Conf-910350--1

SAND--91-0175C

DE91 007070

Advanced Lead-Acid Batteries for Utility Applications

Abbas Akhil
Sandia National Laboratories

Al Landgrebe
U.S. Department of Energy

ABSTRACT

During 1990, Sandia National Laboratories initiated an advanced lead-acid battery development program supported by the U.S. Department of Energy's Office of Energy Management. The goal is to develop a low maintenance, cost effective battery by the mid- to late 1990's that is tailored to a variety of electric utility applications. Several parallel activities are being pursued to achieve this goal. One activity seeks to quantify the economic benefits of battery storage for specific cases in candidate utility systems and identify opportunities for field demonstration of battery systems at electric utility and utility customer sites. Such demonstrations will not only generate valuable operating experience data, but will also help in building user confidence in battery storage systems. Other activities concentrate on cell- and battery-level research and development aimed at overcoming shortcomings in existing technologies, such as Valve-Regulated Lead-Acid (VRLA), or, sealed lead-acid batteries.

Introduction

Sandia National Laboratories (SNL) is managing the development of several advanced rechargeable battery technologies for the U.S. Department of Energy. During 1990, an advanced lead-acid battery program was initiated to develop a battery specially suited for electric utility applications, that would be market-ready by the mid- to late-1990's. Existing flooded-cell lead-acid batteries have already been demonstrated in several utility projects both in the United States and overseas. But, the prospects for widespread battery energy storage applications in electric utilities would be greatly enhanced if Valve Regulated Lead-Acid (VRLA) batteries could be used instead of flooded-cell battery systems. Thus, the goals of the advanced lead-acid battery program are to improve existing technology such that low maintenance lead-acid batteries meet or exceed the performance of flooded-cell batteries in utility applications and to quantify and demonstrate its benefits to promote widespread utilization by the utility industry in the targeted time frames.

The near term commercialization goals of the advanced lead-acid battery development program dictate a different programmatic approach than that compared to other "advanced" technology battery programs such as sodium/sulfur and zinc/bromine whose development is also being managed by SNL. The key difference in this program is a greater involvement by electric utilities, and a special effort to create working relationships between utilities and battery developers, such that each understands the needs and requirements of the other.

Given the short-term horizon, several simultaneous activities are being pursued to ensure that the goals are met in a timely manner. These activities are aimed at not only improving the technology, but also at demonstrating the viability of the technology to the electric utility industry, such that a "market" develops in the next few years.

The program is made up of four distinct activities:

* Lead-acid technology improvement
* Utility-specific system studies
* Testing and demonstration
* AC Battery development and demonstration

Each of these activities is described in further detail:

Lead-acid battery technology development:

Flooded-cell lead-acid battery technology has been demonstrated in several projects in electric utility systems both in the United States and overseas. However, the utility industry prefers the advantages of reduced maintenance and simpler facility design offered by VRLA batteries. But, VRLA battery technology has not been demonstrated in utility scale applications and early testing indicates a need for some improvements before it can be considered ready for utility applications.

The technology development activity seeks to overcome these shortcomings by pursuing research and development at the cell and battery level. A three year research program has been defined and a contract with a major battery manufacturer is being negotiated to perform the research.

The battery manufacturer has identified two utility applications with the assistance of a "host utility". The host utility remains involved throughout the contract effort and identifies areas for technology improvements based on the requirements of their chosen application. Various economic analyses are performed to justify expected performance improvements versus its cost impact on the battery.

The host utility concept has been incorporated into this effort to encourage participation in the program by electric utilities such that their application requirements guide the development efforts of the battery manufacturer and forge a working relationship from an early development stage. Such an involvement will enable the utility to understand the process that is followed by the battery manufacturers in developing and manufacturing the battery, and the service support structure of this industry.

Utility-specific system studies:

Utility-specific system studies are aimed at identifying the complete range of battery energy storage applications in a utility system and quantifying the related benefits. Traditionally, emphasis has been placed on load-levelling as the primary application of battery storage in utility systems. Yet, there is strong evidence that suggests that there are other applications in utility systems that have equal or greater economic value. Along these same lines, it is also possible that multiple applications are combined and the battery is operated in a "dual" use mode - maximizing its economic worth to the system.

