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

30 October 2001

Interpretation Request #1
Topic: Testing and maintaining of vented lead acid stationary batteries for substations (69 kV to 380 kV, 100 Ah to 2500 Ah). **Relevant Clauses:** Definitions 3.1 and 3.2; Subclauses 5.1, 6.2, 6.3, and 6.4; and Table 1.

Related Definitions and Subclauses:

- 3.1. Acceptance test: A constant current or power capacity test made on a new battery to determine that it meets specification or manufacturer rating.

- 3.2: capacity test: A discharge of battery at a constant current or power to a specified terminal voltage.

- 5.1: Acceptance. An acceptance test of the battery (6.4) should be made upon initial installation the test should meet a specific discharge rate and duration to the manufacturer rating or to the purchase specifications requirements. NOTE: Batteries may have less than rated capacity when delivered. Unless 100% capacity upon delivery is specified, initial capacity can be as low as 90% of rated.

- 6.2: Test length. The recommended procedure is to perform a capacity test for approximately the same length of time for which the battery was sized.

- 6.3: Test discharge rate. For acceptance test the discharge rate should be a constant current or power load equal to the manufacturer rating of the battery for the selected test length.

- 6.4: Acceptance test: b) Maintain discharge rate until the battery terminal voltage decrease to a value equal to the minimum average voltage per cell as specified by the design of installation. d) If one or more cells is approaching reversal of its polarity (+1 V or less) and the test nears 90-95% expected completion time, continue the test until the specified terminal voltage is reached.

Sample specifications for new battery to be acceptance tested are as follows:

Capacity: 800 Ah; Discharge time: 8 hours; End voltage: 1.75 V; Temp: 25° C; Number of cells: 58; Minimum capacity upon delivery: 90%
When performing acceptance discharge test (i.e., 100 * 0.9 = 90 A for 8 hours, at 25° C/or consider temperature correction factor as per Table 1) the following cases have been noticed:

- Case A) Some batteries deliver 90 A for 8 hours and all cell voltages are equal to or above 1.75 V (usually from very good manufacturers).
- Case B) Some batteries deliver 90 A for 8 hours and few cell voltages reach below 1.75 V, but battery terminal voltage is equal to or above 1.75 * 58 V.
- Case C) Some batteries deliver 90 A for 8 hours but few cell voltages reach below 1.75V and battery terminal voltage reaches 1.75 * 58 V before 8 hours.

Engineers accept Cases A) and B) and reject Case C).

The acceptance discharge test [Case A)] was stopped 30 minutes after rated time (after 8.5 hours) when one cell reached rated end voltage (1.75 V); however, the test was resume until the battery bank terminal voltage reached rated voltage, even though more than guaranteed capacity is reached in the test. During retest it took more than 9 hours to reach battery bank rated terminal voltage (1.75*58 V), but the voltage of 2 cells reached below 1 volt. It was declared that the battery passed the acceptance discharge test.

Let it be noted that some manufacturers are recommending keeping the terminal voltages above 1.5 V. Adhereing to that recommendation, a test was performed using a 20-year old battery. It delivered 100% capacity.

Should engineers continue the acceptance test even after the guaranteed capacity/expected completion time is reached (per manufacturer/purchaser specifications)? Is this not a clear misinterpretation of IEEE Std 450-1995?

Interpretation Response
This response has been reviewed by the SCC 29 Interpretations Subcommittee.

The first test was stopped prematurely per subclause 6.4 item b). An acceptance test is run to completion, which is defined as the minimum per cell voltage times the number of cells or 1.75 x 58 = 101.5 V. Since the test was stopped prematurely, there is no valid

way to apply the capacity calculation of subclause 6.5. Therefore, the decision to re-test is correct.

On the question of dropping below 1 V on individual cells, per 6.4 item d): if the test had exceeded 90-95% of its expected completion time (8 x .9 = 7.2 hours) prior to the cell reaching the 1 V limit, the test is to continue without jumpering of the cell until the minimum battery voltage (in this instance 101.5 V) is reached. Based on the first test it can be assumed that the time prior to a cell reaching the 1 volt limit exceeded 8 hours or 100% of the expected time, therefore it was correct to continue the test even if the cell(s) dropped below 1 V prior to test completion.