# FIELD COMPARISON BETWEEN IMPEDANCE AND CAPACITY TESTING

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## Overview

Impedance, conductance and resistance measuring devices are becoming standard tools of the battery maintenance trade. When internal resistance measurements are compared to baseline or previous measurements major changes usually indicate an abnormal condition. But, can one set of measurements (a snap shot) provide useful information? This field comparison was conducted to answer that question. Specifically:

1. Can "snap shot" resistance measurements be used to find potential problem cells or batteries?

2. When no baseline resistance data is available what parameters can be used to determine if a battery is abnormal?

3. Is this method reliable for VRLA-10, VRLA-20, Vented LA and NiCad battery types?

## Testing Method

The resistance and capacity of 68 battery systems were compared. Internal resistance measurements were taken immediately prior to performing a battery capacity test. Only the cells which were "abnormal" were considered in the final comparison. The following parameters were used to determine "abnormal" cells or batteries.

a. Cells which had less than 80% of rated capacity as determined by the capacity test.
b. Cells which were 25% greater than the average string internal resistance.

When abnormal conditions were found measurements were recorded. A profile of the systems tested, by cell type, is shown in Table 1.

It should be noted that many of the systems tested were known to be near end of life. The number of abnormal units listed in table 2 are not indicative of the battery type. The age of the units tested ranged from less than 1 month to 11.5 years.

**Table 1 Types of Battery Systems Compared**

| Cell/Battery Type | Number of Systems | Total Number of Cells/Batteries |
|---|---|---|
| VRLA 10 yr. | 32 | 1020 batteries |
| VRLA 20 yr. | 26 | 624 cells |
| Vented LA | 4 | 492 cells |
| NiCad | 6 | 540 cells |

Table 2 indicates the number of units of each type which were found to be abnormal and were included in the comparison.

**Table 2 Number of Cells/Batteries found to be abnormal**

| Cell/Battery Type | Number of "Abnormal" Cells/Batteries |
|---|---|
| VRLA 10 yr. | 215 batteries |
| VRLA 20 yr. | 17 cells |
| Vented LA | 26 cells |
| NiCad | 11 cells |
| Total | 269 units |

## Comparison

The capacity test data and the internal resistance for each unit in an abnormal string were compared. Comparative results were totaled for each battery type. Tables 3 through 6 summarize the comparisons for each battery type.

Summary VRLA 10 Yr (Table 3)

| | |
|---|---|
| Resistance abnormal / Capacity Normal | 23 |
| Resistance normal / Capacity abnormal | 97 |
| Both abnormal (agreement) | 95 |
| Total abnormal | 215 |

Summary VRLA 20 Yr (Table 4)

| | |
|---|---|
| Resistance abnormal / Capacity Normal | 0 |
| Resistance normal / Capacity abnormal | 17 |
| Both abnormal (agreement) | 0 |
| Total abnormal | 17 |

Summary Vented LA (Table 5)

| | |
|---|---|
| Resistance abnormal / Capacity Normal | 2 |
| Resistance normal / Capacity abnormal | 21 |
| Both abnormal (agreement) | 3 |
| Total abnormal | 26 |

Summary NiCad (Table 6)

| | |
|---|---|
| Resistance abnormal / Capacity Normal | 0 |
| Resistance normal / Capacity abnormal | 11 |
| Both abnormal (agreement) | 0 |
| Total abnormal | 11 |

