B O T C O L A B O R A T O R I E S

1184 Chapel Street, New Haven, Connecticut

CONFIDENTIAL

LABORATORY INVESTIGATION
TEST REPORT

Report Title: EFFICACY OF LONGA-BATT BATTERY LIFE EXTENDER

Test Study number
F 209 A

Submitted to: PROTEC INTERNATIONAL
1832 Cedar Oak Road
Placerville, California

June 30, 1990

Responsible Investigator: Marvin Botwick
Director of Laboratories

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1184 Chapel Street, New Haven, Connecticut

To:

PROTEC INTERNATIONAL
1832 Cedar Oak Road
Placerville, California

Gentlemen:

We are submitting herewith the results of our laboratory investigations, re the efficacy of LONGA-BATT Battery Life Extender, which were conducted in our laboratories under rigid controlled conditions.

This laboratory investigated the effects of LONGA-BATT Battery Life Extender on two groups of batteries. The first, a group of sixty (60) new dry charged batteries obtained from members of the Association of American Battery Manufacturers. Only those batteries which were manufactured within 60 days from the date of the initiation of the test studies were used. All were adequately tested and examined for defects and to determine their true condition. The second group of batteries studied were twenty (20) older sulphated batteries that were adequately examined and found to be mechanically sound.

These studies were conducted to determine the efficacy, if any, of LONGA-BATT in increasing the degree of charging and discharging efficiency, the reduction of internal operating temperatures, and the inhibition of the conversion of the porous, soft, spongy mass of lead within the grid framework of the negative plates to a larger, more brittle, less porous, i.e., sulphated surface.

In addition, observations were made to determine whether the addition of LONGA-BATT Battery Life Extender would harm lead acid batteries.

These studies have taken place over a six month period, and we are submitting the attached report to you with recommendations that another investigation be implemented to investigate other matters not covered in this initial laboratory study.

Should you deem it desirable, we will be pleased to furnish you with whatever additional details you may require in regard to the test procedures, specifications and techniques utilized by this laboratory during the investigations.

Respectfully submitted,

B O T C O L A B O R A T O R I E S

MB ga

Marvin Botwick
Director of Laboratories

A U T H O R I T Y

The work covered by this report was undertaken at the request of

ProTec International, 1832 Cedar Oak Road, Placerville, California.

The object of this laboratory investigation was to determine by means of controlled laboratory studies the efficacy, if any, of LONGA-BATT Battery Life Extender.

The study was made utilizing the facilities and services of Botco Laboratories under the supervision of Marvin Botwick, Director of Laboratories.

SELECTION OF SAMPLES & DEFINITIONS AND DESCRIPTIONS

As even new lead acid storage batteries show some minor variation, this laboratory exercised its best efforts to reduce variable error as much as possible. The consistency and uniformity of results with all of the batteries tested scientifically permits us to draw definitive conclusions, particularly in view of the fact that we began with some minor variations.

Sixty (60) new dry charged batteries manufactured within 60 days from the start of this study were obtained from a member of the Association of American battery Manufacturers. All were tested and examined for the presence of any defects and to determine their condition.

Activation of the dry charged batteries were carried out in strict accordance with the manufacturer's recommendations. Following their activation, these batteries were tested and examined in order to obviate the introduction of additional variables into the study. Manufacturers electrolyte was used and added as per instructions.

