1. Can Impedance testing truly find battery problems?
Since the internal components of a battery (or cell) are a series of resistors such as post-to-strap weld, strap-to-plate weld, amount of plate sulfation, low specific gravity, etc., impedance measures the sum total of all of these resistances. The higher the impedance the worse the battery condition is because the ideal resistance should be close to established baseline values. The higher the Ah rating of the cell the lower will be the Impedance value. When the capacity of the cell decreases, the Impedance of the cell will increase. Therefore there is a strong correlation between battery capacity and impedance value.

2. What does the acronym BITE mean?
Simply stated, Battery Impedance Test Equipment. The EBITE (discontinued) is Enhanced BITE, the MBITE is Miniature BITE, the C-BITE is Compact BITE and the P in BITE 2P is for printer.

3. Can I use my Impedance tester to identify poor intercell connections?
An additional part of Impedance testing is the ability to measure intercell connection resistance to determine if retorquing is necessary. The intercell strap resistance readings should be measured before wholesale retorquing of every strap in the system. When cells with more then two-2 terminals are present the DLRO, C/N 247001-11 should be used to make an independent study of the intercell strap connections. This test is noted in IEEE-450 and other IEEE recommended procedures for battery systems, for establishing base line intercell strap connections.

4. Is the BITE Impedance Test Equipment easy to use?
The BITE line of products is designed with the user in mind. And it is fast, at less than 20 seconds per battery jar/cell, the dc Voltage and the Impedance of each jar/cell along with the Resistance of each intercell strap is measured. An entire 60-cell substation string can be measured and evaluated within 30 minutes. The MBITE & BITE 2P will then generate a report showing the relative impedance of each cell as it varies from the average of the jar/cell in the string. This data can be transferred to a laptop computer for data trending in an Excel spreadsheet.

Other types of "internal ohmic" measurements require moving the clamp-on leads from cell to cell which is a time-consuming operation (especially in battery cabinets) compared to the simplicity of the BITEs. The other types may also be affected by surface corrosion on the terminal unless extreme care is taken to break through the corrosion. BITEs have hardened tips to break through the corrosion easily and are much less effected by the corrosion, anyway.

5. How much AC Ripple current is too much, where does it come from and how is it reduced?
Ripple current is due to a lack of filtering on chargers and rectifiers. It is an artifact of the AC input line. Over time, continuous Ripple current may shorten battery life due to battery heating or cycling possibly due to a charging/discharging caused by the AC ripple frequency. The general consensus is that ideal Ripple current is in the ballpark of 3 to 6 Amps for every 100Ah of battery capacity. The less the ripple current is the better the battery life will be due to ripple current effects.

Ripple current measurements are suggested in IEEE-1188, as heating is a cause of thermal runaway in VRLA batteries. The BITE2 & BITE 2P will allow for an independent measurement of 50/60 Hz component of ripple current. Increases in ripple current indicate possible degradation in the battery charger, rectifier or inverter connected to the battery system.

6. Does the use of BITE testers harm the battery?
BITEs will not harm the battery since they do not discharge the battery. One of the most harmful aspects to batteries is cycling, whether intentional due to testing, or unintentional due to AC mains outages or continuous AC ripple. Many batteries, especially of the lead-calcium, flat-plate type have low cycling lifetimes, perhaps as low as 30 deep cycles.

7. Can impedance testing predict end-of-life?
The trending of data provides the ability to see how fast a cell/string is degrading. The recommended practice is to take readings every six months until variations become greater than 10% from either the benchmark or the string average. Then take readings every three months when the variations become 15%. By that point, the speed at which a cell is failing can be used to predict it's end-of-life.

8. Can a replacement cell be measured? Against what benchmark do you compare it to validate its capacity?
Replacement cells can most certainly be tested as long as a freshening charge has been applied per the manufacturer's recommendations. You may use the same benchmark initially. Some deviations may occur due to manufacturing variability. After a couple of measurements, its own benchmark will be established. Compare this benchmark to that of the rest of the string. Furthermore, AVO maintains an extensive database of impedance values.

9. What about single-battery equipment such as emergency lighting?
Normally, there are several emergency lighting units in a facility. By measuring these, a benchmark can be established. Also, an initial baseline can be obtained for only one unit. After several readings are taken over, say a year's time; deviations in excess of 20% should be evaluated.

10. Why is alternating current better than direct current?
If DC is used, then the battery is being either charged or discharged depending upon current direction. The battery is then not truly in a float condition, whereas Impedance does not have any impact on the battery, either positive or negative. Additionally, with BITEs (Impedance) a 4-wire Kelvin-style measurement is taken, which eliminates all effects due to resistance in the leads, all contact resistance (with the battery terminals). Impedance measurements provide high quality data, which is highly correlated to battery capacity.

