battery leading to the manufacture and testing of a 5 MW h BEST battery. In addition to the specified RD&D, information will be provided on the potential recyclability, the environmental impact, and the safety factors of lead–acid batteries. The annual cost and design study of a lead–acid load leveling battery system based on the developed advanced concepts will be carried out to identify areas of improvement for further development effort.

The program management and quality assurance plans for this effort are being prepared for ANL approval.

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

ESB, Inc., 19 West College Ave., P.O. Box 336, Yardley, PA 19067 (U.S.A.)

This project has just begun and it encompasses the research and development and demonstration of advanced lead–acid battery technology with major goals of increased cycle life of utility sized, stationary lead–acid batteries from the state-of-the-art of 2000 cycles to >3000 cycles at the reduced cost per cycle of ~1.5 ¢/kW h cycle^{-1} and a reduced operating and maintenance cost of <0.5 mil/kW h.

These goals are to be accomplished in three phases. The first phase (3 years) will emphasize cell design optimization accomplished through the evaluation of critical variables affecting battery energy output, energy efficiency and cycle life. Tests will be conducted using full size cells. Phases II and III (3 years) will emphasize the engineering development of advanced lead–acid battery design, the manufacture and testing of a 5 MW h BEST battery incorporating cost reduction and improved life design. In addition to the specified RD&D, information will be provided on the potential recyclability, the environmental impact, and the safety factors of lead–acid batteries. An annual cost and design study of the lead–acid load leveling system using the results of advanced concepts developed will also be provided. During this period, the program management and quality assurance plans for this effort were completed.

BATTERY ENERGY STORAGE TEST (BEST) FACILITY

Public Service Electric and Gas Company, 80 Park Place, Newark, NJ 07101 (U.S.A.)

The objective of this work is the design (Phase I), construction (Phase II), and acceptance testing (Phase III) of a national test facility to evaluate

and assess advanced load-leveling batteries and power conversion equipment in an utility environment. Under the current funding and schedule the facility will become operational in late 1980 with a 1.8 MW h lead–acid battery. A contract modification providing for the outfitting of the second test bay to accommodate a 5 MW h zinc–chlorine battery is expected. During the operations phase of the project a variety of advanced utility load-leveling battery energy storage systems in the range 5 - 10 MW h will be tested.

(1) During the early part of 1979 the final design of the facility was completed and additional RFQ's for equipment were issued. Construction of the facility commenced in July, 1978, and continued to the end of this reporting period. Also during this time, design changes were made on the power conditioning and data acquisition and control system to take into account updated information on advanced battery characteristics and to extend operating ranges, permitting wide-range control for testing of smaller battery units (approximately 250 kW h and upwards).

All major equipment for the baseline facility is now on order and progressing in fabrication: The Facility Monitoring and Control System, a 2.5 MW Power Conditioning System, and a 1.8 MW h Lead–Acid Facility Shakedown Battery.

(2) In parallel with the design and construction of the facility, analytical studies were performed to determine functional requirements for test data analysis and processing. Also prepared were plans for acceptance testing of the baseline facility and for subsequent operation. Plans and proposals were submitted to DOE and EPRI for the implementation of the second test bay to accommodate a 5 MW h zinc–chlorine battery for testing *ca.* 1981, and for the procurement and installation of an advanced, self-commutated power conversion system by 1982.

(3) Development of a diversified test program was started with the aim of providing three possible test services to the user: development testing, prototype testing, and demonstration testing. A flexible data processing and analysis scheme is in development which will afford the equipment developer continuous and interactive access to test data in addition to daily, weekly, and monthly test summaries produced by the test facility.

Salient features of the plan for operation are provisions for a variety of operating modes that will permit the BEST Facility to exercise charge and discharge cycles without central power system dispatch control. Most tests will be program-driven and computer-controlled for projected typical utility operating modes to permit testing and evaluation in a realistic environment. The plan includes provisions for demonstration-type testing in which a complete battery energy storage system can be dispatched directly by the PSE&G power system dispatch center.

