LEAD-ACID TYPE STORAGE BATTERIES
CONTINUOUS FLOAT OPERATION

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1. GENERAL

1.01 This section covers the continuous float operation of low specific gravity (nominal 1.210) and high specific gravity (nominal 1.300) lead-acid batteries.

1.02 This section is reissued to update and revise the information for the continuous float operation. A Table of Contents has been added. The information on routines, records, boost charge, and charge after cell reversal has been deleted from this section and included in Section 157-601-701. Since this is a general revision, change arrows are omitted. This reissue affects Equipment Test List.

1.03 For a listing of sections dealing with charging rectifiers and power supplies, see Numerical Index Division 167, 169, and 802.

1.04 Unless otherwise specified, all recommendations apply to both lead-antimony and lead-calcium cells.

2. OPERATION

Caution: Avoid creation of sparks, including those from static electricity or the use of an open flame near batteries since the gas is explosive when sufficiently concentrated.

2.01 ***Float Voltage:*** Nominal float voltage is now specified as 2.17 volts per cell for low specific gravity cells, 2.25 volts per cell for high specific gravity lead-antimony cells, and 2.30 volts per cell for high specific gravity lead-calcium cells.

See INTERVAL, VOLTAGE, AND SPECIFIC GRAVITY REQUIREMENT CHART in Section 157-601-701 for float voltage limits. Operation of batteries outside of the specified float voltage ranges will result in a loss of expected battery life.

2.02 ***Voltmeters:*** It is extremely important to maintain accurate float voltage. The Weston Model 931 voltmeter is suitable for most voltage readings, Model 280 or 281 may be used but they are less accurate. Emphasis must be placed upon the necessity for periodic checks for voltmeter accuracy and calibration using a properly scaled standard. Power board voltmeters returned from adjustment at an instrument test shop shall be rechecked with a standard upon installation to reduce the possibility of errors introduced in handling. See 4.02 for information on differential voltmeters.

2.03 ***Trickle Charge:*** A cell continuously floated at no load is being given a trickle charge. Engine starting battery and emergency cells are examples of cells usually maintained on trickle charge. A trickle charge supplies the current necessary to replace local action and keep a battery in a fully charged condition. A cell floated continuously at the proper voltage will automatically take the trickle current it needs. The trickle rate for cells of nominal 1.210 specific gravity ranges from 1/4 of 1 percent to 1 percent of the 8-hour discharge rate for new lead-antimony cells and between 1/50 and 1/15 of 1 percent for lead-calcium cells, depending on such factors as temperature and specific gravity. The trickle rate remains about the same for the life of lead-calcium cells but may increase enormously for lead-antimony cells as they age. The low trickle current of lead-calcium cells has the advantage of saving power costs and reducing water additions. However, it has the disadvantage of making it more difficult to bring a nonuniform cell into line during normal float. Because of this, when one cell requires an extra charge, it is better to use a single cell charger. Such chargers can be placed across one cell or two adjacent cells in a working battery with no service reaction.

2.04 ***Continuous Automatic Float:*** A voltage regulator automatically holds the voltage at all times very close to the nominal float value. The battery does a minimum amount of work which results in maximum battery life. Maximum reserve capacity is always available and very close voltage regulation is obtained for the connected circuits. Due to these advantages, this method of operation is the most desirable and widely used.

2.05 ***Continuous Manual Float:*** Manual control is not as good as automatic control except at no load and constant loads. Some emergency cells and engine starting batteries are examples of continuous manual float control at no load (see 3.07).

3. AVERAGE BATTERY FLOAT VOLTAGE AND REGULATOR SETTING

3.01 ***Average Float Voltage and Reading Interval:*** ***The battery*** float voltage check (see Part 4 for individual cell voltage checks) shall be made weekly. See Interval Chart in Section 157-601-701. Special condition annual battery checks are described in 3.02, 3.05, and 3.06. Set voltage regulator so that the uncorrected battery average float voltage is 2.17 ± 0.01 volts per cell for low-gravity batteries or 2.25 ± 0.01 volts per cell for high-gravity lead-antimony batteries or 2.30 ± 0.01 volts per cell for high-gravity lead-calcium batteries. Use an accurate voltmeter (see 2.02). In some small offices, the rectifier cannot be set as high as these values during heavy load periods. However, higher float during the light load and high line voltage period should cause the average to approach the required volts per cell.

3.02 ***Float Voltage Regulation at Battery:***

(a) With ***regulation at the battery,*** the voltage at which the battery floats does not tend to vary appreciably with office load. Regulation at the battery is used at the following type locations:

(1) Constant-load plants

(2) Plants with commercial charging sets or regulated rectifiers where the regulating leads run directly to the battery

(3) Plants with common charge and discharge leads if the regulating leads are connected at the battery control board.

(b) With regulation at the battery, check ***annually*** by applicable method following:

(1) Where the battery voltage is drifting slowly (max to min period greater than 5 minutes) take ten readings of battery voltage at 5-minute intervals and use the average of these ten readings.

(2) Where the battery voltage is swinging regularly over an appreciable range, note the high and low for each of five consecutive swings and use the average of these ten readings: If the average battery float voltage is outside of 2.16 to 2.18 volts per cell for low-gravity cells or 2.24 to 2.26 volts per cell for high-gravity lead-antimony cells or 2.29 to 2.31 volts per cell for high-gravity lead-calcium cells, recheck the voltmeter and the voltage regulator and reset the regulator if required.

Note: In some constant-load plants, there is no regulating equipment and float voltage adjustment is made by changing charger setting.

