CHAPTER 11 POWER SUPPLIES

11.1 DESCRIPTION

This section shall apply to:

A. Power supplies operating above 50Volts.
Exception: Commercial high voltage power supplies specified for use in AC Power systems when fabricated, tested, and installed in accordance with NEMA Standard ST- 20, ANSI C37 and C57 series standards.

B. Power supplies associated with the energy-storage devices that are described in chapters on capacitors and inductors (Chapters 6 and 9, respectively).

11.2 TYPES OF HAZARDS

A. A power supply in a remote location could be energized and personnel could unknowingly come in contact with the energized equipment (connected load).

B. Electrical faults or switching transients can cause voltage surges in excess of the normal terminal voltage rating of the power supply.

C. Internal component failure can cause excessive voltages on external metering circuits and low-voltage auxiliary control circuits.

D. Overload or improper cooling can cause excessive temperature rise, resulting in possible equipment damage and associated hazards.

E. Electrical faults can cause conductors to melt and cause other components, such as insulating materials, to melt, explode, or burn.

F. Output circuits and components can remain energized when input power is interrupted, due to parallel power sources or stored energy in reactive components (e.g., capacitors).

G. Auxiliary and control power circuits can remain energized when the main power circuit is interrupted.

H. When power supplies serve more than one experiment, switching errors can result in energizing the wrong equipment (load), creating hazards to nearby personnel.

I. Overcurrent-protective devices rated for conventional applications, such as fuses and circuit breakers, may not adequately limit or interrupt the total inductive energy and fault currents in highly inductive dc systems.

11.3 DESIGN AND CONSTRUCTION CRITERIA

A. Circuits, components, or other equipment not essential to the power supply shall not be installed within the power-supply enclosure.

B. Energy barriers shall be provided to prevent high-voltage stored energy from being dissipated in a low-voltage supply and/or control circuits. See Chapter 4 for barrier descriptions.

C. Overcurrent, undervoltage, or other protection shall be provided for both power supply and load, as appropriate.

D. For each power supply, the main-power input-circuit breaker (disconnect) shall be clearly identified. The breaker should be located within sight of the power supply, if feasible. If not feasible, then the remote breaker or disconnect shall be equipped with lockout provisions and a second means of input-power shutdown, such as an E-STOP, shall be installed locally at the power supply.

E. Alarms, signs, or lights shall be provided to warn personnel that the power supply is energized, especially on remote loads and power supplies above 600volts.

F. Multiple input-power sources should be avoided, where possible.

G. Inductive loads shall have a thyrite or equivalent device connected across the power supply dc terminals to assure satisfactory discharge of stored energy.

H. Verify that combination fuse-circuit breakers are properly coordinated by referring to their listing and the manufacturers application data.

I. Power supplies above 600 volts should haveautomatic switches or contacts should be provided that ground and short power supplies when they are turned off. In addition, temporary grounding and shorting devices, discussed in Chapter 15, shall be provided for use when personnel are allowed access to an area containing high-voltage equipment. Such equipment includes Capacitor Banks (Chapter 6), certain enclosures (Chapter 8), and Inductors (Chapter 9).

J. Power supplies above 600 volts to reactive loads shall be provided with means for disconnecting and grounding the loads before access to the power supplies is permitted.

K. Power supplies containing flammable liquid shall conform to NEC Article 450-26.

L. The number of control stations from which a power supply can be operated shall be minimized. The local controls of the power supply must incorporate a lockout of all remote controls (except the “emergency-shutdown” function) to prevent inadvertent operation of the power supply (see Chapter 5, paragraph 5.5.6).

M. Emergency-shutdown pushbuttons (E-STOPs) shall be provided at control stations and at other locations where there is a potential hazard to personnel created by operation of the power supply (see Chapter 5, paragraph 5.6).

N. Enclosures for power supplies shall be constructed of noncombustible, conducting material that shall be grounded to adjacent building steel with a conductor suitable for fault conditions and using approved connections. Access doors shall be screwed on with the voltage level and warnings stated on the door. Door interlocks shall be provided on all power supplies above 600 volts.

O. Remote-control and monitoring circuits shall have overload or short-circuit protection connected at the point where the conductor receives its supply.

P. Prior to initial operation, the power supply shall be "meggered" or "hi-potted," protective devices shall be calibrated, and control devices functionally checked, with the results recorded for future troubleshooting.

Q. Overload, short-circuit, and (if required) ground-fault protection shall be used in the power supply output.

11.4 OPERATING CRITERIA

A. Protective devices shall be periodically calibrated, checked, and the results documented.

B. Before entering a power supply or associated equipment enclosure, the following precautions shall be taken to positively de-energize the circuit(s) that feed the equipment:

1. Turn off power supply and de-energize the circuit(s) by opening the main input-power circuit breaker(s) or disconnect(s). Move metal-clad breakers to the racked-out or withdrawn position. Lockout and tagout their handle or racking mechanism and, if available, the disconnecting means.

2. Check for auxiliary-power circuits that could still be energized and positively de-energize them.

3. Visually inspect automatic shorting devices to verify proper operation.

4. Using personal protective equipment and tested meter, test for energized circuits. Verify operation of meter before and after use.

5. Once verified that the circuits are de-energized, proceed immediately to short-circuit and ground the ungrounded conductors at the power supply with grounding cables and grounding sticks. Tagout the grounding connection.

C. Label equipment to identify their power sources and label power sources to identify their loads.

D. Equipment that is remotely controlled or unattended while energized shall be labeled with both emergency-shutdown instructions and the identification of responsible personnel to contact in case of an emergency.