Chart 1 Worst case scatter diagram VRLA 10 year product

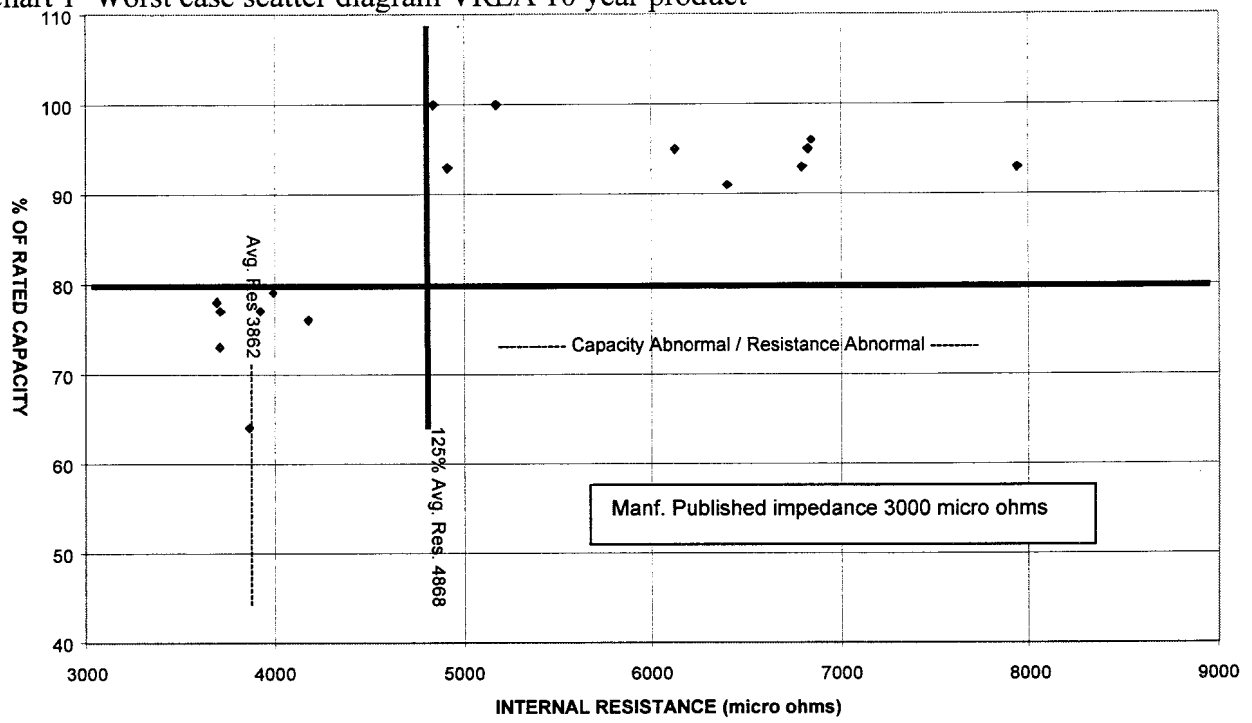


Chart 2 Best case scatter diagram VRLA 10 year product

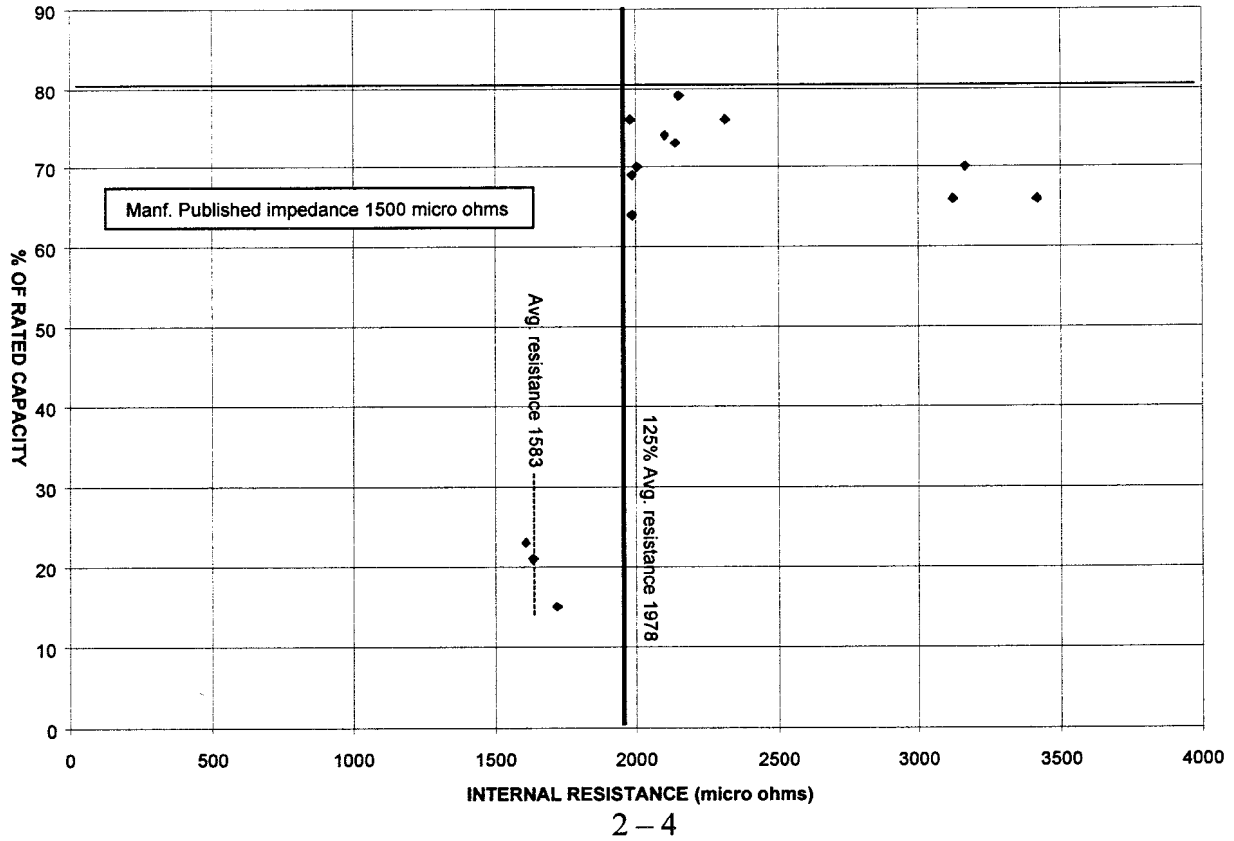

Chart 1 is a scatter diagram for the worst case VRLA 10 year data comparison. Three parallel strings of 30 blocks each, were tested. Seven blocks had capacity below 80%. Nine blocks had "abnormally" high resistance. Among these sixteen aberrant blocks none of the data corresponded, as the chart indicates. Three of the low capacity units had resistance's below the string average.

Chart 2 is the best case example for VRLA 10 year products. In this example eleven of the 14 defective units had capacities below 80% and resistance greater than 125% of the string average. Three units had capacities below 80% and resistance near the string average.

The reason for the wide variation between the best and worst case comparisons (charts 1 and 2) is not known. The variation may be due to the cause of the cell defect. For example "dry out" verses "grid corrosion". Six of the seven low capacity units in Chart 1 were in the 72% to 79% capacity range and would be considered borderline units not hard failures. The three abnormal capacity units in chart 2 which had normal resistance were in the 15% to 23% capacity range and would be considered hard failures.

## Conclusions

1. Can "snap shot" internal resistance measurements be used to find potential problem cells or batteries?
   This field comparison indicates that "snap shot" internal resistance measurements were of little value in locating defective cells/batteries. If only resistance measurements had been used many normal batteries would have been condemned but more importantly defective batteries would have been left in circuit and in many cases would have failed immediately under load.

2. When no baseline resistance data is available what parameters can be used to determine if a battery is abnormal?
   Several comparisons were made using different normal/abnormal set points. In general, when the set point was lowered, more false abnormal cells were recorded. Manufacturers published impedance was close to string average but did not help to isolate defective units. Previous resistance measurements would have been helpful.

3. Is this method reliable for VRLA-10, VRLA-20, Vented VRLA and NiCad battery types?
   Internal resistance measurements were most reliable with VRLA 10 year products. Less correlation was found in larger amp hour cells of any type.

Our company has no intention of discarding the ohmic measuring devices we presently use. But, we now have a better understanding of the limitations of the data they provide. In general, internal resistance measurements are of little value unless they can be compared to reliable baseline measurements.