Issue

In the NRC's April18, 2013 public meeting on "Mitigating Strategies Integrated Plan Review", the NRC raised the following issue:

> Several licensees have stated that their Class 1E station batteries can last beyond 8 hours. The Institute of Electrical and Electronics Engineers (IEEE) Standard 535-1986, "IEEE Standard for Qualification of Class 1E Lead Storage Batteries for Nuclear Power Generating Stations," as endorsed by Regulatory Guide 1.158, "Qualification of Safety-Related Lead Storage Batteries for Nuclear Power Plants," provides guidance for qualifying nuclear-grade batteries and describes a method acceptable to the NRC staff for complying with Commission regulations with regard to qualification of safety-related lead storage batteries for nuclear power plants.
>
> Identify the length of the duty cycle for which a vented lead-acid battery is qualified per IEEE Standard 535-2006.
>
> Discuss if there are any limitation(s) on the length of the duty cycle for a vented lead-acid battery, and please specify the technical bases (i.e., methodology, assumptions, and prerequisites) used to establish this.

Response

1) The industry does not believe IEEE 535 is applicable to beyond design basis events and battery qualification for an extended loss of ac power event is not intended.

2) Typically to extend the FLEX mission time of the batteries, stations are relying on timely load shedding of non-essential loads (including non-essential Class 1E loads) from the batteries. Engineering calculations are utilized to provide a reasonable engineering basis to demonstrate that the batteries will have sufficient FLEX mission time to maintain power to key instruments until deployment of on-site portable FLEX equipment. The actual FLEX battery mission time needed at a site is dependent upon the individual station FLEX strategies.

3) Existing station batteries are qualified to meet their design basis function throughout their qualified life. Current Technical Specification surveillance and safety-related maintenance practices ensure the station's safety-related batteries are maintained ready to perform their function when required.

4) The existing maintenance and surveillance programs are adequate to trend battery capacity and to ensure age-related or other degradation is addressed for station safety-

related batteries before the design basis capacity is challenged. An aging factor is included when sizing lead-acid batteries for design basis loads to allow time for replacement once degradation is detected/confirmed.

5) Based on the well-maintained condition of the safety-related batteries (as a result of existing maintenance and surveillance programs), the capacity of the batteries to carry design basis loads is known.

6) Load shedding is an established industry practice to extend battery mission time. Given the known capacity of nuclear plant station batteries, load shedding is a reasonable strategy to extend battery runtime during an ELAP to meet the FLEX battery mission time. Load shedding was explicitly identified in NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide", Section 3 as a means to extend battery runtime.

7) IEEE 485, "Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations", methodology is the industry Standard for battery sizing, taking into account correction factors for aging, temperature, and design margin, with the certified manufacturer's discharge data. The IEEE 485 methodology has been proven over time in many nuclear station applications and is widely used by manufacturers, utilities, consultants, and others throughout the battery industry.

    a. Using the specific FLEX load profiles as design inputs, the effect of load shedding on the battery runtime can be evaluated using IEEE485.

    b. The aging correction factor is an integral part of IEEE 485 methodology to adjust the battery sizing for the proper end-of-service life condition (normally 80% of rated capacity).

    c. Testing a stationary battery to detect signs of degradation and/or when to replace the battery can be accomplished by testing the battery per IEEE 450. When degradation occurs or capacity approaches 80%, then cell replacement can be planned. This is current industry practice.

    d. The certified manufacturer's discharge data is supplied with the batteries and gives a range of discharge rates for various times and end voltages based on various factory tests. The discharge times typically range from 1 minute to several hours. This discharge data may be in a tabular form or a discharge characteristic curve as described in IEEE 485-2010, Annex F.

e. Certified discharge data load profiles similar to FLEX load profiles should now be available for most if not all station batteries which support the FLEX sizing calculations.

8) In terms of battery qualification, the same battery model can be qualified for a 2-hour duty cycle in one application and a 4-hour duty cycle in another. In addition to these qualified uses, this same model could also deliver capacity for an 8-hour duty cycle and longer runtimes if required. While it was not qualified for the longer runtimes, such a battery can perform in projected BDB functions consistent with the certified discharge data available.

9) The preliminary test results from on-going testing at Brookhaven National Laboratory (BNL) demonstrate performance during extended discharge runtimes is consistent with the above calculation methodologies. In addition, the BNL testing has not identified any new or unusual battery failure mechanisms associated with extended battery load durations.

Conclusions:

A. Additional battery qualification for FLEX load profiles is not required nor intended.

B. Following accepted industry guidance in calculating battery runtime for the projected BDB Extended Loss of AC Power (ELAP) event for the FLEX strategies, results in a defendable engineering basis for the calculated FLEX battery mission time. This FLEX battery mission time provides an engineering basis for establishing a mission time to install portable FLEX equipment in accordance with the station's FLEX strategies.