Introduction to Batteries & Battery Maintenance

This course will introduce the student to both the lead acid and nickel cadmium batteries that are still used in the majority of battery backed applications. It is intended for persons that are currently involved in the installation and maintenance of these battery systems.

Day One

Introduction to Batteries

Objective

Introduce the basic principles and associated terminology of an electrochemical battery and its applications through the historical record.

Lesson Outline

This lesson will introduce the student, through the history of battery development, to the construction and characteristics of the cells and batteries we have in service today. It will start with an explanation of the fundamental difference between the galvanic and electrolytic cells. The limitation of these early designs will be discussed and the importance of Faure's development of the flat plate method of cell construction as a precursor of today's batteries will be explained.

Lead & Nickel Based Batteries

Objective

To explain in detail the construction and electrochemical behavior of the Vented Lead Acid (VLA) battery, the Valve Regulated Lead Acid battery (VRLA) and the pocket and sintered plate versions of the Nickel Cadmium battery.

Lesson Outline

Each of the components that make up the individual battery types will be identified, and their functions described. This will include the design and electrochemical responses of the plates, separators, and the electrolyte during a charge/discharge cycle.

Battery Selection & Sizing

Objective

Although many of the students may never be involved in the selection and sizing of a battery, it is important to understand the process that determined the battery's selection, in order to determine the correct type of discharge test, the required runtime and discharge rate, in order to carry out and correctly interpret the results of a discharge test.

Lesson Outline

The lesson will start by establishing that each battery manufacturer will typically offer a series of battery models, each with the different operating characteristics that are designed to meet the specific requirements for companies in Communications, Utilities and Data Centers. The students will then learn about how to determine the type of battery to use for several specific applications and establish the battery capacity required, based on the methods contained in the IEEE Recommended Practices for the chemistry selected. This will allow the students to better understand how to determine the type and duration of a discharge test.

Battery Failure Mechanisms

Objective

All batteries have a finite life, and the time and place of their demise is determined by a number of factors. This lesson will cover the primary reasons why these batteries fail and what steps can be taken to minimize the risk of premature failure.

Lesson Outline

The lesson will start by examining the natural aging processes, which occurs even when the battery is operated under ideal conditions, and why batteries designed for specific applications are often specified with a different life expectancy than others. Unfortunately, batteries are seldom operated under ideal environmental and operational conditions and the impact that this has on battery life will be examined in detail. While many of those conditions are an inherent part of the application where the battery is being operated, this lesson will also provide the student with a guide to the measures that can be taken to minimize that impact.

Battery Backed Power Systems

Objective

Up to now, there has only been passing references to the operational environment in which the battery will be required to operate. In this lesson, the student will be introduced to the other components in the infrastructure that provides electrical power to the Communications, Utility and Data Centers in the event of a utility power failure.

Lesson Outline

In this lesson, the operational objectives that require a battery-backed power system to be installed will be examined, and how that can affect the eventual system configuration will be explained. The individual components that are used to assemble the required power system will be identified and discussed in detail. This will include the chargers and inverters, types of power distribution and associated over current protection. cable types and the always important grounding and bonding.

Safety

Objective

In many of the studies into power system failure, human error while the plant was undergoing maintenance is often very high on the list. While many of these incidents do not involve injury, too many do. This lesson will identify the six areas of risk that are present in all battery-backed power plants and provide the methods by which that risk can be minimized.

Lesson Outline

In the US, the regulations that cover workplace safety are published by the Occupational Safety and Health Administration (OSHA), but one of the challenges is that they provide no indication as to what is required to meet these regulations. NFPA 70E is the document that provides that level of guidance with respect to the electrical and chemical hazards found in areas where batteries are installed. This lesson will cover how to comply with all the requirements of NFPA 70E and the other requirements with respect to explosion, fire and general safety.

Day Two

Battery Maintenance

Objective

To minimize the potential for a battery failure during a utility power outage, it is essential that all the operational parameters are measured and recorded on a regular basis. This lesson will identify all the required parameters that need to be measured and explain the use of the required tools and test equipment.

Lesson Outline

The most comprehensive set of procedures that cover the maintenance for VLA, VRLA and NiCd battery types are contained in a collection of IEEE Recommended Practices. The relevant methods and procedures used to collect the data outlined in these documents for each battery type will be covered in detail. This will include the measurement of both voltage and current at both the system and unit level, plus the unit temperatures and the ambient temperature at the time of measurement. It will also include the measurement of the ohmic value of each unit and the associated interconnect resistances.

Visual Inspection

Objective

While the data collection is an important part of the maintenance plan, some of the early indications of potential problems will manifest themselves visually, both internally and externally, on the individual units before there is an electrical indication. This lesson will provide a guide to what a visual inspection should cover and provide examples.

Lesson Outline

The lesson will be sectioned into two parts. First, the students will be shown a series of pictures that represent a cross section of the typical problems that can be observed. For each one, there will be an explanation as to what the problem is and what corrective action should be taken. In the second part of the lesson, a further series of pictures will be shown, and the students will be given the chance to try and identify the possible problem and suggest what corrective action could be taken.

Discharge Testing

Objective

As all batteries lose capacity as they age, and Discharge Testing is the only way in which the remaining capacity can be determined. Depending on the tests objective there are a number of different versions of discharge test that can be used, so in this lesson each version of the test will be reviewed along with the Pre and Post test procedures when these are required.

Lesson Outline

The students will be introduced to each version of the test and the requirements for pretest and posttest actions will be covered. They will then be shown how to establish the correct discharge rate for a fictitious battery and application when the importance of understanding how the battery was originally sized as demonstrated in lesson three will become very apparent. The method by which the discharge test is carried out will be covered in detail and the method by which a failed cell can be bypassed to allow the test to be completed will be explained. Based on a set of data from the fictitious battery discharge, the actual capacity of the battery will be determined.

Battery Analytics

Objective

To introduce the methods by which the data collected as part of a maintenance plan can be analyzed in order to identify potential points of failure.

Lesson Outline

Because no single measured parameter provides an accurate representation of a battery's operational condition, each parameter and its relationship with the other parameters will be examined while the battery is open circuit and under float, discharge, and recharge conditions. This will provide the students with the basics of battery analysis and a better understanding as to the value of the data being collected. The lesson will finish with a number of examples of what happens when the analysis is ignored.