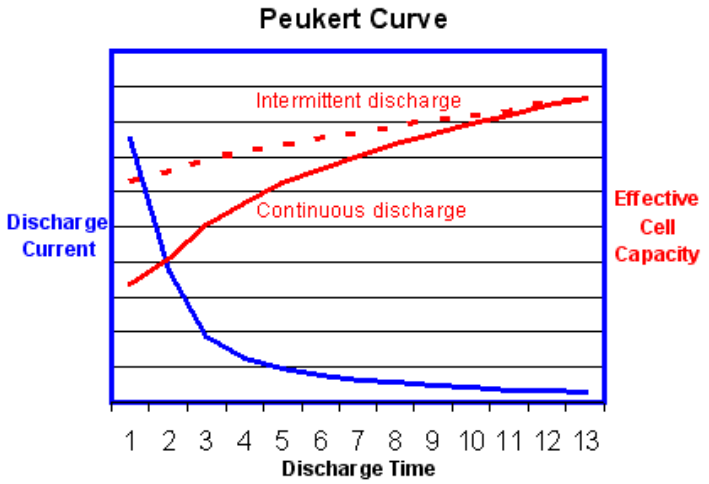
THE PEUKERT EQUATION – An explanation of Battery Discharge Rates for Single vs. Multiple Battery Strings

The Peukert equation is a convenient way of characterizing cell behavior and of quantifying the capacity offset in mathematical terms. This is an empirical formula which approximates how the available capacity of a battery changes according to the rate of discharge. $C = I^n T$ where "C" is the theoretical capacity of the battery expressed in amp hours, "I" is the current, "T" is time, and "n" is the Peukert Number, a constant for the given battery. **The equation shows that at higher currents, there is less available energy in the battery. The Peukert Number is directly related to the internal resistance of the battery. Higher currents mean more losses and less available capacity.**

The value of the Peukert number indicates how well a battery performs under continuous heavy currents. A value close to 1 indicates that the battery performs well; the higher the number, the more capacity is lost when the battery is discharged at high currents. The Peukert number of a battery is determined empirically. For Lead acid batteries the number is typically between 1.3 and 1.4

The graph to the right shows that the effective battery capacity is reduced at very high continuous discharge rates. However with intermittent use the battery has time to recover during inactive periods when the temperature will also return towards the ambient level. Because of this potential for recovery, the capacity reduction is less and the operating efficiency is greater if the battery is used intermittently as shown by the dotted line. Note that this is the reverse of the behavior of an internal combustion engine which operates most efficiently with continuous steady loads. In this respect electric power is a better solution for delivery vehicles which are subject to continuous interruptions.



Source: http://www.mpoweruk.com/performance.htm

A real life example of the battery discharge time difference between one vs. two battery cabinets follows:

A 225 kVA/202 kW UPS utilizing (1) battery cabinet with 500 watt/cell batteries vs (2) battery cabinets with 500 watt/cell batteries in each cabinet. The single battery cabinet provides 5 minutes of backup time at 202 kW. The two battery cabinet solution provides 18.5 minutes of backup time at 202 kW. The initial thought might be that the 2 cabinet solution would provide 2 times the backup time. In fact, the 2 cabinet solution provides more than 3.5 times more backup time. The two cabinet solution also provides redundancy.

That is the power of The Peukert Equation.

NOTE: The current discharge is equally shared between multiple parallel battery cabinets. (The actual current discharge is slightly different due to impedance from the different wire lengths from each battery cabinet to the UPS) Therefore, the current discharge is two times higher with one battery cabinet vs. two battery cabinets. As described above, the Peukert curve explains that less power is available at higher discharge current – explaining the non-linear difference in battery runtime when comparing (2) battery cabinets (or more) vs. (1) battery cabinet.

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