11. Does the current from the transmitter affect the batteries?
See question #6.

12. What will the Battery Ground Fault Locator (BGL) and Tracer (BGFT) do to the protection circuits?
The 25Hz test current does not affect the operation of the relay protection circuits. Normally, the current injection, red lead is connected to the side of the bus that has the fault to ground. Verify this condition with a dc voltmeter and connect the Red lead to the side of the bus with the lower of the two voltage readings. The black is connected to the system ground. Therefore you can connect to either the negative or positive side of the bus; you want to inject the test current on the side of the bus closest to ground. Then you identify the circuit with the lower resistant path to ground. The 25Hz test current is used with a "Null Balance Bridge Circuit" to identify the circuits with the lowest resistances and capacitance's to ground, which pre-identifies the main circuit path to follow with the hand held tracer, to the source of the ground

13. What is the value of specific gravity?

Specific gravity traditionally has not provided much value in determining impending battery failure. In fact, it changes very little after the initial 3-6 months of a battery's life. This initial change is due to the completion of the formation process, which converts inactive paste material into active material by reacting with the sulfuric acid. A low specific gravity may mean that the charger voltage is set too low causing plate sulphation to occur.

14. What does float voltage of a cell tell me?
Float voltage indicates that the charger is working but does not indicate the condition of the cell. There have been times that the float voltage is within acceptable limits and the battery fails. A low float voltage may indicate that there is a short in the cell. This is evidenced by a float voltage at about 2.06 or below for lead-acid (if the charger is set for 2.17 V per cell). In some cases a cell floats considerably higher than the average. This may be caused by the high float blotage cell compensating for another cell that is weak and is floating low. It is possible that one cell floats much higher to compensate for several cells floating a little low. The total of all cells' voltages must equal the charger setting.

15. What are the recommended maintenance practices for the different types of batteries?
IEEE Recommended (Maintenance) Practices cover the three main types of batteries: Flooded Lead-acid (IEEE 450), Vale-Regulated Lead-acid (IEEE 1188) and Nickel-Cadmium (IEEE 1106). Generally speaking, maintenance is essential to ensure adequate back-up time. There are differing levels of maintenance and varying maintenance intervals depending upon the battery type, site criticality and site conditions. For example, if a site has an elevated ambient temperature, then the batteries will age more quickly implying more frequent maintenance visits.

16. How important is intercell connection resistance?
Our experience has found that many battery failures are due to loose intercell connections that heat up and melt open rather than from cell failure. Whether a cell is weak or an intercell connector is loose, one "bad apple" does spoil the whole bushel. When lead acid batteries are frequently cycled, the negative terminal may "cold flow" thus loosening the connection.

17. What does ripple current tell me?
Ripple current is a manifestation of the rectifier/charger which converts AC into DC. No charger is 100 percent efficient. Therefore, some AC "carryover" occurs. The level of this carryover depends upon the quality and features of the charger itself. The most basic chargers do not have filters to remove ripple components and therefore, apply higher levels of ripple to the battery. This is typical in UPS systems. Because ripple creates hum on telephone lines, telco rectifiers are very well filtered. As the chargers age, ripple current increases. Battery manufacturers have defined a loose guideline of 6A rms ripple for every 100 Ah of battery capacity. Above this level, heating of the battery may occur, thus shortening the life of the battery.

18. How often should impedance readings be taken?
The frequency of impedance readings varies with battery type, site conditions and previous maintenance practices. IEEE Recommended Practices suggest semi-annual tests. With that said, AVO recommends that VRLA batteries are measured quarterly due to their unpredictable nature and semi-annually for NiCd and flooded lead-acid.

19. How do I interpret the data?
There are three general modes of data interpretation: instantaneous, short-term and long-term. For more details, please refer to the "Data Interpretation" Application Note.

20. How can I predict when I need to change a cell or the entire battery?
Even though there is not a perfect correlation between battery capacity and impedance (or any other battery test), the amount of increase in impedance is a strong indicator of battery health.

21. At what point should I stop changing cells and replace the entire battery?
In shorter strings (less than 40 cells/jars), the entire should be replaced when three to five units have been replaced. In longer strings, a similar percentage-replaced is the criterion.

22. What are the most common failure modes and how can impedance find them?
There are numerous failure modes, again depending upon battery type. Please refer to the "Battery Failure Modes" Application Note.