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RESEARCH, DEVELOPMENT, AND DEMONSTRATION OF A LEAD–ACID BATTERY FOR ELECTRIC VEHICLE PROPULSION

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The objective of this project is to develop and demonstrate improved and advanced lead–acid battery systems for electric vehicles (EVs). Key technical goals for 1982 are a specific energy of 45 Wh/kg at the 3-h discharge rate, a specific peak power of 104 W/kg for 30 s when 50 percent discharged, and a life capability of 650 cycles at an 80 percent depth of discharge.

In the development of improved state-of-the-art (ISOA) lead–acid batteries, Globe has identified the plate size, plate aspect ratio, number of plates, and acid concentration best suited for EV application. A low corrosion grid alloy was selected to enhance cycle life. In addition, Globe has developed an innovative electrolyte mixing pump that has increased both specific energy and cycle life.

During 1981, Globe delivered two 96-V (23.4-kW h) ISOA batteries to the National Battery Testing Laboratory (NBTL) for preliminary testing.

The batteries were subsequently shipped to the Jet Propulsion Laboratory (JPL) for in-vehicle testing. In NBTL tests, 6-cell (12 V, 250-A h) ISOA modules fabricated by Globe demonstrated a specific energy of up to 41 W h/kg, a specific power of 104 W/kg, and a life of up to 508 cycles. In addition, Globe delivered five 190-A h cells to NBTL for testing. These cells incorporate all the ISOA technology advances, but yield 12-V modules having dimensions that are more amenable to retrofitting of existing EVs. Life cycle testing of these cells has now exceeded 400 cycles in ongoing testing.

Achievement of the 1986 goals of 800 cycles and a selling price of $70/kW h (1981 dollars) appears to be feasible. Thus, present efforts are focused on increasing the specific energy of lead–acid batteries while maintaining the long cycle life and low cost. This increase in specific energy is expected to be accomplished through two design improvements. First, the use of plastic–lead composites as the grid material (instead of lead alloy), along with additional design changes, is expected to increase the specific energy to over 45 W h/kg. Second, unique design concepts that have shown promise of dramatically increasing the PbO_2 active material utilization are expected to yield a specific energy of 56 W h/kg.

The R & D effort at Globe in 1983 will include activities directed at achieving the technology goals through increasing the utilization of the active materials to improve performance and reduce costs; developing improved alloys to reduce the long-term corrosion rate of the positive grid and thus increase life; improving the structural integrity of the positive active material to improve battery life; developing plastic–lead composites for the positive and negative grids to improve performance and reduce battery cost; and improving charging techniques, watering/venting subsystems, and electrolyte stirring systems to improve life and reliability and reduce cost. Globe will be fabricating and delivering cells, modules, and batteries to ANL for test. These will include advanced cells and modules that demonstrate technology improvements such as the lead–plastic grids and an EV-190 battery pack for standard characterizational testing and in-vehicle evaluation.

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RESEARCH, DEVELOPMENT, AND DEMONSTRATION OF A NICKEL/IRON BATTERY FOR ELECTRIC VEHICLE PROPULSION

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The objective of this contract is to develop an advanced nickel/iron battery capable of meeting the near-term battery performance and projected cost goals for electric vehicle propulsion. The goals for 1982 were an energy density of 54 W h/kg, a peak power density of 104 W/kg, and a cycle life of 800 cycles.

The 1982 program continued to involve the fabrication and evaluation of full-sized prototype cells, modules, and batteries. It will be aimed at advancing the technical capabilities of the nickel/iron battery while reducing its potential cost in materials and process areas. Improved full-sized pasted nickel electrodes (25-A h capacity, 2.4-mm thick) have shown stable capacity over 700 cycles at the C/3 rate. Composite iron electrodes (1.0 mm) have exhibited a stable capacity exceeding 24 A h in over 1000 cycles in three plate cells. Complete cells on test at Westinghouse have demonstrated a specific energy of 57 to 63 W h/kg at the C/3 rate and cyclic stability over 1200 cycles at 80 percent depth of discharge (DOD). Two five-cell modules (220 A h) at the National Battery Test Laboratory have demonstrated a specific energy of 43 W h/kg, a peak sustained 30-s power of 90 W/kg, and a cycle life of over 900 cycles at 80 percent DOD at the C/3 rate to failure (capacity reduction to 75 percent of rated). A weight penalty of 0.26 kg/cell was included to allow for the weight of the electrolyte management system. Temperature tests have been performed on a six-cell module and have shown a decrease in capacity at 0 °C of only 25 percent in ampere hours and 29 percent in watt hours as compared to performance at 25 °C.

In 1983 reduction in nickel electrode swelling (and concurrent stack starvation) to improve cycling will continue to be an area of major effort to reach the final battery cycle life objectives. Pasted nickel electrodes with modified active material composition continue to show promise for meeting the life objective while providing a low manufacturing cost. Other efforts are