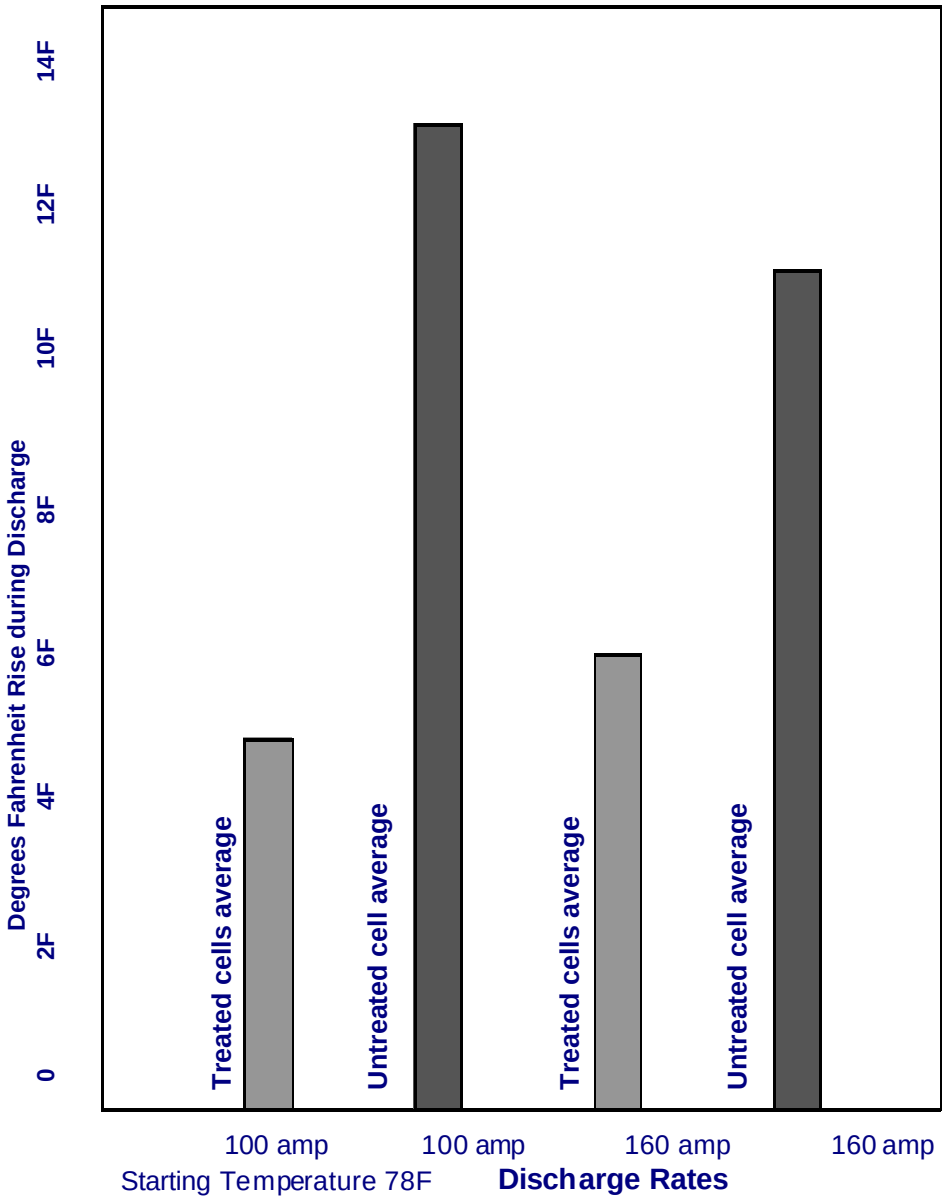
A second group of twenty (20) batteries were obtained and found to be sulphated but mechanically sound.

Throughout the report the word “cell” will be used to designate a single unit consisting of a set of positive and negative plates together with the container in which they are held. The word “battery” will be used to designate any group of cells which have been subjected to the same treatment. Cells in any one battery should be comparable one with the other and comparisons between batteries are undesirable. Accordingly, and wherever applicable, comparisons were limited to the different cells in any particular battery.

Ordinary room temperatures were maintained throughout the study (75° F $\pm$ 5°). Those cells picked for treatment with LONGA-BATT Battery Life Extender for the various comparative studies were arbitrarily chosen.

