



Fire Industry Association

Thames House, 29 Thames Street
Kingston upon Thames, Surrey, KT1 1PH
Phone: +44 (0) 8549 5855
Website: www.fia.uk.com

Testing Lead-acid fire panel batteries

1. Background - Methods of testing batteries

Depending on the type/chemistry of the battery, there are several different testing methods on the market. These methods include simple voltage measurement, coulomb counting, impedance / conductance measurement, and in some cases electrolyte analysis.

Acceptable methods vary by battery type, chemistry and application. For example, one of the characteristics of the Lithium Ion and Nickel Metal Hydride (NiMH) chemistries is that they have a relatively flat discharge curve. This means that the battery's terminal voltage is nearly the same at 90% capacity or 40% capacity, compared to other chemistries such as alkaline or lead-acid whose voltage decreases notably with discharge.

Simply measuring the battery's voltage or even voltage under a small load, like many conventional battery testers do, is not, therefore, a reliable method to test a lead-acid battery. The alternative of measuring and recording the amount of current discharge (coulomb counting), has its drawbacks in secondary cells because it assumes that the battery begins with full capacity – an assumption that ignores age and other factors as well as assuming that the battery will be able to actually deliver its capacity at the necessary rate. Impedance and conductance measurement methods in lead-acid type batteries also assume that the battery will be able to deliver its rated capacity.

It's fairly well known, that throughout the fire industry a number of service companies are making full use of the un-reliability of certain types of lead-acid battery testers to generate extra revenue by failing batteries before their time. As the nominated "Responsible Persons" become more informed and aware of their responsibilities some service providers are now facing embarrassing questions that is rightly questioning the professionalism of the Fire Industry.

It is also fairly clear that some service engineers are not thinking to question the results that they obtain and/or are not following the instructions for the battery tester resulting in wildly inaccurate results being recorded.

A method of testing a range of batteries that a fire service engineer could come across, in a reliable, easy and fast way would be of huge benefit to the industry.

Fact File No 35

2. Available lead-acid battery test methodologies

Type of tester	Pros	Cons
Full load test	<ul style="list-style-type: none"> • Accurately evaluates the state of charge • Widely accepted as the most accurate method of testing • Same test can be applied to various battery technologies 	<ul style="list-style-type: none"> • Heavy • Expensive • Leaves tested battery requiring a recharge after test. No good for Fire panel battery. • Time-consuming test
Electrolyte analysis		<ul style="list-style-type: none"> • Inaccurate results • Temperature sensitive • Requires look up tables • Requires adjustment calculations for certain battery technologies • Known to fail batteries before they need replacing • Cannot test new, freshly charged batteries without resting • Prone to overheat when testing large capacity batteries back to back
Momentarily load or Pulse load	<ul style="list-style-type: none"> • Accurate and consistent results • Not temperature dependant • Leaves lead-acid battery fit to continue after test (ideal for fire panel batteries) • Readout in % of rated capacity (as suggested by FIA trainers). • No lookup tables • No calculations or adjustments to be made. • New, freshly charged batteries can be tested without the need to rest. 	
Battery voltage reading	<ul style="list-style-type: none"> • Simple and easy to read using available DMM 	<ul style="list-style-type: none"> • Does not give a true indication to health and condition of the battery • Prone to misinterpretation • Susceptible to temperature and battery age
Current discharge (coulomb counting)	<ul style="list-style-type: none"> • Accurate if implemented well 	<ul style="list-style-type: none"> • Battery must be fully capacity • Does not take account of self discharge or coulombic efficiency of cells

		<ul style="list-style-type: none"> • Has to be built into the charging / discharging circuits of the battery
Impedance and conductance measurement methods	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Battery must be fully capacity • Does not give a true indication to health and condition of the battery

3. Requirements for testing (standards)

BS 5839-1: 2002, 45.3 Recommendation for periodic inspections and test of the system

45.3(e) "Batteries and their connections should be examined and momentarily load tested with the mains disconnected... to ensure that they are in good serviceable condition and not likely to fail before the next service visit..."

BS 5839-1: 2002, 45.3

FIA Training: BS5839-1(2002) Fire Alarm System Maintenance UNIT 5

On FIA training course, *Fire Alarm System Maintenance – Unit 5*. Reference is made to the requirements of BS5839-1, and the FIA training course promotes the testing of Fire panel lead-acid batteries every 6 months and suggests that the % of rated capacity is recorded against the battery for each 6 monthly visit and stored in a table. Once the battery capacity falls below 75%, it should be replaced.

