As the termination of battery life is based on the delivery of 80 per cent of rated capacity, any cell when discharged at the 3-hour rate which does not deliver this current value for at least 2.4 hours before the voltage drops below 1.75 should be rejected. In certain applications where large capacity cells are applied for light-duty service, the batteries are operated until the capacities fall as low as 65 per cent and sometime 50 per cent of rated capacity.

Symptoms and Tests to be Considered

C. B. McCormick

Field Engineer, Electric Storage Battery Company, Philadelphia, Pa.

(1) The positive plate of the lead-acid storage battery wears out either through loss of the active material in the form of sediment deposited in the bottom of the jar or through disintegration of the grid structure. A visual inspection, of the plates and the amount of sediment, is sufficient to determine the condition of the positive plates. In floating service there is very little shedding of active material or sediment deposit, the mechanical breaking of the grid usually determining the life of the plate.

However, as long as the grid structure is intact, and even if cracks have started to develop, the positive plate of itself will give full capacity, which may be more than the rating. Even with small pieces of plate cracked off, the cell may deliver more than rated capacity and, therefore, cracks in themselves are not a signal for replacement, particularly in view of the fact that many cells have given several years' additional service after cracking started to develop.

(2) Weakening of the negative plate is accompanied with a falling off of the specific gravity of the electrolyte, and so long as the full-charge specific gravity of a cell checks approximately with what it was when new, the negative plate will give good capacity. For this reason, when installing a new battery, the electrolyte level should be checked and all cells restored to the level line on the side of jar, that are not already so. After bringing to full charge, hydrometer readings of all cells should be carefully taken and kept, together with the electrolyte temperature of one or two cells at the time, as a permanent record for future comparison.

Where accurate readings of specific gravity, electrolytic temperature and solution level are taken and recorded, a comparison of these from time to time will give assurance that the capacity of the negative plates is satisfactory if there is no appreciable falling off of the specific gravity. However, the required accuracy is sometimes not practicable of attainment, and in such cases the test outlined below under Item 3 is preferable in giving assurance that the negative plates are up to normal.

(3) A weakening of the negative plates of a cell is accompanied by a relative falling off in its charging voltage, particularly at amperage rates somewhat higher than normally required at the location. Therefore, in floating service, if a battery will respond readily to an increased charge, which is indicated by the voltage rising rapidly when the charging rate is increased and by the cells gassing freely, the battery is in satisfactory condition and may be considered service perfect. Should any cells upon making this test lag in voltage and gassing, the high rate should be maintained for a reasonable length of time to give the lagging cells an opportunity to revive.

On a battery composed of cells of the same age and subject to the same treatment, the rise in voltage should be fairly uniform for all cells, and there should not be a wide spread in individual cell voltages. Any cells that do not respond, should be separately charged at a higher rate to at least a 20-hour maximum of gravity and voltage and then discharged as a check on available capacity, followed by an immediate recharge.

(4) To determine the actual capacity of a battery, possibly the most convenient test to make is to discharge it at approximately the one-hour rate and take cell voltage readings to the hundredth of a volt at the end of 2 minutes and again at 10 minutes. If the battery was in a fully-charged condition at the start, close to full capacity will be indicated if each cell shows less than a 0.03-volt difference between its two-minute and its 10-minute readings. If any cell shows more than a 0.03-volt difference between its 2-minute and 10-minute readings, then it will be necessary to continue the discharge longer to determine its capacity.

The advantages of the one-hour rate are that it is sufficiently high to indicate good condition or poor condition within a few minutes, and in case the discharge is carried for the full time, the amount in ampere-hours taken out is only one-half the 8-hour capacity and hardly one-third of the 72-hour capacity. A test of this nature may be made in the field on a doubtful battery by using a portable resistor suited to the purpose. Ordinarily the resistor may be connected to the battery terminals without first disconnecting the latter from the load.

(5) To sum up, if, in floating service, the day-to-day and month-to-month average voltage has been maintained at the proper value and the battery is recharged in a reasonable length of time following an emergency discharge and is otherwise maintained in a healthy condition, it will continue to give satisfactory service until the positive plates have worn out as described above in Item 1.

If there is any doubt that the average voltage has been low, Item 3 or 2 tells how to check quickly the condition of the negative plates. A discharge test (Item 4) need be made only in case of any uncertainty regarding indications in Items 1, 2 or 3, or the 10-minute part of this test could be made routine as a substitute for Items 1, 2 and 3.

Purple Signal Glasses

"What information is available as to the use of improved types of signal glasses to provide a more satisfactory purple aspect?"

Latest Purple Glasses Better

W. F. Zane

Signal Engineer, C.B. & Q. Chicago

The proceedings of the Signal Section, A.A.R., include information on the subject of purple signal glasses, as the result of the valuable work of Committee VI. Authentic information may also be secured from the laboratories of the glass manufacturers, where color research has been in progress for a long time.

Purple is one of the poorest colors, as it has a very short range and also is easily affected by atmospheric shading. Fog, snow, mist, and even heat waves, change not only the color intensity but also, under some conditions, the actual color.