GRAPH # 1

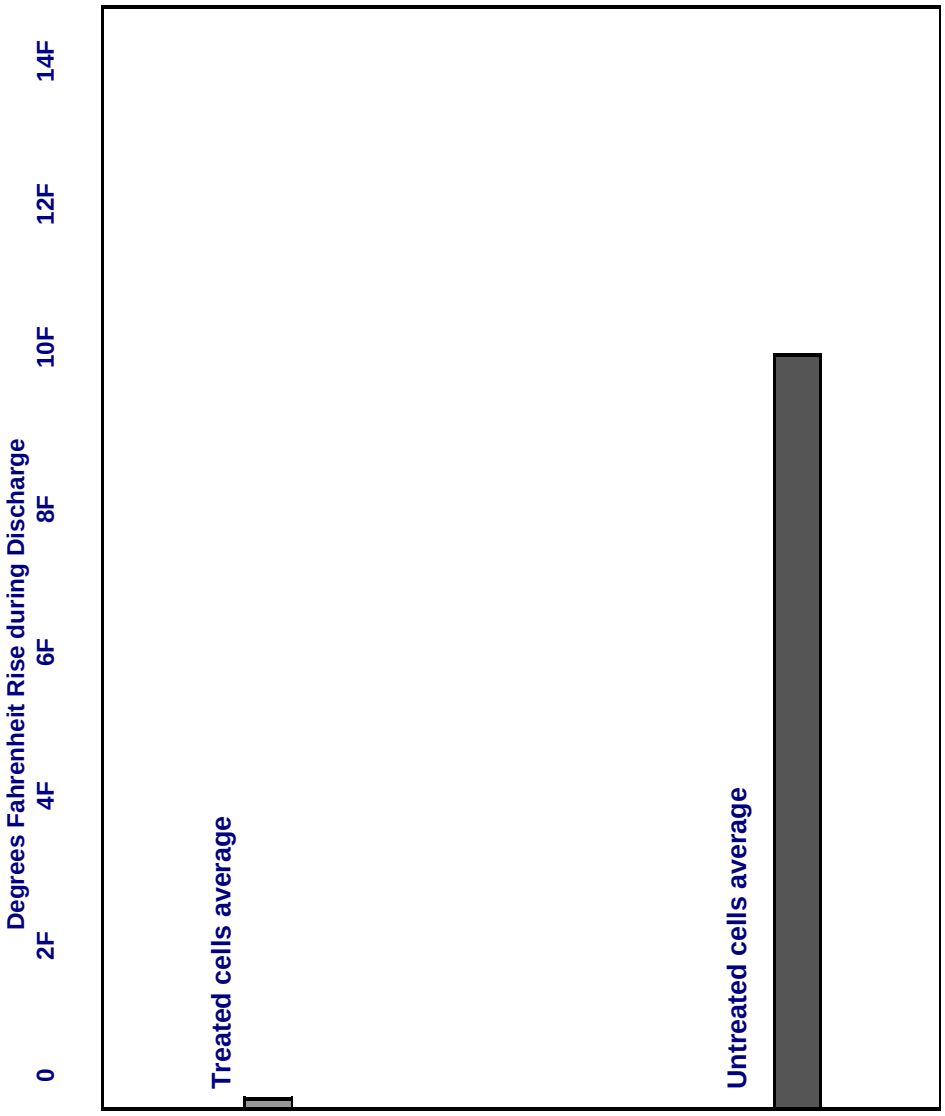
The averages illustrated in the graph relate to the new cell study as well as those of other mechanically sound sulphated cells.



Graph illustrating less heat rise in treated cells during high amperage discharge. Cells discharged to terminal voltage of 1.85 ± 0.5 volts per cell. Treated cells took longer to reach terminal velocity.

