

ADVANCED LEAD-ACID BATTERIES FOR ELECTRIC UTILITY LOAD LEVELING

Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL 60439 (U.S.A.)

This project is directed to the research, development, and demonstration of advanced lead-acid battery technology, leading to increased cycle life, energy efficiency, and area density and to reduced initial cost (\$/kW h) and operating and maintenance cost (mi/kW h) of the battery for electric utility load-leveling applications. The results of studies, *i.e.*, projected cost and life of the state-of-the-art lead-acid batteries, showed these batteries to be marginally acceptable to industry. It is the purpose of this project to advance the lead-acid technology and produce a battery more acceptable to the utility industry. The major development efforts are being subcontracted, on a cost-sharing basis, with battery manufacturers who have developed the background technologies. Other activities to support this program include a small support research group at ANL and battery verificational testing at the National Battery Testing Laboratory (NBTL).

Under this project, industrial R & D contracts were initiated in 1979 by C & D Batteries and by Exide. At C & D Batteries, 150 test cells, with various design factors projected to increase cycle life and decrease cost were designed, fabricated, and put on test. The C & D program was discontinued in March 1981 due to funding limitations. Although insufficient testing had been accomplished to be able to project the 4000-cycle goal, 3000 cycles could reasonably be projected as possible. A cost and design study by C & D indicated an original equipment manufacturer battery cost of \$76 to \$91/kW h. The R & D effort at Exide continued through September 1982. Exide has demonstrated, through accelerated testing, greater than 4000 equivalent cycles. A cost study by Exide has yielded a cell cost of \$85/kW h.

In verificational testing at NBTL, testing and evaluation of a 15-kW h state-of-the-art lead-acid module was completed. This test was conducted to establish the baseline level of the technology and to assess the adequacy of the test procedures developed for evaluating advanced lead-acid load-leveling batteries. Three high-current (1000-A, 0 to 20-V) test stations have been commissioned. Testing of 12 Exide advanced lead-acid cells (3500-A h) was initiated in April 1982.

Performance and life verificational testing at ANL/NBTL will constitute the major effort of the 1983 program. An Exide six-cell module (12-V, 3500-A h) will be tested to determine performance and life under standard laboratory conditions. Two Exide three-cell modules (6-V, 3500-A h) will be tested on various simulated electric utility application cycles. Elevated temperature and low temperature operating characteristics will be evaluated. Self-discharge rates, thermal management requirements, and maintenance

requirements will be evaluated. Limited charge optimization studies will be undertaken to quantify the energy efficiency/capacity trade-offs and to establish optimized charging procedures. Battery temperatures under various operating conditions will be analyzed and recommended methods for proper thermal management will be defined. If appropriate, post-test analyses of failed cells will be conducted.

Recent publications

- 1 C & D Batteries Division of Eltra Corp., Final summary report — research, development, and demonstration of advanced lead–acid batteries for utility load leveling, Argonne National Laboratory, *Report ANL/OEPM-81-15*, March 1982.
- 2 K. Ledjeff, H₂O₂ recombination device for load-leveling lead–acid batteries, *4th DOE Battery and Electrochemical Contractors' Conference, Washington, DC, June 2 - 4, 1981*.
- 3 R. M. Meighan, D. R. Green and C. W. Fleischmann, Advanced lead–acid load leveling battery, *Progress in Batteries and Solar Cells*, 3 (1981).
- 4 Varta Batterie Co., Cost/design study and fabrication /testing of a 300-W gas recombination device for utility lead–acid cells, Argonne National Laboratory, *Report ANL/OEPM-82-4*, May 1982.

ADVANCED LEAD–ACID BATTERIES FOR ELECTRIC UTILITY LOAD-LEVELING APPLICATION

Exide Management and Technology Company, 19 West College Avenue, P.O. Box 336, Yardley, PA 19067 (U.S.A.)

This project encompasses the research, development, and demonstration of advanced lead–acid battery technology with major goals of increasing cycle life of a utility-sized stationary lead–acid battery from the state-of-the-art of 2000 cycles to greater than 4000 cycles at reduced cost of \$50 to \$68/kW h (1977 dollars) and operating and maintenance cost of less than 0.5 mi/kW h. Phase I (3 yr) emphasizes the research and development of low-maintenance cells capable of long-lived cycle application. The reduction of cost and increased cycle life will be achieved primarily by R & D of improved active material, using low-corrosion grid alloy, electrolyte circulation, improving the separator retainer, and developing a subsystem for further reduction in battery maintenance.

In Phase I, accelerated testing of 156 cells with full-sized plates is nearing completion. In a continuous overcharge test at 50 to 55 °C, 24 400-A h cells have accumulated 127 000 A h overcharge at rates from 30 to 90 A.