Past studies have identified the economic value of battery storage for applications other than load-leveling, such as spinning reserve, black start, and frequency control. But, because these studies were based on general assumptions, their results cannot be used by utilities in their system planning. The system studies in this program differ from the previous efforts by being customized to a particular utility. They are specific to the operating conditions and economic circumstance of that particular utility. The results to be obtained will provide the utility the information it needs to not only evaluate the technology, but also an action plan with regards to its implementation.

Several utilities that have an interest in battery technology or have operating conditions that indicate that they could potentially benefit from this technology have been contacted to explore the possibility of conducting the system studies. These utilities will be offered assistance in performing the study under SNL contracts on a cost-shared basis.

If the study identifies specific applications within the utility, the economics of these applications will be evaluated in detail. If the results indicate that the economics are favorable, it is anticipated that the utility will independently consider its implementation. If the economic evaluation indicates only marginally favorable economics, then some incentives may be offered to even the balance, and make it attractive to the utility to implement a demonstration project.

Testing and Demonstration:

Concurrent with the other activities of the program, this activity focuses on obtaining as much test data as possible with existing technology VRLA batteries, under various operating conditions.

Two VRLA batteries of approximately 120 to 130 kWh, which were fabricated as part of the 5 MW battery project planned for the Princeton Plasma Physics Laboratory, Princeton, New

Jersey are being tested at the BEST Facility, Somerville, NJ, using a simulated area regulation mode. The test will last for at least one year.

Opportunities for other tests and demonstrations will be utilized as they become available, if they can make a meaningful contribution to the development program.

AC Battery Development:

The AC Battery is a modular battery concept patented by Omnion Power Engineering Corporation, Mukwonago, Wisconsin. The concept will be carried through the detailed design, prototype assembly and test phase during the next 12 months under a SNL contract.

The AC battery concept as currently visualized, consists of thirty six factory assembled and tested 14 kW/14 kWh "modules" to form a 500 kW/500 kWh canister that can be trucked to the site. Each module is a self-contained storage unit comprised of a battery and power conversion system within it, thus eliminating any Dc outside of the module. All module interconnections within the 500 kW canister are in Ac, eliminating the high-voltage Dc bussing of "conventional" battery systems.

Internal logic in each module monitors its operating status, including battery performance, and if a fault or performance deviation is detected, the module isolates itself from the other modules in the canister and signals a central control of the failure. The remaining modules in the canister continue to operate. The malfunctioning module can be interchanged in the field and sent to a repair shop without interrupting the operation of the canister as a whole.