GRAPH # 2

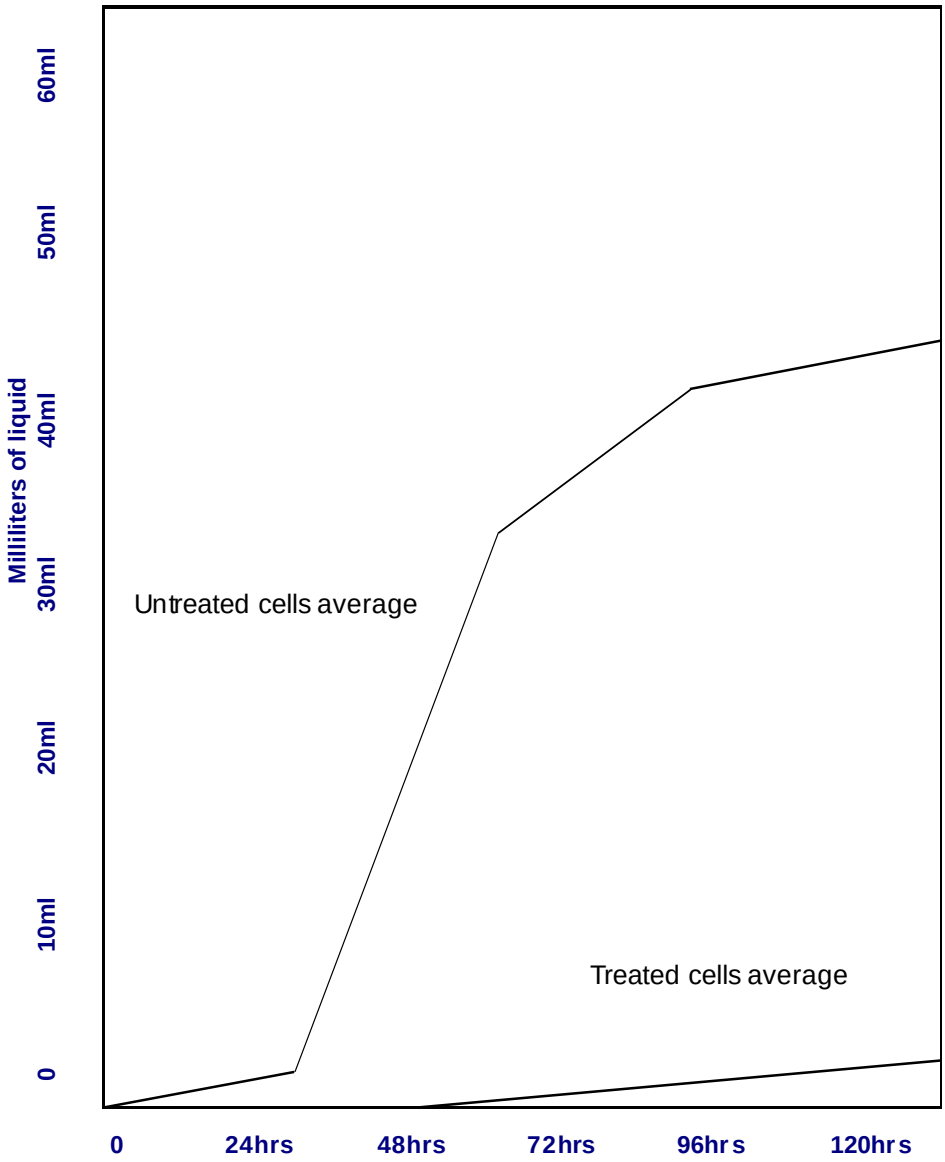
The averages illustrated in the graph relate to the new cell study as well as those of other mechanically sound sulphated cells.



Charged at 10 amperes for 72± 6 hours. At the end of this period all cells were fully charged having an average of 2.50 ± 5% per cell and specific gravity 1265-1270 per cell. Temperatures were taken while still on charge at the end of the period.

GRAPH # 3

The averages illustrated in the graph relate to the new cell study as well as those of other mechanically sound sulphated cells.



Comparative graph illustrating liquid loss averages in untreated Batteries "cyclesd" for 120 hours as compared to liquid loss in treated cells.