A subcontract with AiResearch Mfg. Co., 2525 West 190th Street, Torrance, CA 92509 covers hardware requirements for a Power Conversion System (PCS) with a nominal rating of 2.5 MW, using line-commutation. The equipment includes all systems necessary for operation, control, protection,

annunciation, communication, support, and protective coordination of lead–acid and advanced batteries within the BEST Facility, and will have the capability of operating over a continuous voltage range from 0 to 1000 V and a continuous current range from 0 to 5000 A d.c. In addition to this extremely wide operating range, the equipment will also have the capability of reversing polarity of voltage and current at the battery terminals and permit testing of single battery modules. Included in the subcontract are simulation studies to determine interactions between batteries, conversion equipment, and the utility grid.

The power conditioning system hardware has been manufactured and assembled. Simulation studies have been completed. Factory testing and subsequent shipment are scheduled for late 1979.

A procurement contract has been placed with C&D Batteries, 3043 Walton Road, Plymouth Meeting, PA 19482 for the fabrication and factory testing of a 1.8 MW h state-of-the-art, lead–acid, calcium-grid battery with a 1750-cycle life. The primary purpose of the battery is to test selected performance capabilities of initial equipment and future Power Conditioning Systems at the BEST Facility. The battery is specified as a complete system including all equipment necessary for cooling, physical support, interconnections and monitoring, and to achieve specified low emission rates.

The battery system is currently in the assembly stage, and scheduled for factory testing during late 1979. Delivery and installation is projected for early 1980.

The subcontract for the design, fabrication, and factory testing of the software and hardware of a Monitoring and Control System to perform the following functional requirements:

Plant control
Data acquisition
Information display
Logging
Calculations
Operation guidance

has been placed with Honeywell Inc., Process Control Division, 2222 West Peoria Avenue, Phoenix, AZ 85029. The system is specified to incorporate suitable protection for safe, reliable operation in an electric utility environment, such as protection from interference caused by nearby high voltage transmission lines, distribution system switching surges, and induced transients by lightning. During 1979, modifications were made to the subcontract to provide for future field addition of a redundant central processing unit and for additional equipment.

The Monitor and Control System is currently in the assembly stage; program development will begin during the third quarter of 1979, leading to an expected factory test date of December, 1979. Installation, check-out, and start-up of this system is scheduled to commence in early 1980.

Recent publications

1 PSE&G, Draft functional description of the BEST Facility Test Data Processor, presented at the *Meeting of the EPRI Testing Methodology Group, Argonne, Illinois, September 19 - 21, 1978.*
2 PSE&G, Guidelines for BEST Facility Battery Testing Programs: A working paper, presented at the *Meeting of the EPRI Testing Methodology Group, Argonne, Illinois, September 19 - 21, 1978.*
3 P. A. Lewis and A. Pivec, The BEST Facility — accelerating the development of utility load leveling batteries, *28th Power Sources Symp., Atlantic City, New Jersey, June 12 - 15, 1978.*
4 R. V. Snow, The design of the battery energy storage test facility, *IEEE Power Engineering Soc., Summer Meeting, Los Angeles, California, July 16, 1978.*
5 E. A. Hyman and A. Pivec, The Battery Energy Storage Test Facility: test programs and data processing — an update, *14th Intersoc. Energy Conversion Engineering Conf., Boston, MA, August 5 - 10, 1979.*

TECHNICAL AND ECONOMIC ASSESSMENTS OF ELECTROCHEMICAL ENERGY STORAGE SYSTEMS

PSE&G Research Corporation (PSE&G Company), Newark, NJ 07101 (U.S.A.)

The objective of this program plan is to provide a comprehensive methodology for systematically implementing the analytical, technical, and economic assessments of electrochemical energy storage systems.

The application of this methodology will result in objective and realistic technical and economic assessments of advanced battery systems which can aid in the acceleration of advanced battery systems for commercial load leveling applications.

Four major tasks are required to implement the needed technical and economic assessments. These tasks are:

1. Overall Technical Assessments
2. System Stability Impact Assessments
3. Overall Economic Assessments
4. Battery Cost Methodology.

Each of these tasks and accomplishments to date are briefly described.

(1) Overall technical assessments

In order to perform an overall technical assessment, each of the four battery systems listed below will be examined:

— zinc–chlorine
— sodium–sulfur
— lithium–sulfur
— advanced lead–acid.