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Ups battery calculation pdf

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Determine the need for a UPS before selecting one, as it can be used for various purposes such as lighting, startup power, transportation, mechanical systems, heating, refrigeration, production, fire protection, space conditioning, data processing, communication, life support, or signal circuits. The acceptable delay between primary and backup power availability, emergency power duration, and load criticality are crucial factors in UPS sizing and selection. Single-phase power is commonly used in homes and small businesses for running lights, fans, computers, and motors up to 5 horsepower. However, single-phase power draws significantly more current than equivalent three-phase power, making it less efficient for industrial applications. Three-phase power, on the other hand, is widely used in large businesses, data centers, and industries due to its efficiency and ability to support larger loads. The choice of UPS type (single-phase or three-phase) depends on factors such as load capacity, electrical distribution within the facility, and building incomer specifications. Three-phase UPS systems offer more power than single-phase systems and are often preferred in large-scale applications. The laws of physics and Ohms Law govern cable sizing and output amperage requirements for UPS systems. Key considerations when selecting a UPS include determining the acceptable delay between primary and backup power availability, emergency power duration, and load criticality. Additionally, factors such as electrical distribution within the facility, building incomer specifications, and load capacity must be taken into account to determine the most suitable UPS configuration. Commercial and industrial buildings often have three-phase electrical connections through local distribution transformers to the mains. This allows for efficient handling of large electrical power demands. Three-phase circuits may be required throughout these buildings, especially for heavy KVA loads. From a UPS (Uninterruptible Power Supply) perspective, connecting it to a three-phase supply requires a 3/x configuration. If the loads are also three-phase, a 3/3 setup is needed, while single-phase loads might require a 3/1 configuration. Using a three-phase UPS system can simplify power continuity plans and enable centralised power protection, where one large UPS protects an entire building or critical circuits. This contrasts with decentralised plans that use multiple smaller UPS for individual clusters of loads. Single-phase UPS systems (1/1) are used for lighter loads like desktop computers, file servers, and telecoms systems. These are typically rated at 230Vac 50Hz in India. For single-phase UPS above 5KVA, hardwired installations with a maintenance bypass switch are required. When sizing UPS, both the phase configuration (mains supply vs. load) and overall load size must be considered. Electrical consultants and contractors often specify load size and phase configuration together, such as '120KVA three phase'. Understanding these configurations is crucial for determining the correct UPS system capacity. A 120KVA three-phase UPS could be met with smaller single-phase output UPS (40KVA each), but this would increase capital, installation, and energy efficiency costs. Three-phase/one-phase (3/1) UPS systems are used in office environments where loads are predominantly single phase. UPS Configuration Steps DC power supply to inverter becomes vital component when main fails Lead acid batteries widely used in UPS systems due to their reliability. They have a one-way valve system which helps to remove oxygen from negative plate. This technology is known as "recombinant" and reduces production of hydrogen. Sealed maintenance free (SMF) VRLA batteries are commonly used in UPS systems. They do not require watering and should never be opened. The battery's nominal cell voltage is 2V, six cells connected in series for final 12V. Capacity defined as Ampere Hour (AH). Batteries connected in parallel to increase capacity, in series for increased voltage. Battery life affected by factors such as charge, cycle usage, temperature and operating conditions. Design life determined by manufacturer but real service life depends on various factors. When powering a UPS with AC power, it may lead to prolonged battery discharges or even more. Frequent cycling can significantly shorten the battery life. Properly sizing batteries ensures that they can cater to loads for an extended period (autonomy) designed for specific applications. Inadequate sizing leads to poor autonomy times, permanent damage from over-discharge, and UPS shutdown due to low voltage. To size batteries correctly, consider factors like load nature, duration, momentary, or continuous, as well as battery autonomy time, design margin, ageing factor, and temperature effects. Design margin provides a capacity buffer for unforeseen load additions or suboptimal operating conditions. Adding 10-15% load to calculations can ensure this. Ageing factor accounts for the decline in performance due to age; after reaching 80% of rated capacity, batteries should be replaced. Temperature correction factors are necessary when installation temperatures deviate from standard 25°C. IEEE 485 provides guidelines for vented lead-acid cells (see table), while sealed lead-acid and Ni-Cd cell manufacturers' recommendations should be consulted. Note that high temperatures reduce