The improved types of purple signal glass are much better than the older types and give a more decided color, because the manufacturers have been able to control the other colors and thereby give a more pronounced purple. They have also been able to increase the range, but in the use of a purple glass the intensity of the light

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For other answers on this subject see page 434 of the August issue.

source is quite important, as the other colors in the heated filament may be noticeable. Some railroads are now using the improved types of purple glass and are obtaining an improved indication.

Aerial Cable Versus Open Line

"What are the advantages or disadvantages of aerial cable as compared with open line wires for line circuits on automatic signal territory or coded C.T.C. territory?"

Would Consider Cable for C.T.C. Code Wires

C. A. Taylor
Superintendent of Telegraph and Signals
Chesapeake & Ohio, Richmond, Va.

The general practice on the Chesapeake & Ohio has been to use open line wires in automatic-signal territory, especially where the number of wires required could be carried on one crossarm. In the majority of cases where more than one crossarm has been required, we have used aerial cable rather than installing a second arm. However, we have had but few cases where the pole line was in such condition that a second arm could be added without rebuilding the line.

There is no question in my mind but that the use of aerial cable in place of open line wire, especially in territories where the wires are subjected to heavy sleet storms, provides more dependable service. However, there is a question as to whether the additional expense of the aerial cable would be justified in most instances.

It is our practice to use copper-covered steel weather-proof line wire for signal circuits, and, with our pole lines being maintained in good condition, little trouble resulting from breakages of the wire has been experienced during bad weather in winter months.

We have never installed any long stretches of C.T.C., but if we should ever have occasion to make an installation of this kind in territories where there are usually severe sleet storms, we would probably consider very seriously the use of aerial cable for the code wires. We feel, however, that before definitely deciding which type of construction should be used, a check would have to be made as to the number of sleet storms that had occurred in that particular territory in recent years. From this study we could then determine whether we would be justified in spending the additional money that would be required to place the code wires in cable, as against installing open line wires.

Advantages More Important with C.T.C.

J. H. Schubert
Signal and Telephone Engineer
Nashville, Chattanooga & St. Louis
Nashville, Tenn.

The advantages of aerial cable are as follows: Fewer interruptions from breaks due to wind and sleet, and less liability of trouble from crosses, grounds and lightning. These advantages are considerably more important in C.T.C. territory than in automatic signaling.

The disadvantages of aerial cable are the comparatively high first cost and possible trouble from being damaged by shots or bullets.

Open Line for Coded C.T.C.

B. J. Schwendt
Assistant Signal Engineer,
New York Central
Cleveland, Ohio

The advantages and disadvantages of open line or cable in connection with C.T.C. are quite fully discussed in my article on page 31 of the January, 1930, *Railway Signaling*. At that time unit-wire controlled C.T.C. was in mind, involving a greater number of conductors, and cable was recommended. In the meantime, coded C.T.C. has come into use, and the total number of line conductors as a result has been materially reduced. This changes the problem in favor of open line wire, as many of the conditions justifying cable instead of open line wire, pass out of the picture.

In addition to this, I believe it would require a special design of cable or a "loading" of cable circuits in order to overcome the capacity effect on impulses transmitted over long distances. For short distances (10 or 15 miles) this would probably not be difficult or cause any extra expense.

Disadvantages Are Few

W. F. Zane
Signal Engineer, C. B. & Q., Chicago

The advantages of aerial cable, as compared with open line wire, considerably outnumber the disadvantages. Aerial cable suspended in rings on messenger, with the messenger grounded at frequent intervals, practically eliminates lightning trouble from the line. This results in a saving in avoiding damage to the apparatus and in reducing train delays.

The installation of aerial cable also greatly strengthens a pole line, which reduces the chances of the signal conductors being out of service and helps to keep the telegraph and telephone conductors in service during storms. During storm trouble, even if the pole line goes down, an aerial cable can be kept in service by hanging it on a fence or laying it on the ground.

The construction of aerial cable is such that the C. T. C. control circuits are protected from crosses with telegraph or other current-carrying wires. In numerous cases sleet will break and tangle the wires above the cable and wind them about it, but no shorts or grounds develop.

Another source of trouble, prevalent in territory with which I am familiar, is that of persons along the right-of-way throwing pieces of baling wire into the line. If the conductors are non-insulated, or if the insulation is old and off, the baling wire causes a cross in the signal circuits; an aerial cable installation eliminates this trouble.

The disadvantages in the use of aerial cable may be classified under one heading, namely, some one shooting into it. Such cases are not frequent enough to be considered prevalent. The painting of the cable may be thought of as a disadvantage, but my experience has been that the cost of painting, about once every six or seven years, is the only necessary maintenance, and is less than the maintenance of open line. Aerial cable, I believe, is preferable for C. T. C. use, as it completes an installation in a permanent way.

Cost Considerations Decide

J. P. Muller
Signal Engineer, Boston & Maine
Boston, Mass.

It seems to me that there are very few facts that can be definitely stated concerning the use of open line wire or cable. However, the following is my opinion of the uses of both.

The use of aerial cable, or of open line wire would depend primarily on the number of conductors, the location of the pole line and the density of traffic. If more than 10 conductors were required, aerial cable would appear to be the choice, while for a smaller number of conductors it may be advisable to use open line wires. The initial cost of the two

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