8 E. C. Gay, W. E. Miller, V. M. Kolba and H. Shimotake, Lithium/iron sulfide cell development for electric-vehicle propulsion, *Proc. High Temp. Secondary Batteries Session of the 29th Power Sources Symp.*, Electrochem. Soc., 1981, pp. 173 - 176.
9 E. C. Gay, W. E. Miller and F. J. Martino, Use of multiple regression analysis to develop equations for predicting Li–Al/iron sulphide cell performance, *J. Applied Electrochem.*, *11* (1981) 423 - 431.
10 F. J. Martino, W. E. Moore and E. C. Gay, Effect of thermal cycling on the performance and lifetime of LiAl/FeS cells, *Electrochem. Soc. Mtg., Montreal, Canada, May 9 - 14, 1982, Extended Abstracts, 82-1* (1982) 559 - 560.
11 W. E. Miller, E. C. Gay and D. J. Kilsdonk, Performance of a LiAl/FeS battery and cells, *Proc. 30th Power Sources Symposium, Atlantic City, NJ, June 7 - 10, 1982.*
12 L. Redey and D. R. Vissers, Construction of reference electrodes for long term testing of compact Li–Al/FeS cells, *J. Electrochem. Soc.*, accepted for publication, 1982.

ANL Reports

1 D. L. Barney, R. K. Steunenberg, A. A. Chilenskas *et al.*, Lithium/iron sulfide batteries for electric-vehicle propulsion and other applications, Progress Report for October 1979 - September 1980, *ANL-80-128*, February 1981.
2 D. L. Barney, R. K. Steunenberg, A. A. Chilenskas *et al.*, Lithium/iron sulfide batteries for electric-vehicle propulsion and other applications, Progress Report for October 1980 - September 1981, *ANL-81-65*, February 1982.
3 J. E. Battles, F. C. Mrazek and N. C. Otto, Post-test examinations of Li–Al/FeS_x secondary cells, *ANL-80-130*, December 1980.
4 V. M. Kolba, J. E. Battles, J. D. Geller and K. Gentry, Failure analysis of Mark IA lithium/iron sulfide battery, *ANL-80-44*, October 1980.

DESIGN, DEVELOPMENT, AND FABRICATION OF THE MARK II LITHIUM/IRON SULFIDE ELECTRIC AUTOMOBILE BATTERY

Eagle–Picher Industries, Inc. (EPI), P.O. Box 47, Joplin, MO 64801 (U.S.A.)

The objectives of the project are to develop a cell having the following performance and lifetime characteristics: specific energy, 95 W h/kg; peak specific power, 120 W/kg at 50 percent state of charge; and cycle life, 400 cycles mean time to failure. The cell performance goals are expected to be achieved with a stabilized capacity of 335 A h at the C/3 rate.

Development work was continued on batteries and on multiplate cells with BN felt separators. Two groups of status cells were produced at Eagle–Picher and tested at ANL. The second group of cells raised the state-of-the-art specific energy and power for production-type cells to 90 W h/kg and 80 W/kg, respectively, and demonstrated a mean time to failure of 350 cycles for the group. Development cells, not yet in production, have demonstrated greater than 95 W h/kg and greater than 100 W/kg. Two 10-cell modules were built and tested. One demonstrated a cycle life of 270 cycles.

DESIGN, DEVELOPMENT, AND FABRICATION OF THE MARK II LITHIUM/IRON SULFIDE ELECTRIC AUTOMOBILE BATTERY

Gould Inc., 40 Gould Center, Rolling Meadows, IL 60008 (U.S.A.)

The objective of this work is the development of an engineering lithium/iron sulfide cell having the following performance and lifetime characteristics at a C/8 charge and C/3 discharge:

- Specific energy — 95 W h/kg,
- Peak specific power — 120 W/kg at 50 percent depth of discharge,
- Cycle life (mean time to failure) — 400 cycles.

The end of life is when the cell capacity decline exceeds 20 percent of the initial stabilized capacity or when the coulombic efficiency drops below 95 percent.

Work has continued during the past year in further developing the powder separator-immobilized electrolyte approach initiated at Gould in 1980. As of June 1982, over 150 (200-A h) powder separator cells have been constructed in a dry room environment. A group of 12 status cells (Group II) tested at ANL has attained a specific energy of approximately 80 W h/kg with a mean time to failure of approximately 300 cycles. The peak specific power of these cells was 74 W/kg at 50 percent depth of discharge.

In subsequent developmental cells that have an improved current collector design and some minor changes in the electrode/separator formulations to the Group II cell, there has been an overall improvement in performance. The specific energy has been increased to approximately 90 W h/kg and the peak power to approximately 130 W/kg at 50 percent depth of discharge without any sacrifice in cycle life; indeed there has been a modest increase with most of these cells failing in the 350- to 400-cycle range.

Assuming that funds are available in 1983, work will continue to improve the performance and cycle life of the powder separator-immobilized electrolyte, iron-monosulfide-type cell. It is anticipated that significant improvements will be accomplished, particularly in peak power, by pursuing a major engineering design program for the electric vehicle cell. The goals for 1983 will be a specific energy of approximately 100 W h/kg and a peak power of approximately 130 W/kg at 80 percent depth of discharge with a mean life of 500 cycles.