

## IEEE Standards Interpretation for IEEE Std 450™-1995 IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications

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### Interpretation Request #2

**Topic:** Batteries in service at nuclear power plants whose specific gravity may approach the action limit established in their technical specifications **Relevant Clauses:** Subsections 4.3; 4.3.1 Item h); 4.3.2 Item a); 4.3.3 Item a); 4.4.2 Item b); and Annex A.1.

A concern has arisen that if the measured battery specific gravity approaches the action limit of specific gravity during the IEEE Std 450-1995 specified general inspections, quarterly inspections, or yearly inspections, the battery has received less than optimum maintenance and the battery's capacity or state of charge is reduced.

From a review of the "Relevant Clauses" of the IEEE Std 450-1995, specifically 4.4.2, it would appear that a specific gravity reading approaching the action limit does not indicate a loss of capacity or state of charge. Please advise on the following:

Question #1: Are measurements of specific gravity an accurate indicator of battery capacity?

Question #2: Are measurements of specific gravity an accurate indicator of battery state of charge?

Question #3: What test or inspection does provide an accurate measure of the battery capacity?

Question #4: What test or inspection does provide an accurate measure of the battery state of charge?

**Interpretation Response**

Question #1: No. Specific gravity is not addressed as an indicator of battery capacity in IEEE Std 450.

Question #2: Although specific gravity does provide some indication of state of charge, per 4.5 of IEEE Std 450-1995, "Specific gravity readings may not be accurate when the battery is on charge following a discharge or following the addition of water."

Also stated in 4.4.2 regarding specific gravity, "An equalizing charge should be given if the specific gravity, corrected for temperature, of an individual cell falls below the manufacturer's lower limit." This condition, "if allowed to persist for extended periods, can reduce battery life;" but, does "not necessarily indicate a loss of capacity."

Question #3: As stated in 6.5, battery capacity is determined by an acceptance test (at the factory or initial installation) or by a performance test. Also as stated in 5.4, a modified performance test would determine battery capacity.

Question #4: As stated in 4.5, "The most accurate indicator of return to full charge is a stabilized charging or float current."

Also "Annex B - Determining the State of Charge when a Specific Gradient Exists" states in part that "The pattern of charging current delivered by a conventional voltage-regulated charger after a discharge is the most accurate method for determining state of charge. As the cells approach full charge, the battery voltage rises to approach the charger output voltage, and the charging current decreases. When the charging current has stabilized at the charging voltage, the battery is charged, even though specific gravities have not stabilized." (Refer to the annexes for informative details.)