

US EPA ARCHIVE DOCUMENT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Office of Research and Development  
Washington DC 20460



ENVIRONMENTAL TECHNOLOGY VERIFICATION STATEMENT

<b>TECHNOLOGY TYPE:</b>	<b>RECHARGEABLE ALKALINE HOUSEHOLD BATTERY SYSTEM</b>
<b>APPLICATION:</b>	<b>1.5 VOLT BATTERIES IN STANDARD SIZES AAA, AA, C, AND D</b>
<b>TECHNOLOGY NAME:</b>	<b>RENEWAL<sup>®</sup></b>
<b>COMPANY:</b>	<b>RAYOVAC CORPORATION</b>
<b>ADDRESS:</b>	<b>601 RAYOVAC DRIVE MADISON, WISCONSIN 53711-2497 P.O BOX 44960</b>
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The U.S. Environmental Protection Agency (EPA) has created a program to facilitate the deployment of innovative environmental technologies through performance verification and information dissemination. The goal of the Environmental Technology Verification (ETV) Program is to enhance environmental protection by substantially accelerating the acceptance and use of innovative, improved, and more cost-effective technologies. The ETV Program is intended to assist and inform those individuals in need of credible data for the design, distribution, permitting, and purchase of environmental technologies. This Verification Statement provides a summary of the performance results for the Rayovac Corporation's Rechargeable Alkaline Household Battery System, trade name Renewal<sup>®</sup>.

## PROGRAM OPERATION

The EPA's ETV Program, in partnership with recognized testing organizations, objectively and systematically documents the performance of commercial ready technologies. Together, with the full participation of the technology developer, they develop plans, conduct tests, collect and analyze data, and report findings. Verifications are conducted according to a rigorous workplan and established protocols for quality assurance. Where existing data are used, the data must have been collected by independent sources using similar quality assurance protocols. The EPA's ETV Program, through the National Risk Management Research Laboratory (NRMRL), has partnered with the California Department of Toxic Substances Control (DTSC), under an ETV Pilot Project, to verify the performance of pollution prevention, recycling, and waste treatment technologies.

## TECHNOLOGY DESCRIPTION

Rayovac redesigned their alkaline household batteries so that they could be recharged. The additional charge cycles extend battery life by increasing the energy capacity, which benefits the environment by generating less waste. The design changes included increased void space, and addition of lead and silver. The Rayovac Renewal<sup>®</sup> Rechargeable Alkaline Household Battery System consists of rechargeable alkaline zinc-manganese dioxide 1.5 volt batteries, in sizes AAA, AA, C, and D, and a recharging device for the batteries. Typical consumer applications of household batteries include toys and games, portable audio equipment, cameras, sporting goods equipment, test equipment, personal care products, hearing aids, portable data terminals, sub-notebook computers and personal digital assistants, watches, flashlights, lanterns, and cellular phones. Such applications typically require continuous currents of up to 400 milliamperes (mA), which is within the range of the Renewal<sup>®</sup> batteries, sizes AA, C, and D. Size AAA can supply up to 150 mA continuous current, which is sufficient for applications such as clocks.

## EVALUATION DESCRIPTION

The approach of this evaluation was to verify the independent data for energy capacity performance previously collected as part of the DTSC certification, and to collect additional data for toxicity and cost. The specific objectives were to:

- 1) determine the initial and cumulative capacity of the Renewal<sup>®</sup> System's batteries under controlled laboratory conditions using, to the extent possible, industry-accepted standard tests that model typical consumer applications, and to compare the Renewal<sup>®</sup> batteries' performance to that of Rayovac's non-rechargeable alkaline batteries;
- 2) determine what levels of federally regulated toxic metals might leach from the Renewal<sup>®</sup> System's batteries, using the federal Toxicity Characteristic Leaching Procedure (TCLP) test method; and
- 3) estimate consumer costs, using conservative calculations and independently verified cost and performance data.

Availability of independent data limited performance verification to initial, five, and twenty-five cycle energy capacity tests. Initial energy capacity indicates how much energy a battery contains when first used, while cumulative energy capacity indicates the total energy the battery yielded after a series of discharge/charge cycles. TCLP data are used to determine if a waste is regulated as hazardous by EPA, and to estimate land disposal impacts of the waste.

In 1995, Tracor, Inc., a contractor with an independent battery testing facility, conducted several series of American National Standards Institute (ANSI) energy capacity tests. Tracor conducted a total of 12 tests on four sizes of Renewal<sup>®</sup> batteries. The tests measure how long a battery provides energy under conditions that simulate the electrical load and cutoff voltage of typical consumer devices such as toys, tape players, portable lighting, or transistor radios. (The cutoff voltage is the lowest voltage on which a device will operate.) The batteries were drained, charged to their initial voltage, and drained again to their cutoff voltage for a total of five cycles. Each test was conducted on four batteries of the same size so performance variability could be analyzed. In 1996, four Size AAA batteries were further tested for 25 cycles. For ETV, in 1998, TCLP tests were performed for all four sizes of the Renewal<sup>®</sup> batteries. For TCLP results, the batteries were purchased, prepared, and analyzed by an independent analytical laboratory.

