GOING BEYOND THE BASICS OF UPS SIZING WITH A COMPREHENSIVE DESIGN PLAN

PROPERLY DESIGNING AND INTEGRATING AN UNINTERRUPTIBLE POWER SUPPLY SYSTEM MUST ACCOUNT FOR NUMEROUS VARIABLES

Every industrial, utility, commercial, and institutional operation places heavy demands upon its electrical network to deliver safe and reliable power 24/7/365. To minimize the risk of costly interruptions, users depend upon uninterruptible power supplies (UPS) to step in and deliver emergency power nearly instantaneously and seamlessly when the electrical grid experiences outages. The primary function of a UPS is to supply power in the gap between when a power fault on the grid occurs and when a generator or other longer-term backup power source activates. However, UPS systems are often required to do much more – getting this component right is paramount for such operations.

UPS systems must be designed to protect sensitive electronic equipment used in data centers, healthcare facilities, industrial environments, and offices against power inconsistencies, including power outages, voltage sags and surges, brownouts, power spikes, frequency noise, and harmonic distortion.

The most basic standby UPS systems provide power protection by switching to battery backup when they detect power fluctuations. More sophisticated line-interactive UPS systems adjust voltage levels as required, offering moderate power protection with voltage regulation. Double conversion UPS systems are commonly used in critical data centers, medical facilities, and extensive enterprise applications and provide comprehensive power protection by converting incoming AC power to DC and back to AC, ensuring a consistent and clean power supply regardless of input quality.

A Guide to UPS Sizing

Sizing a UPS correctly for the intended application requires considering several factors.

1. *Assessing the risk of power outages*: Reviewing historical data on the frequency and severity of power outages for the network being evaluated offers valuable insights into how demanding the application will be for a UPS system.

2. *The total power demand*: Listing all the critical loads and their power ratings that the UPS will be expected to operate
    a. Add the power demand of all loads connected to the UPS in watts
    b. Calculate or estimate the power factor (PF = watts/volt*amps) of the connected load, where PF reflects the efficiency with which each device converts electrical power into useful work output (typically 0.6 to 0.8 for many devices)
    c. Add a safety factor of 20-25% or as required to the total power draw (calculated as watts/PF) to accommodate peak load conditions and potential future expansions.
3. *The redundancy needed*: Configuring the UPS system to achieve the level of system reliability required by the application in the event of a UPS failure
    a. N+1 redundancy provides a full UPS backup should one UPS system fail or be pulled from service to undergo maintenance
    b. 2N or 2(N+1) redundancy offers higher reliability for more critical applications by duplicating the UPS backup should one set of UPS systems fail or require maintenance.
4. *The scalability required*: Factoring in the anticipated future growth of the network that the UPS must protect without requiring a complete refurbishment.
5. *Environmental issues like temperature and humidity*: Variations in temperature from an optimal 68°F to 77°F can affect the performance of UPS systems, particularly their batteries
    a. High temperatures tend to reduce the lifespan and efficiency of batteries, resulting in more replacements and additional battery capacity to deliver desired runtimes
    b. Extremely low temperatures diminish a battery's power output, requiring more batteries to produce the necessary power.

    High humidity leads to condensation, increasing the risk of short circuits in the electrical network. Low humidity can increase the chance of static electricity build-up that can damage electronic components.
6. *Runtime requirements*: Knowing how long a UPS must fully power its connected load at the battery's rated voltage during a power outage is crucial to sizing the battery energy capacity, measured in watt-hours (Wh).

    *Battery Energy Required (Wh) = [Total Connected Load (W)] * [Desired Runtime (h)]*

    Add 10-20% to the watt-hour requirement to account for inefficiencies and energy losses in the UPS. If applicable, factor in performance degradation based on battery age and environmental temperature considerations.

Battery capacity is commonly measured in ampere-hours (Ah). To determine the battery's required Ah rating, use the formula:

Required Battery Capacity (Ah) = [Adjusted Required Energy (Wh)] / [Battery Voltage (V)]

7. *Harmonic distortion*: Non-linear loads like computers and electric motors can generate currents and voltages with frequencies that are multiples of the fundamental frequency, creating harmonic distortion. The impact of such distortion can lead to overheating, equipment malfunction, and reduced efficiency. Selecting a UPS with a higher kVA rating or designed to handle high harmonic loads may be necessary.

8. *Load crest factor*[1]: Defined as the ratio of the peak value of a waveform to its RMS (root mean square) value, crest factors often become an issue of concern in modern IT equipment due to electronic switched-mode power supplies. Handling high crest factors without overheating or tripping may require oversizing the nominal capacity of a UPS.

9. *Leading and lagging power factors*: Capacitive loads such as variable frequency drives, lighting ballasts, and cables create conditions where the current waveform leads the voltage waveform. Leading power factors can cause problems regulating voltage and create instability for a UPS. Inductive loads such as motors and transformers cause the current waveform to lag voltage. Lagging power factors can reduce the available actual power capacity of a UPS.

A properly designed UPS system provides invaluable protection against the loss of production and operations and significantly reduces the risk of equipment damage and possible harm to workers. Sizing a UPS correctly is not a trivial exercise. Consulting with a UPS manufacturer employing the latest sizing tools should provide valuable insights and recommendations tailored to the specific requirements of the application.

At Global Power Systems, we perform specialized UPS studies that comprehensively evaluate your existing power systems. From our research, we can help you determine the need, feasibility, and optimal strategy for integrating an uninterruptible power supply system for your application.

Contact us today to learn more about our turnkey backup power solutions and engineering capabilities that reduce your risk of loss from power outages.

[1] https://www.electricalvolt.com/what-is-crest-factor-or-peak-factor/