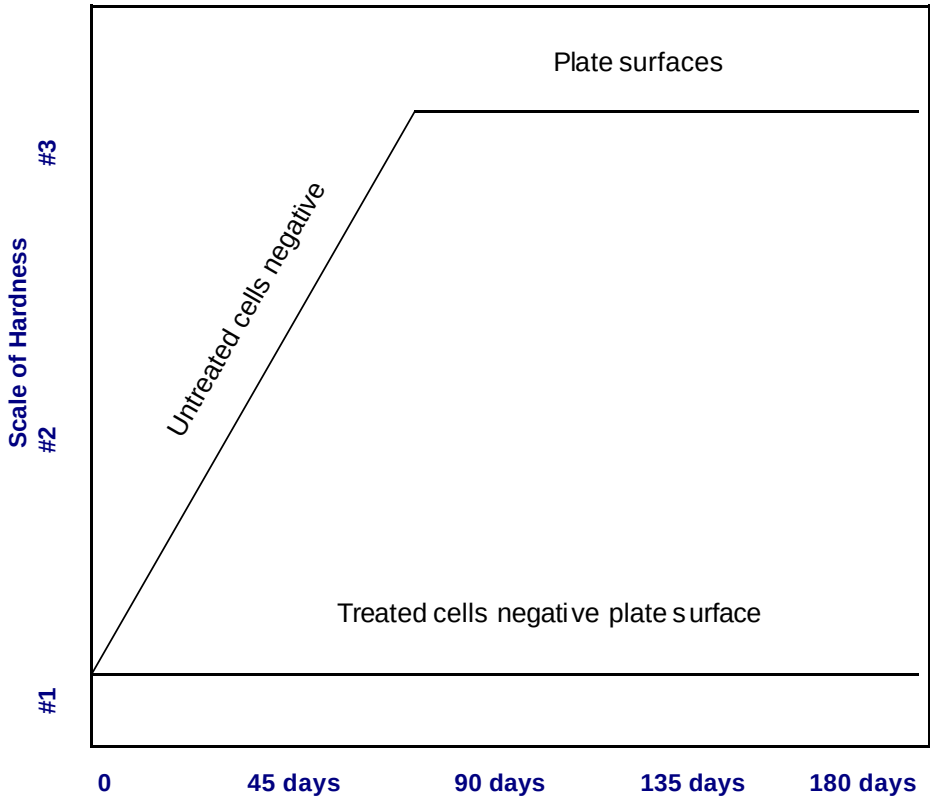
GRAPH # 4

Degree of Sulphation based on Scale of Hardness: Fingernail Probe and Plow.

#1 **Surface, musty paste area on negative plate. Fingernail can easily plow up material.**

#2 **Medium hardness. I.e. fingernail could scrape up surface with effort and surface felt less hard and brittle than # 1.**

#3 **Relatively hard negative plate, so that fingernail could not plow up any material, and surface felt hard and brittle on scraping with fingernail.**



The averages illustrated in the above chart graph relate to new cells studied.

GENERAL DISCUSSION AND OBSERVATIONS

LABORATORY STUDIES

The test studies conducted by this laboratory were designed to afford a controlled laboratory evaluation as to the efficacy, if any, of LONGA-BATT Battery Life Extender.

Based upon the data collected and interpreted by this laboratory, we can conclude, e.g., that due to cooler internal operating temperatures and the fact that more time is required for treated cells to reach terminal voltage under heavy ampere discharge loads, the use of LONGA-BATT can produce additional ampere hours of capacity. (see Graph #1). Cooler internal temperatures were also found during the charging cycle. (See graph #2). We can also conclude from these studies that LONGA-BATT is not harmful to lead acid storage batteries, and that the use of LONGA-BATT resulted in less liquid being lost during charging and discharging cycles. Untreated cells averaged 90% more liquid lost than treated cells.)Total liquid lost equiv. To 100%, i.e., untreated cells averaged a loss of 35 ml. Of liquid, treated cells averaged a loss of 2.5 ml. or 32.5ml. less than untreated cells (See Graph #3).

Upon observing the appearance and testing the surface properties of the grid surfaces of the negative plates of treated and untreated cells, we can also conclude that the use of LONGA-BATT inhibits the conversion of the desirable

PREPARATION OF THE SAMPLE FOR TESTS

Complete examinations of the batteries selected for tests were conducted, including internal examination. The second group study, that is, of the twenty older, used, sulphated batteries were also adequately examined and in order to eliminate another variable, controlled electrolyte was added to those cells to make up the electrolyte level.

TEST METHODS

Charging Conditions

All cells in any given battery were charged in series in order to make certain that the same number of ampere hours passed through each cell in the battery. Whenever individual cells were found not to be dead before charging, they were brought to a dead condition by discharging to a point where, on a direct short through an ammeter less than one ampere was indicated on the meter, the full square reading being twenty-five amperes.

Discharge Conditions

During discharge in a given battery, each cell was individually discharged and the rate of discharge was the same for every cell within $\pm$ 1.5%.

Measurement of Specific Gravity

Specific gravity were ordinarily measured by the use of service station hydrometers. Separate hydrometers were used for treated cells and separate hydrometers for untreated cells. For the measurement of any gravity below 1100 a float in a graduated cylinder was used. On checking the hydrometers, all were found to read the same and the additional float was found to check out the hydrometers used at the 1100 point.