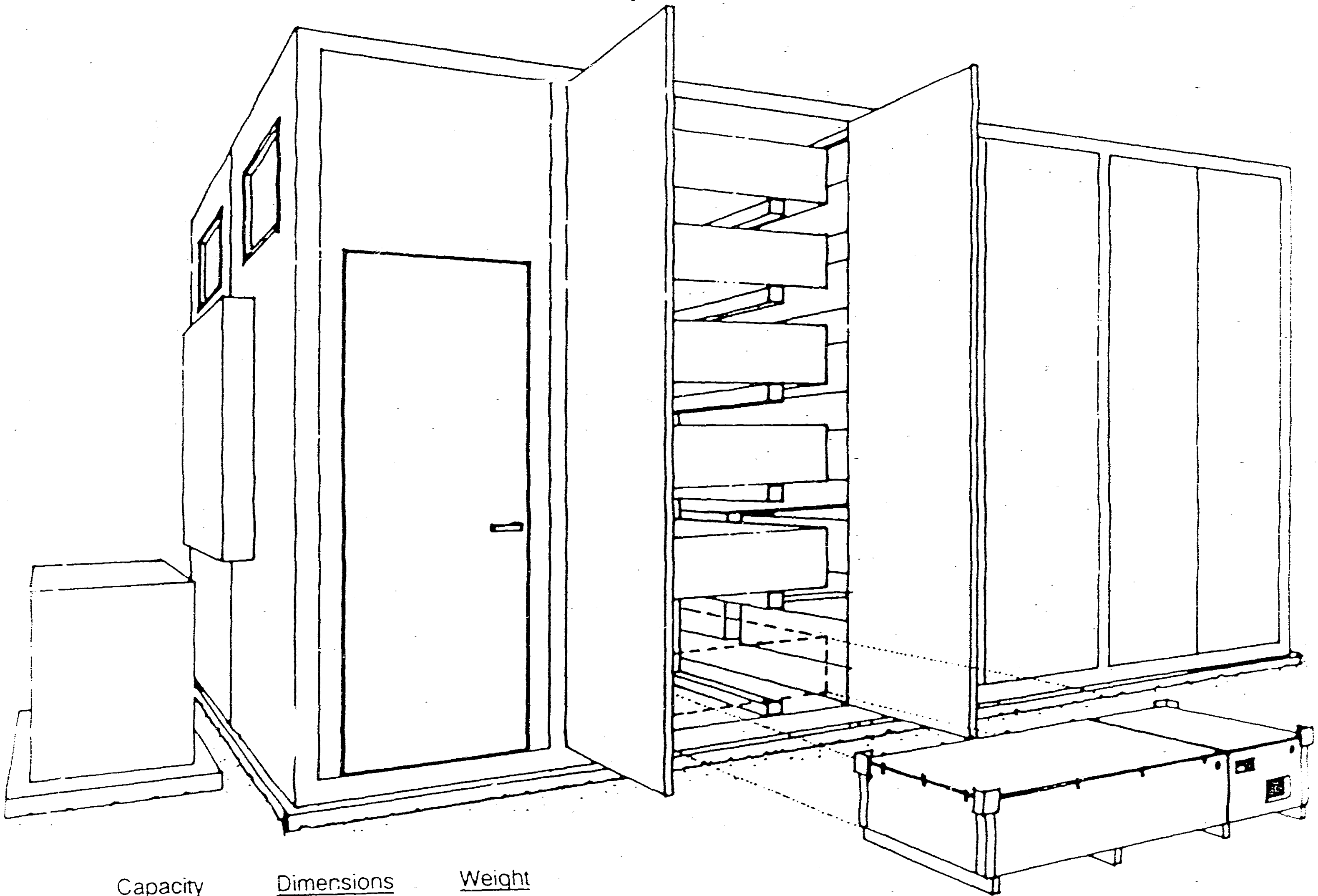
The canister has been sized so that it can be trucked to the user's site, with eighteen of the thirty six modules on one truck. Another truck carries the remaining eighteen modules. The dimensions and weight of the canister and its components have been chosen to keep its shipping in compliance with trucking size and weight requirements in the United States. Figure 1 illustrates an artist's concept of a complete 500 kW/500 kWh canister.

At the site, the canister is installed on a concrete pad and all the modules are loaded into it and activated. The canister is then interconnected with the user's system through the appropriate transformers and switchgear. This eliminates any permanent building to house the battery, and the extensive site assembly that is required by conventional battery systems. Capacities in excess of 500 kW are obtained by aggregating the necessary numbers of individual 500 kW canisters to meet user requirements.

Conclusion:

Successfully meeting the near-term commercialization goals of this program will mark a significant achievement not only for the benefit of this technology but also for the follow-on advanced battery technologies that are currently in the development phase. Achieving these goals involves overcoming the technical and institutional barriers that are encountered in all such undertakings. The various activities of this program have been defined to address these issues, while at the same time introducing some new approaches.

FIGURE 1
AC Battery Modular System



	Capacity	Dimensions	Weight
Module	14 kW/14 kWh	72" L x 44" W x 18" H	1800 lbs
Container	500 kW/500 kWh	25' L x 8.8' W x 12' H	72,000 lbs

END

DATE FILMED

02 / 19 / 91