If lead-acid batteries are installed in pairs and one battery falls below 75% of capacity, both should be replaced. The reason that the FIA training course promotes 6 monthly checks is that it is the only way to be sure that the battery will not fail before the next required service visit.

BS 5839-1: 2002 25.4 Recommendations for standby supplies

25.4(c) "Labels should be fixed to all batteries indicating their date of installation. The labels should be so sited that they can be read without disturbing the batteries."

LPS1014 and BS5879-1 both make reference to ISO 9000 series

In regard to the calibration of test equipment (including lead-acid battery testers).

Extract from ISO 9001 section 7.6

Where necessary to ensure valid results, measuring equipment shall

a) be calibrated or verified at specified intervals, or prior to use, against measurement standards traceable to international or national measurement standards; where no such standards exist, the basis used for calibration or verification shall be recorded;

NFPA 72-2002: Table 10.4.2.2 Battery Testing

"...under load, the battery shall perform in accordance with the battery manufacturer's specifications..."

NFPA 72-2002: Table 10.4.2.2

4. The reasons for, and logic behind, these requirements

It is widely accepted that the best way to discover the state of charge and condition of a battery is to carry out a full load test. This method of testing has significant drawbacks when applied to fire panel lead-acid batteries.

A full load test takes time to perform and it is unlikely that you would have a result in less than 20 minutes (dependant on capacity of battery). It also has one major drawback in that it leaves the tested battery completely depleted and unable to fulfil its roll as a secondary backup power source without first charging before replacement. Placing the lead-acid battery back in the panel without first charging could mean that the battery will take 24 hours to fully recover (recharge), in this time it will not be able to act as reliable secondary power source.

BS5839-1 calls for a “*momentarily load*” test. Battery testers that test a battery under no load (eg. electrolyte analysis battery testers) do not accurately simulate the battery's performance under operating conditions and thus do not comply with the standards. The test must simulate as near as possible a full load in order to give an accurate reading of how a battery would perform if called into use.

Currently, the best known method of testing a fire panel lead-acid battery in compliance with BS5839-1 and give fast, true reliable results that does not leave the battery depleted is to use pulse load technology.

Pulse load battery testers verify that a lead-acid battery can deliver power by actually making it deliver power. The duration and repetition of the load test cycles varies depending on the battery type and size and this means fast, accurate results can be obtained and the battery can be put back into to the panel with full confidence that it be able to fulfil its task as secondary power source after testing.

A fundamental requirement of a lead-acid battery tester for fire panel batteries is that it gives repeatable and reliable readings in any situation. This sounds an obvious requirement, but it is known that battery testers which use electrolyte analysis do not give consistently accurate and reliable results. Carrying out back to back tests with this type of battery tester on the same battery can give wildly differing results. This is a well known fact with many fire maintenance engineers and supervisors/managers who continue to exploit these incorrect readings.

The displayed battery tester results must be easy to understand and interpret. They should not require the engineer to carry out calculations and adjustments to the results according to ambient temperature and/or type of battery under test, or to use lookup tables. A reading in % of state of rated capacity would be the simplest result that would not be open to misinterpretation or calculation errors and would follow the FIA trainers' recommendations.

Time costs money and the ability to produce quick and accurate results are essential. The standards call for the battery to be changed once the capacity falls below 75% and the FIA trainers recommend recording the % of capacity against time in a table for each battery. A battery tester that momentarily loads the battery and gives the results as a percentage of capacity readout would be ideal and easy to understand and would comply with the requirements of the BS5839-1 and the recommendations of the FIA trainers.

AGM lead-acid batteries are not the only type of batteries that a Fire alarm maintenance engineer could come across. There are a number different battery technologies, ie. AGM, Gel, spiral and wet cell batteries, to name but a few. Again, the ability to test a variety of battery types without the need to make correction factor calculations is a must. It is not widely know that electrolyte analysis type battery testers require a readout adjustment calculation when testing Gel lead-acid batteries. Although this is covered in the battery tester user manual, very few engineers are aware of the need to apply an adjustment factor to the readout and this again leads to inaccurate results and more lead-acid batteries being failed before their time.