Temperature Readings

All temperatures were measured with calibrated laboratory thermometers and all thermometers used were routinely checked against each other at room temperature.

Discharge Resistances

An assortment of variable nichrome wires capable of carrying 10, 50, 100, and 160 amperes were used to control the current on discharge. The discharge rate was kept reasonable constant within approximately 1/10 of an ampere, except when voltages were falling very rapidly during discharge.

INTERNAL EXAMINATION OBSERVATIONS

The negative plates of treated cells were invariably found to be considerable softer than the corresponding plates of untreated cells. Many of the soft areas were fairly well distributed across the plate surfaces, and sometimes the soft areas were concentrated around the edge of the plates. Differences of the degree of hardness were readily noted even by using a fingernail as a combination probe and plow to scrape or scoup up the softened surface. Under the same testing conditions the hardened areas on untreated negative plates could not be plowed up.

Access to these plates was obtained by lifting the complete cell from the container at the end of the charging period. The treated negative plates were found to yield a soft, mushy quantity of paste by this “fingernail” procedure, while the untreated negative plates were hard and yielded no such plowed up material. In some of the negative treated plates the soft spots were found only around the plate edges.

A gross decrease in the amount of sediment was observed in the treated cells, as compared to the untreated cells.

In those cases where cells under tests had had the tops removed so that the complete surface of electrolyte was visible, marked differences in the appearance were noted during the charging period. Gas evolving from treated cells was in the form of tiny pinpointlike bubbles rising slowly and breaking at through the surface with very little disturbance, as compared to the untreated cells whose gas bubbles were very much larger and which bubbles rose very rapidly and broke through the surface with considerable amounts of splattering.

It was observed that the amount of liquid lost during charge was less in the treated cells than the amount of liquid lost in the untreated cells. Initially, all cells were brought up to the same level, and after charge the liquid loss was adequately measured by determining the number of milliliters of liquid required to bring the level back to the initial point. (See Graph #3).

SUMMARY OF LABORATORY OBSERVATIONS

On the basis of the controlled laboratory investigations made by this organization, we have concluded the following:

1. When used according to the manufacturer's directions, a normal, mechanically sound, lead acid battery is not harmed by the use of LONGA-BATT .
2. In those cells treated with LONGA-BATT there was found to be less shedding of active material and the material in a softer condition.
3. Further, as against some disintegration in untreated cells, the grids were found to be firmer in the treated batteries.
4. The examination indicated that the positive plates from treated cells showed a softer and finer texture of the lead peroxide, their color being red-brown to dark brown. However, in those untreated cells,

7. Upon comparison with untreated cells, those cells treated with LONGA-BATT indicated a more effective, that is, higher charging efficiency.

8. An extensive internal examination indicated that sulphated cells treated with LONGA-BATT were in better condition mechanically than those cells which were untreated.

9. It was also observed by this laboratory that the separators in batteries treated with LONGA-BATT appeared to suffer less physical deterioration than the separators of untreated batteries.

10. Extensive internal examination indicated that when LONGA-BATT was added to cells containing sediment, the amount of sediment was decreased when the battery was on charge and when it was not on charge.

11. Laboratory observations indicated that LONGA-BATT treated cells when on charge have a distinctly different appearance from untreated cells on charge. The gas bubbles evolving in the LONGA-BATT treated cells were much smaller than those evolved in the untreated cells.

12. In those cells treated with LONGA-BATT, both in the new batteries and in the mechanically sound sulphated batteries, the conversion of the desirable soft, spongy, porous mass of material of the grid surface of the negative plate into a

harder, brittle, less porous – that is, sulphated condition, is inhibited. Accordingly, we can conclude that this inhibition will add to the useable life of a battery.

The laboratory evaluation of a material such as LONGA-BATT Battery Life Extender is complicated by some minor variations in the cells subjected to study, even though every effort has been made to select test units and to initiate controlled conditions so as to minimize any such variation.

However, as stated hereinbefore, the consistency of the results obtained both in regard to the new batteries and older mechanically sound sulphated batteries, scientifically negates any effect upon the findings between minor variations which exist in all batteries.