DC Power Supply Protection
W4NPN

This is a compilation of advice and suggestions I've gathered over the years from people smarter than me; mostly engineers and highly trained technical people. Unfortunately, I've never seen a compilation of protection and safety information in one place, so this is my understanding of the subject.

AC Input: Use a slow-blow fuse rated to carry the load plus about 30% and round up. Thus, a 3 amp load would require 3 x 1.30 = 3.9 amp fuse. Use a 4 amp; 5 amp will do if no 4 amp can be found.

The fuse should be the f**irst device** in the AC line, not after the AC safety capacitors and not after the switch. Putting it after some circuitry such as the AC safety caps is a common design error. Should they short, the fuse won't blow and a fire or shock hazard might exist.

Consider using an NTC Varistor or a relay-type "Slow-Start" circuit in the transformer primary lead. Solid state rectifiers switch on instantly, giving the transformer a real jolt, especially if they feed into a large filter capacitor bank (which looks almost like a short circuit at start-up). Additionally, large transformers (think microwave oven transformers, for instance) demand a huge amount of current when energized. Until the inductive resistance and magnetic fields build, they essentially act as short circuits. The inrush spike can be as much as ten times the normal current. These two factors explain why the transformer might hum or buzz upon turn-on, why fuses or breakers might blow and why some sort of soft-start device is advisable for large transformers.

The old style tube rectifiers don't begin to conduct until the filaments reach about 60% of their voltage so they have a built-in slow start feature. The inductive resistance and magnetic field factors still remain, even with tubes, but to a lesser extent.

A slow start circuit can be removed from a junked microwave oven – all the ovens with linear power supplies have them. And NTC Varistors are cheap. I have used them for years in both rewound low voltage and high voltage microwave oven transformer circuits, with no fuse or breaker problems.

Be aware that NTC Varistors have a cool-down time period before they are back to their intended slow start mode. So if you flip the HV switch on-off-on, it might not have cooled enough for it to do its job on the second turn-on. Wait at least a minute before flipping the HV switch again.

Consider placing 30 to 50 ohm resistors in each leg of the secondary winding. Again, this slows the inrush to the rectifiers which reduces the jolt to the transformer as well. This is an old-fashioned inrush abatement technique but it works.

Immediately following the solid state rectifier(s), and before the filter capacitors, place a high voltage fuse. If this is a high voltage power supply, use one designed for use in Microwave ovens. They are cheaply available on Amazon or Ebay. Size it with enough headroom that it will blow with, say, a 50% overload. Use one that comes housed in a protective plastic case. If it blows, you don't want glass shards flung throughout the power supply, waiting for your fingers.

NEVER use an ordinary 120/250 VAC fuse in the very HV power supply. These can arc over and cause real mischief. They are safe for medium voltage supplies, however, perhaps up to 350 volts. And don't let the glass portion acquire fingerprints, grease or dirt. Keep the glass clean to reduce the liklihood of a flash-over.

After the HV fuse, place a wirewound “glitch resistor.” This is normally about 50 ohms, of as many watts as you can find. For a 2500 volt power supply, a 50 watt resistor is optimal, but use what you have. A ten or 20 watter is probably OK. It’s purpose is to soak up an instantaneous surge such as a brief flashover or arc and will protect the fuse in many cases.

Some designs use the filter capacitor equalizing resistors to discharge the caps upon shut-off, rather than installing a proper safety bleeder. Whichever way you choose, size them so that they will discharge the HV before the time it takes to open the supply’s cabinet and stick your fingers in.

If the case of your HV power supply has the type of lid that can be quickly popped open, strongly consider a switch-and-relay system that will instantly ground the HV through a 10K or 20K wirewound resistor of at least 20 watts (the current surge will last only a fraction of a second).

If you use a safety bleeder in an HV supply, don’t use a single high value resistor – it might arc over. Use several resistors in series. Example: for a 10 ma bleed in a 2500 volt supply, 250,000 ohms are needed. Use five 50K resistors in series. Four 60K would be close enough.

You DO unplug the unit and READ THE HV METER before opening the unit, don’t you?