The Importance of Battery Discharge Testing

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Introduction

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The Current Battery Problem

Why in the 21st century potential operational battery failure is still a reality ?

Users demand a 100% predictable positive outcome for a stored energy device to perform its designed duty for the entirety of its designed life.

Reality

A diverse range of interactive dynamics affect performance.

- Purity of materials
- Repeatable manufacturing processes, tolerances
- External electrical environment,
- Thermal response,
- Reaction to different maintenance regimes,
- Previous discharge history
- … the list is almost endless

Battery Alternatives

- Flywheels
  - Mechanical
- Super-capacitors
  - Acetyl Nitrile + Cyanide
- Fuel Cells
  - Cost + Membrane Contamination

The Commercial Problem

- Intense Competition
- Cost Reduction + ‘Spec-manship’
- Lower Operational Integrity

Current Approaches

- Monitoring
  - Voltage
  - Current
  - DC Resistance
  - Float Current
  - AC Non-vectored impedance
  - Conductance
- Discharge Testing

The Old Game

- Specific Gravity
- Discharge Testing

The Automotive Analogy

- The true speed of a car
  - Specification
    - Only approximates designed speed
  - Dynamometer
    - Only simulates perfect road conditions more accurate but not real
  - Road Test
    - Only true operational test

The Automotive Analogy

- The true performance of a battery
  - Specification
    - Only approximates designed autonomy
  - Indirect Parameter Measurement
    - No indication of state of charge and difficult to accurately map to potential performance
  - Discharge Test
    - Only true operational test

Case Studies

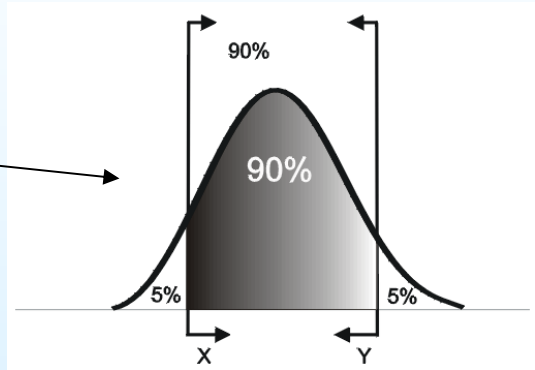
- Airport
  - Regular discharge testing
  - High degree of confidence
  - Zero failure in operation failure in 10+ years
- Power Station
  - No discharge testing
  - High degree of fear
  - In operation failure after 18 months

Implementation of Understanding

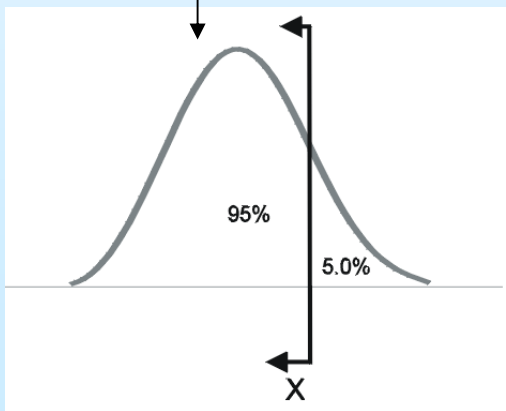
- 2 Elements
  - Confidence
    - The ability to positively predict an outcome with a high degree of probability.
  - Reliability
    - The continuing performance of an entity per specification for the designed life of said entity

Defining Confidence

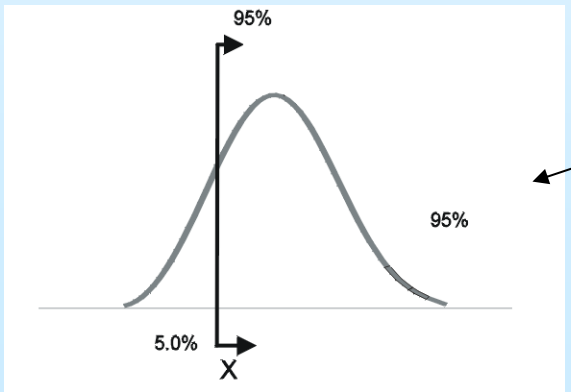
How we can predict to 90% based on repeated discharge tests within limits x & y



How we can predict to 95% based on repeated discharge tests that the # of blocs to fail will be < x



How we can predict to 95% based on repeated discharge tests that the # of blocs to fail will be > x



Reliability

$$N = \frac{C}{(\Delta T)^{\gamma}}$$

Where

- N is the number of battery discharge cycles to failure.
- C is a constant, characteristic of the battery technology which depletes proportionally to the average cell age.
- γ is a (in the case of a lead acid battery) constant derived from the thermal temperature range the equipment is subjected to
- T is the average depth of discharge of battery

Good Mitigation Techniques

•Use of fold-back techniques. (the rectifier is not turned of but a voltage is reduced below battery open circuit voltage but above low dc load level cut off point)

•Use of a battery monitor to assess individual cell voltage levels – use of an abort process should be in place prior to initiation of test.

Summary

- By predicting the outcomes of anticipated future sampling we can pro-actively maintain the battery and can keep 100% operational up time.
- Monitoring is not dismissed out of hand and performs a vital function as filling in vital parts of a complicated jigsaw puzzle.
- Confidence is a psychological phenomenon and subjective as much as emotional. Have the strength and determination to pursue a regiment of discharge tests supported by sound engineering principles.
- Have confidence in the equipment through a solid methodical approach to maintenance. Do not procrastinate with defect progression. – Replace poor cells proactively.
- Use monitoring as a part of the bigger picture of the battery.
- Understand the mechanisms for failure and look for them.