Details of the evaluation, including data summaries and discussion of results, may be found in the report entitled, "U.S. EPA Environmental Technology Evaluation Report: Rayovac Renewal<sup>®</sup> Rechargeable Alkaline Household Battery System" (EPA/600/R-99/005)."

## VERIFICATION OF PERFORMANCE

The observed performance characteristics of the Renewal<sup>®</sup> System include the following:

- **Energy Capacity:**

The initial energy capacity of the Renewal<sup>®</sup> batteries, as compared to non-rechargeable alkaline batteries of the same size, was as follows: Size AAA: 4.0 hours (51.9% of that of a nonrechargeable alkaline), size AA: 4.0 hours (76.0%), size C: 14.4 hours (81.4 %), and size D: 14.7 hours (89.6%).

After five cycles, for sizes AAA and AA, the Renewal<sup>®</sup> batteries produced cumulative hours of service that ranged between that produced by two and three non-rechargeable alkaline batteries of the same size. For sizes C and D, the Renewal batteries produced cumulative hours of service that ranged between that produced by two and four non-rechargeable alkaline batteries of the same size.

After 25 cycles, for size AAA, the Renewal<sup>®</sup> batteries produced cumulative hours of service that ranged between seven and eight non-rechargeable alkaline batteries.

- Toxicity Tests:**

TCLP results for all metals were below their respective EPA regulatory limits. Only barium and silver were found above the detection limits; barium was found at two orders of magnitude below its regulatory limit, while silver was found at one order of magnitude below its regulatory limit. The maximum results are listed below (in milligrams per liter); results below detection limits are listed as <(detection limit):

METAL	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
REGULATORY LIMIT	5.0	100.0	1.0	5.0	5.0	0.2	1.0	5.0
MAXIMUM DETECTED	<0.036	0.32	<0.0068	<.065	<.029	<.0083	<.39	0.19

\* Regulatory Limit values are EPA TCLP regulatory thresholds, 40CFR261.24, 1997.

- Cost Estimates:**

Consumer capital and operating costs were estimated and compared to non-rechargeable alkaline batteries by purchasing batteries in packs of four at 1998 prices. Capital costs include the cost of batteries and charger; the only operating cost is the cost of electricity for charging. Renewal<sup>®</sup> batteries cost slightly more than twice that of Rayovac non-rechargeables, and the cost of chargers ranges from \$10 to \$20 before rebates. The average cost to charge four batteries was conservatively estimated to be three fourths of a cent. A savings of \$2 to \$12 per pack of four is estimated as compared to non-rechargeables. This savings is based on a useful life of at least 25 charges, and varies depending on the size of batteries and type and number of chargers purchased.

Results of the verification show that the Renewal<sup>®</sup> System is capable of reducing waste volume by extending battery life through recharging. The amount reduced depends on the battery size, application type, and user practices such as frequency of charging. In addition, no TCLP results were above EPA levels for regulating metals as hazardous waste, and were below detection limits for most metals. Finally, the costs of the Renewal<sup>®</sup> System were compared to the costs of non-rechargeable alkaline batteries for Size AAA. For this case, based on 25 useful charging cycles, total costs were estimated to be lower for the Renewal<sup>®</sup> System. Actual savings depends on current prices, the type and number of batteries and chargers purchased, and user applications and practices.

*Original Signed By*  
*E. Timothy Oppelt*  
 3/26/99

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E. Timothy Oppelt                      Date  
 Director, National Risk Management  
 Research Laboratory  
 Office of Research and Development  
 United States Environmental  
 Protection Agency

*Original Signed By*  
*James T. Allen, Ph.D.*  
 3/19/99

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James T. Allen, Ph.D., Chief              Date  
 Chief, Office of Pollution Prevention  
 and Technology Development  
 Department of Toxic Substances Control  
 California Environmental Protection Agency

<p>Notice: Verifications are based on an evaluation of technology performance under specific, predetermined criteria and the appropriate quality assurance procedures. EPA and Cal/EPA make no expressed or implied warranties as to the performance of the technology. The user is solely responsible for complying with any and all applicable federal, state, and local requirements.</p>
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## Availability of Verification Statement and Report

Copies of the public Verification Statement (EPA/600/R-99/005VS) and Verification Report (EPA/600/R-99/005) are available from the following:

(Note: Appendices are not included in the Verification Report. Appendices are available from DTSC upon request.)

**1. US EPA / NSCEP**

P.O. Box 42419  
Cincinnati, Ohio 45242-2419

Web site: <http://www.epa.gov/etv/library.htm> (*electronic copy*)  
<http://www.epa.gov/ncepihom/> (*hard copy*)

**2. Department of Toxic Substances Control**

Office of Pollution Prevention and  
Technology Development  
P.O. Box 806  
Sacramento, California 95812-0806

Web site: <http://www.dtsc.ca.gov/sppt/opptd/etv/txppetvp.htm>  
or <http://www.epa.gov/etv> (*click on partners*)