The ability to test batteries of between 2v and 12v and also batteries of varying capacities for 6v and 12v batteries (up to a capacity of 200Ah) is desirable but brings with it some possible issues. When testing large capacity lead-acid batteries it is important that the lead-acid battery tester does not overheat and is able to perform back to back reliable and accurate tests. The power dissipated during the tests, although often small, may be significant for larger Ah batteries and so the tester must be sufficiently rated to manage these tests without problems.

Tester portability is also important and the lead-acid battery tester must be easy and convenient for the test engineer to carry around and use. A full load battery tester is a sizable, costly piece of kit that is unlike to find its way into maintenance engineer's standard kit.

Battery tester temperature stability is a critical factor and the battery tester should have a wide operating temperature and should not require acclimatisation before testing can commence. Often battery testers will be stored in the maintenance engineer's car overnight during the colder months and must be capable

of performing a reliable reading on first use in the morning on site. Temperature stability is a known problem with electrolyte analysis testers. If the battery tester is not given enough time to acclimatise to the same temperature as the battery to test, it will fail the battery.

Ability to test new freshly charged lead-acid batteries would be useful as many lead-acid battery testers require the battery to be rested for 24 hours before testing.

Battery test leads clips should be suitable for attaching to a variety of battery terminal sizes (1Ah to 200Ah). Also leads should be removable so that they can be easily replaced in the field, should they become damaged.

4.1. Voltage readout.

It has been suggested that the lead-acid battery tester should have voltage readout. It is always strongly recommended that service engineers test the battery float voltage before they test the battery. It is vital to ensure that the battery charger is set right, else the battery life will be shortened or the battery will not charge up. The provision of a multi-meter for a service engineer would have many uses and the inclusion of a voltage readout on the lead-acid battery tester would not negate the need for a multi-meter and would only result in the price of the lead-acid battery tester increasing.

4.2. Service and calibration

It must be possible to calibrate the lead-acid battery tester in compliance with LPS1014 and BS5879-1 which both make reference to ISO 9000 series. In particular ISO 9001 section 7.6:

Where necessary to ensure valid results, measuring equipment shall

a) be calibrated or verified at specified intervals, or prior to use, against measurement standards traceable to international or national measurement standards; where no such standards exist, the basis used for calibration or verification shall be recorded;

5. Common (mal) practice, reasons for it and the implications thereof

The FIA Unit 5 Training Course is very specific in what it covers in regards to testing a Fire Panel lead-acid battery. The course covers testing the battery charger circuit to make sure it is correctly set. It also covers how to read the battery date codes and suggests methods of recording the results as a % of charge against time in a table so as to study the decline of the battery over its lifetime. From my experience many fire engineers omit to carry out these checks and suggestions and go straight into the testing of the panel battery.

Performing the battery test using an electrolyte analysis battery tester (most commonly used battery tester) without paying attention to the operating instructions will result in a premature failure verdict on the battery under test. This could be because the battery tester has not had time to acclimatise to the panel battery temperature and may have taken from a car where the battery tester was stored over night in sub zero temperatures. Or it could be that the battery in the panel is not an AGM but a GEL battery and the engineer has not applied the correction factor. There are a number of operating factors that could cause the battery to be condemned prematurely.

In independent tests carried out by number of respected engineers, results have shown consistently that even when used correctly electrolyte analysis battery testers will fail batteries prematurely. It is very easy to check the results, by charging failed batteries and then carry out a full load test. I would recommend that these steps are taken by any service provider to check the level of confidence they have in their chosen lead-acid battery testers.

6. Conclusions and recommendations

It is imperative to determine whether a fire panel battery would be able to sustain the necessary load for the required amount of time without failing. Equally it is important to accurately obtain reliable and accurate test results that do not condemn a fire panel lead-acid battery before its time.

Practically, out of all the available test methodologies, only pulse load testing can achieve this properly in compliance with BS5839-1 45.3, there is no other way to accurately test a fire panel lead-acid battery and leave it in a fit state to carry on working after testing.

Results that are displayed in a simple and easy to understand format remove the possibility of incorrectly interpreting the results. The simplest format is to display the results as a % of total battery capacity and recorded on each visit as suggested by the FIA Unit 5 Training Course.

DISCLAIMER

The information set out in this document is believed to be correct in the light of information currently available but it is not guaranteed and neither the Fire Industry Association nor its officers can accept any responsibility in respect of the contents or any events arising from use of the information contained within this document.

June 2009