battery life regardless of capacity, and the temperature factor only affects sizing, not actual lifespan. The UPS inverter maintains a constant voltage to connected loads during battery discharge. The DC input voltage decreases as the battery discharges, prompting increased discharge current to maintain power output. Batteries can be connected directly to the inverter's input (refer Figure 8), with load based on output and inverter bridge losses. The battery load for sizing purposes is based on the UPS output rating in watts divided by the efficiency of the inverter. The nominal battery load should be adjusted for ageing and operating temperature conditions, then cross-referenced with the battery manufacturer's discharge characteristics for a specified battery autonomy time. General guidelines for battery selection include calculating the load in Watts-hours as accurately as possible, considering system losses due to efficiencies of power conditioning, and including appropriate factors such as temperature, autonomy, design margin, and depth of discharge (DOD). It is recommended to select highest battery capacities per unit to reduce the number of battery strings in parallel for better charge balance. The maximum recommended number of strings in parallel is four. When determining battery capacity, it's essential to consider factors like permissible temperature rise, permissible voltage drop, and the required distances between control circuits and power circuits to avoid EMI disturbances. Limited by cable insulation, temperature rise depends on core type, installation method, number of touching cables, and voltage drops. Maximum permissible voltage drops vary: • AC circuits: exceed 3% (50-60 Hz), increase conductor cross-section. • DC circuit: exceed 1%, increase conductor cross-section. Special neutral conductor rule for three-phase systems applies. To determine cable cross-section, calculate output current using the cable manufacturer's datasheet and conditions. As a thumb rule, consider 2A/sq mm to select required cables. UPS input power calculation: Step 1: Derive input power of Inverter Step 2: Calculate battery charging power in W Battery Charging Power = 2.2V X No of Cells X Charging Current (10% of AH Capacity) Step 3: Calculate rectifier input power in W Step 4: Convert rectifier input power to KVA, considering input power factor and minimum operating Voltage of Rectifier. UPS to battery cables selection based on current at minimum discharge voltage. Use Uninyvin cables for high current carrying capacity and smaller cross-sectional area. Moulded Case Circuit Breakers (MCCBs) protect circuits from Overcurrent and Short Circuit. They manually open or automatically open the circuit under overload or short circuit conditions, offering improved operational safety and convenience without replacement costs. UPS capability to withstand short circuits varies depending on selection of components. Critical evaluation is needed for its ability to handle short-circuit current on output for certain duration. This depends on whether inverter or source handles current through static bypass. In first case, it strictly depends on UPS design. In second case, it relies on SCR's i2t characteristic in bypass path or fuse if present. Short circuit increases significantly on distribution system output. Fault not cleared within milliseconds risks downtime of connected loads as UPS trips. Minimum i2t let-through upstream device must be higher than maximum i2t let-through downstream device for protection. For short-circuit protection, UPS operates under two conditions: with bypass source available or without it. In both cases, let through energy (i2t) of MCBs has to be managed properly to avoid loss of loads. Let through energy of MCCB2 is crucial as SCR fails if it exceeds SCCB2's capacity. To protect loads and have proper discrimination, the rule i2tSCR > i2tMCCB2, i2tMCCB3 > i2tMCB6 > i2tMCCB7 must be respected. Short circuit without bypass occurs when bypass is disabled or source is not available. Inverter supports short duration before tripping due to electronic protections. Critical coordination of MCCBs' and MCBs' magnetic setting with inverter S.C current is required. Short circuit with transformer in PDU or global output of UPS changes downstream circuit's discrimination. The fault discrimination in question has no relation to the transformer's impedance. The fault circuit current or let-through energy is solely dependent on the transformer's impedance. A 200A-rated transformer with a 5% impedance would have a short-circuit current of 4KA. In contrast, battery performance is vital for UPS systems, providing DC power to inverters when mains fail and getting recharged via rectifiers when mains return. However, batteries also contribute to fault currents during faults on the battery itself. The main parameters influencing fault current magnitude are internal resistance (dependent on plate surface area, internal spacing, and electrolyte type) and external circuit resistance. Short-circuit current varies based on battery condition and age. As batteries age, internal resistance rises and short-circuit current falls. If this reduced current is below the pickup value for the magnetic setting of the breaker, the breaker will not trip, defeating its purpose. To address this issue, the magnetic pickup of the breaker's trip unit is set at 70% of the nominal short-circuit current, ensuring that even at low voltage or when a battery reaches the end of its life, the battery breaker effectively "protects" it.