# Storage Batteries Maintenance and Principles

An Online Continuing Education Course for Engineers

**Course Number: E-5008**

**Credit: 5 Hours / 5 PDH / 5 CPD**

# 1. OPERATION AND CARE OF LEAD-ACID BATTERIES

Batteries are the backup power source for millions of consumers and businesses, as well as medical, military, and industrial facilities worldwide. Critical applications such as computers, servers, instruments, telecommunications, or life-saving equipment require one hundred percent redundancy in every aspect to ensure a high degree of reliability and operation. Although commercial power supply sources are available, any malfunction or interruption of the utility power can be detrimental to the critical operations of the facility. Thus, consistent and reliable performance of batteries is essential for smooth functioning of modern equipment.

In the United States battery replacement is a seventeen billion dollar market. Around seventy-five percent of these batteries—whether "starting," "power," "stand-by," "industrial," "marine," etc.—have stopped working prematurely due to inadequate maintenance, while the remaining twenty-five percent suffer mechanical failures. The number one cause of reduced lifespan and output capacity in batteries is attributed to "over sulfation," a crystallization that occurs when a battery cell is undercharged. Ongoing maintenance of batteries is thus very important.

## 1.1 PURPOSE

The purpose of this section is to outline the duties and responsibilities for routine operation and care of vented lead-acid batteries. Section 2 contains detailed information on lead-acid battery principles.

## 1.2 BATTERY CHARGING AND SPECIFIC GRAVITY TEMPERATURE CORRECTION

### A. Initial Freshening Charge

To establish a reference, give each new battery, or reinstalled battery stored for more than 3 months, an initial freshening charge. Use the equalizing voltage given by the manufacturer for the type cell, but do not exceed the maximum voltage of other loads connected to the charger. Apply this charge until each cell gasses freely and equally and specific gravity (sp.gr.) stops rising. Just before the end of the initial charge, record the voltage of each cell. About 20 minutes after the end of the charge, record the specific gravity of each cell, corrected to 77 °F. For every 3 °F above 77°F, add one point (0.001) to the reading. For every 3 °F below 77°F, subtract one point (0.001) from the reading. Use form in Appendix 2 for these records and keep them for the life of the battery.

*A.1 Pilot Cell.* After the initial charge or to begin a yearly cycle, choose a pilot cell from one of the lowest specific gravity and lowest voltage cells. This cell is used as a representative for readings, for one year. Each year a new pilot cell is chosen.

## B. Float Charge

Charge batteries continuously at the float voltage recommended by the manufacturer. *Monthly* take the voltage across the overall battery terminals with an accurate digital meter and compare this reading with the charger and bus voltmeters. If needed, adjust the charger float voltage based on the *digital* meter. Adjust the charger and/or bus voltmeters to agree with the digital meter if needed.

A battery is said to float when charging voltage is slightly greater than the open circuit voltage of the battery. Floating current required to keep lead-calcium cells at full charge is about one-fourth to one-third that of lead-antimony cells, but lead-calcium cells usually must be floated at a slightly higher voltage. Lead-selenium cells require float voltages slightly above those of lead-calcium.

The operation of a battery by float method is based on overall voltage applied to the battery terminals. The voltmeter used must be very accurate. An inaccurate meter can result in either over or undercharge and resulting problems, which reduce life and service of the battery. See section 1.3.

## TABLE 1. - FLOODED, WET CELL, LEAD-ACID BATTERY MAINTENANCE SCHEDULE

| Maintenance | New Battery | Shift | Monthly | 3-Month | Annual | 5-Year |
|---|---|---|---|---|---|---|
| Visual Inspection See 1.7 | | | Also See 1.10C &D | Flame Arresters See 8.3 | | |
| Battery Float Voltage See 1.3 | | Panel Meter Float Voltage See 1.3A | Battery Terminals with Digital Voltmeter | | Compare Panel Meter to Digital Voltmeter | |
| Cell Float Voltages See 1.3 | All Cells with Digital Voltmeter | | Pilot Cells with Digital Voltmeter | All Cells with Digital Voltmeter | | |
| Specific Gravity Readings See 1.4 | All Cells | | Pilot Cells | 10 Percent of all Cells | All Cells | |
| Temperature Readings See 1.5 | | | Pilot Cells | 10 Percent of All Cells | | |
| Connection Resistance See 1.6 | All Connections | | | | All Connections | |
| Battery Testing See 3.0 | Acceptance Test After 1 week | | | | Yearly Capacity Tests if 5-Year Test <90 Percent | Capacity Discharge Test |
| Check Safety Equipment See 1.7 & 8.0 | | | Wash Equipment; Protective Clothing; Fire Extinguishers, Etc. | | | |

See section 1.11H for surface charge phenomenon (initial voltage drop under load).

## C. Equalizing Charge

The purpose of the equalizing charge is to ensure that every plate in every cell is brought with certainty to a state of full charge by a slight overcharge.

*Do not perform equalizing charges on a routine basis.* If one of the conditions below occurs, apply an equalizing charge at the voltage recommended by the manufacturer for the type of cell. Ensure that all cell levels are at the high level mark before beginning the charge.

1. Following heavy discharge.

2. If specific gravity (corrected for temperature) of any cell is more than 10 points (0.010) below the full charge value while on float.