3.03 ***Regulation at the Charger:*** With variable-load plants having ***regulation at the charger,*** battery voltage is highest at no load and drops with increased load. This class includes diverter pole plants with rectifiers having no separate regulating leads, and plants with centrifugal voltage regulators connected at the charger. It also applies where there are separate charge and discharge leads and the regulator is connected at the control board to the charge leads.

3.04 ***Regulation at the Load Bus:*** With variable-load plants having separate charge and discharge leads and ***regulation at load bus*** on the battery control board, the battery voltage is lowest at no load and increases with load. This class includes all plants with M-type generators, some plants with commercial machines, and some with rectifiers.

3.05 ***Setting Regulator with Regulation at Charger or at Load Bus:*** With regulation at either the machine or the load bus, ***annually,*** during a 5-minute interval of the heaviest load period, record the highest and lowest office load in amperes as well as the corresponding battery voltage. Repeat these readings for a 5-minute interval during lightest load period of the same day. Reset regulation if the average of the highest and the lowest of these two sets of voltage readings (***average battery float voltage***) does not meet the requirements of 3.01. The highest and lowest of these readings establish the voltage range for the particular load range. Frequently note the ***battery voltage*** and load current. If there is a shift in the load range, recheck the average battery voltage and reset regulating equipment as necessary. In resetting the regulator, keep in mind that when regulation is at the charger (see 3.03) the battery voltage varies indirectly with load current (voltage rises as current decreases), but when regulation is at load bus (see 3.04) the battery voltage varies directly with load current (voltage decreases as current decreases).

Note: The preceding settings should suffice for the average office. However, where an office operates for long intervals at one end of load range, a more accurate average can be obtained by averaging more frequent readings during the check or readings taken over extended periods.

3.06 ***Readings for Setting Regulator with Large Battery Voltage Swings:*** With some installations, such as ***301C power plants without 302A type electronic regulator in No. 5 crossbar*** offices, load changes are too large and too frequent to be absorbed promptly by the charger and battery without undesirable voltage swings. In these cases, all battery voltage readings are difficult. The following change from usual routine is suggested. Annually take a set of ten consecutive battery voltage readings at 5-second intervals. Do this four times during the same day with at least an hour between each set of readings. The average of the 40 readings is a good practical estimate of the voltage at which the battery is actually floating.

3.07 ***Voltage Checks on Tapped Batteries:*** When a battery is tapped for a different voltage, such as, a 48-volt battery tapped for 24 volts, one section of the battery is subjected to different conditions than the other section. More frequent checks of float voltage may be necessary to enable correction of any imbalance.

3.08 ***Manually Floated Emergency Cells & Engine Starting Batteries:*** With ***manually floated emergency cells and engine starting batteries,*** the battery voltage tends to vary with ac line voltage, but the dc response to the ac

change is so slow that it is usually satisfactory to disregard ac line voltage when checking float voltage (see 2.05). After the initial charge (see Section 157-601-201), set the rectifier so that the trickle current is about 1/2 of 1 percent of the 8-hour discharge rate for a lead-antimony cell and about 1/8 of 1 percent for a lead-calcium cell. The battery voltage should be checked about ***once a week*** and the charger setting changed if battery is not at the recommended float value of 2.17 volts per cell. See section 157-601-701.

4. CELL FLOAT VOLTAGE

4.01 ***Interval Between Individual Cell Voltage Readings:*** Individual cell float voltage readings should be made every 3 months except that pilot and emergency cell voltage readings shall be made weekly. See section 157-601-701 INTERVAL, VOLTAGE, AND SPECIFIC GRAVITY REQUIREMENT CHART.

4.02 ***Differential Voltmeter for Cell Readings with Wide Battery Voltage Swings:*** When battery voltage swings are large, individual cell voltage readings should, when possible, be made using a differential voltmeter (Sensitive Research Inst. Corp. Model BELLUD Millivoltmeter, or equivalent). With this instrument, one winding is connected across the 23 cells (assuming a 50-volt battery) of the battery and the other winding across a single cell. The voltage of the single cell above or below the average cell voltage for the total 23 cells of the battery may then be read directly from the zero center scale. This is repeated for each cell.

4.03 ***Individual Cell Readings with Battery Voltage Drifting Very Slowly:*** Where battery voltage is apparently constant or is drifting slowly, that is, the full drift cycle does not occur within the time available for each cell reading, a standard Weston Model 931, 3-volt scale, DC voltmeter may be used if the differential voltmeter is not available. Record (for record only) the battery voltage before and after taking the individual cell voltages. Complete the individual cell readings as promptly as possible. These individual-cell voltage readings may be used as a basis for maintenance in accordance with this practice. While not as definite and comparable as might be desired, they are reasonably accurate for routine maintenance and they can be corrected, partially at least, to an average battery voltage later if a special study of the cell behavior ever becomes necessary.

4.04 ***Individual Cell Readings with Battery Voltage Swinging Over Wide Range:*** Where battery voltage is swinging regularly over an appreciable range, the individual cell readings should be taken by one of the following methods, listed in order of preference.

(a) With differential voltmeter as described in 4.02. This method is satisfactory not only when voltage is constant but also when voltage is changing either regularly or erratically.

(b) Read each cell voltage at the instant the battery voltage on the upswing reaches the voltage at which the battery is actually floating at the time of the readings. This requires one employee to watch the individual-cell voltmeter and take the readings when notified by a second employee who is watching the battery voltmeter. These readings are not reliable during periods of appreciable discharge.

(c) Take individual-cell voltage readings at top and bottom of the swing and record these two readings and their calculated average.