can be damaged when operated at high-current or high-voltage levels.
- B. Resistors used in pulsed circuits can be subjected to overvoltages that can cause electrical arcs resulting in possible damage or failure of the resistors.
- C. Failure of a resistor used in a discharge device for an energy-storage system can create a hazardous condition if the discharge circuit does not function as intended during subsequent operation of equipment.
- D. Large currents, due to faults or abnormal circuit operation, may produce forces capable of destroying resistors. Damage to adjacent equipment and injury to personnel may result.
- E. In the voltage divider of a high-voltage metering circuit, failure of a resistor used in the low-voltage section can create hazardous voltages on the low-voltage metering circuit and at the instrumentation location.
- F. Resistors requiring liquid or forced-air cooling are subject to overheating and failure if the cooling system fails.
- G. Hazardous voltages can develop across resistors in grounding circuits when fault or discharge current flows.
- H. Resistors may operate at temperatures high enough to cause severe burns to personnel or ignite combustible materials.
- I. Failure of an inductor-discharge resistor, such as those used for a motor field winding, can result in hazardous and destructive voltages in the motor circuit.
- J. Failure of a power supply bleeder resistor could expose personnel to hazardous voltages.

### 12.3 DESIGN AND CONSTRUCTION CRITERIA

The following shall be adhered to:

- A. Select resistors for pulsed operation so that any possible succession of pulses in the circuit will not raise the temperature of the resistors to levels harmful to the resistors themselves or to surrounding equipment.
- B. Provide resistors that are capable of withstanding any transient overvoltages to which they may be subjected.
- C. Resistors used where large pulse or fault currents may be expected shall have sufficient structural strength to withstand the resulting magnetic forces. Resistors shall be installed in an enclosure capable of minimizing damage and preventing injury should a failure occur.
- D. When failure of a resistor could expose personnel to hazardous voltages, install two or more resistors in parallel, each rated for maximum operating conditions.
- E. Install temperature or flow-sensing devices in resistor installations that require liquid or forced-air cooling.
- F. Resistors operating at voltages or temperatures hazardous to personnel should be installed in an enclosure with the access interlocked to prevent entry while the resistors are energized.
- G. Provide resistor enclosures that are well ventilated and constructed of noncombustible material. See NEC article 470 for details.
- H. Provide adequate "WARNING" or "CAUTION" signs and/or warning lights to alert personnel of the hazards present in resistor installations.
- I. Protect resistors used in high-voltage circuits from surface contamination due to or caused by adverse environmental conditions.
- J. Assure that the insulation of conductors used to connect resistors is adequate for the temperatures and voltages to be encountered.
- K. Install resistors in a manner that inhibits damage to adjacent components due to dissipated heat.
- L. Design resistor networks and configurations so that each resistor operates within its rating or capability.

### 12.4 OPERATING CRITERIA

- A. Conduct a periodic inspection of the condition of resistors, including their connections. Replace resistors in questionable condition. Clean and tighten corroded or loose connections.
- B. Test personnel-safety-interlock systems of resistor enclosures at least annually and document the results. Personnel-Safety-Interlock procedures are described in Chapter 5, paragraph 5.8.4.