3. If the voltage of any cell is more than 0.04 volt below the average cell voltage when the battery is on float.

4. If the level in any cell or cells falls at or near the minimum fill line a lot of distilled water must be added to restore the level to the maximum fill line. If this condition occurs, an equalizing charge must be performed to restore specific gravity.

5. If too little replacement water is being added, typically indicating undercharging (see fig. 1 for typical water consumption).

*Terminate the equalizing charge when all conditions below are met:*

1. Every cell gasses freely and equally.

2. The specific gravity of all low cells has stopped rising, determined by two specific gravity readings measured over the last one-eighth of the charging period.

3. The voltage difference between the highest and lowest cells is no greater than at the initial charge.

Failure to give equalizing charges when needed leads to problems. The ampere-hour capacity of weak cells greatly decreases. During discharge, these cells will be exhausted well ahead of good cells and then become over discharged (see section 2.11) or over sulfated; the plates may buckle, and grids may crack. Continued discharge may reverse the polarity, making positive plates out of the negatives and vice versa, which will destroy the cells.

If one section of the battery runs warmer than the rest, these cells have a higher rate of internal self-discharge, and capacity gradually falls below the others. Hence, a battery must be located so that sunshine or space heaters do not affect a portion of the battery, which would mask internal self discharge temperature increases.

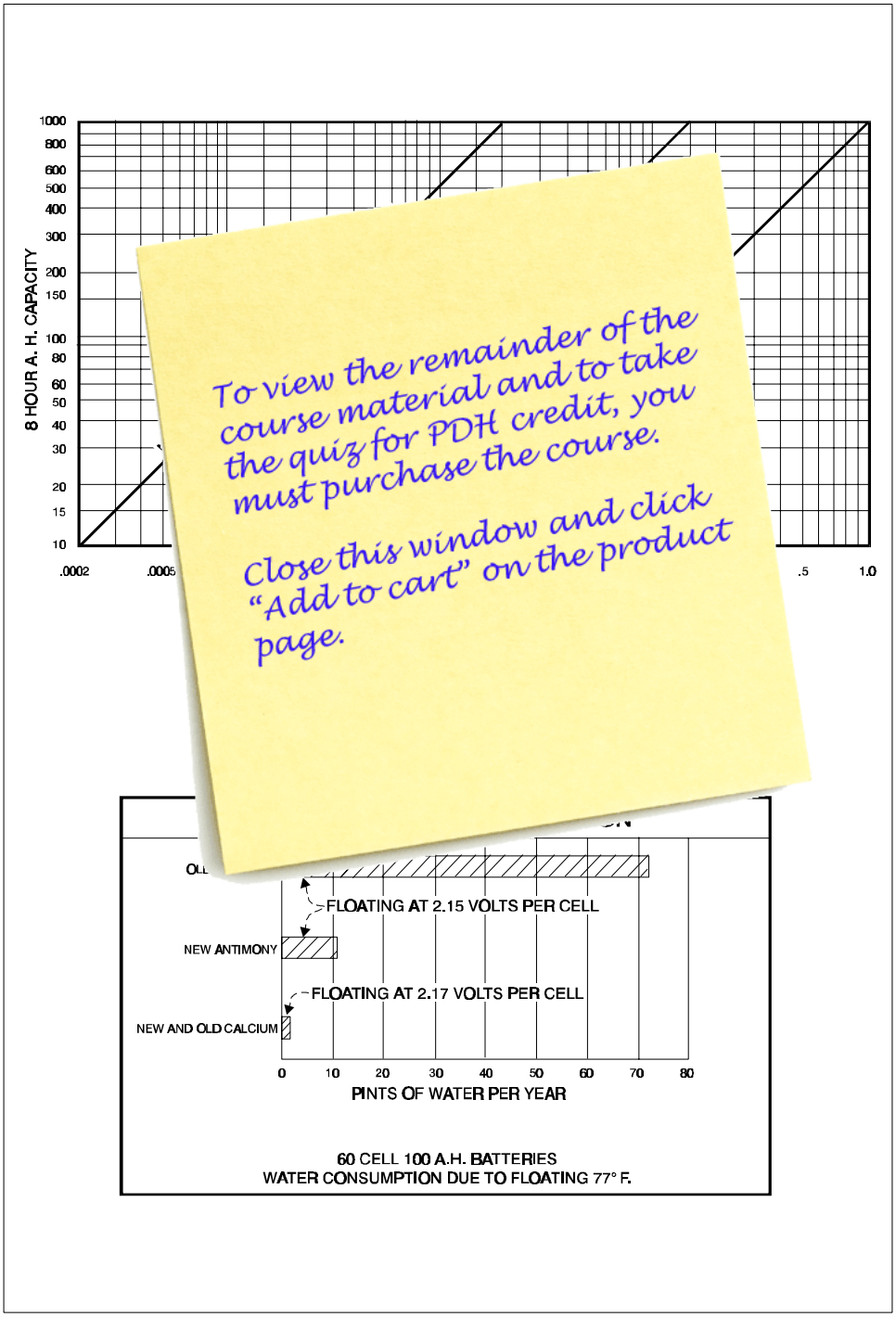


Figure 1. - Water consumption for lead-acid battery sizes and types.