battery will be determined, and an order placed for an injection mold for a 4 cell monoblock. A preliminary and updated cost analysis will be prepared based on the results obtained. A go, no-go decision whether to proceed to Phase II is scheduled for July 1980.

Major technical problems remain, energy density, specific volume, and charged stand capability. Of these probably the most difficult is specific volume, since the design concept of the VIBROCEL involves a discrete spacing between battery plates. Energy density should approach goals by lightweight design features, and the use of high energy nickel cathodes. Charged stand performance has already shown improvement by a proper selection of negative substrate materials and platings.

RESEARCH, DEVELOPMENT AND DEMONSTRATION OF A NICKEL–ZINC BATTERY FOR ELECTRIC VEHICLE PROPULSION

Gould, Inc., New Business Division, Rolling Meadows, IL 60008 (U.S.A.)

The contract covers research and development that will result in the delivery and testing of nickel/zinc electric vehicle batteries having improved performance, life, and cost. The contract includes the design, engineering, and delivery of demonstration modules and the optional procurement of small numbers (up to 15) of full-sized batteries (20 - 30 kW h range) in order to demonstrate the technology; participation with ANL in the establishment of test standards and post-test examination procedures; establishment of maintenance procedures; provision of safety and environmental impact data; a materials availability study; and the design and specification of auxiliary components important to the operation of batteries. The contract is subject to go/no-go decisions during its period of performance. Key technical goals include a specific energy of 70 W h/kg at a 3-hour discharge rate, a specific peak power of 125 W/kg or greater, a life of 400 cycles at 80% depth of discharge, and a volume production price of less than $75/kW h.

Significant progress has been made in the understanding of separator failure mechanisms, and a generic category of materials (ELECTROPOROUS™ separators) is in the development stage. Shape change in the zinc electrode, which has been a significant contributor to capacity loss, has been reduced significantly through the use of electrode and electrolyte additives. The more elusive problems of zinc densification and passivation are now being investigated in depth. Extensive testing of cells, modules, and batteries is done in a minicomputer-based testing facility. Application testing is carried out on dynamometers to characterize and simulate actual missions. A development pilot plant, which utilizes scaled-up processes, is essentially fully operational. It supplies all components/cells/batteries for all project testing activities. Progress in the area of thermal management has been

significant, with the development of a model that accurately represents heat generation and rejection rates during actual battery operation. The result of this effort has been the redesign of cells/modules to maximize heat rejection.

In 1980 separator development effort will concentrate on optimization of electroporous-type systems. This will include optimization of polymer blend composition and continued scale-up in separator production. Recent improvements in zinc electrode performance observed in small cell tests will be extended to full-size cells. Evaluation of the effectiveness of promising electrode and electrolyte additives in extending cycle life will also be continued in scaled-up cells.

Recent publications

1 C. C. Chen and H. F. Gibbard, Thermal management of battery systems for electric vehicles and utility load-leveling, *Proc. 14th IECEC, Boston, August 5 - 10, 1979.*
2 G. D. Bucci, R. J. Fedor, R. P. Fedora and R. R. Steiner, The development of nickel/zinc batteries for commuter electric vehicles, *Abstracts of Papers, ACS/CSJ Chemical Congress, Honolulu, April 1 - 6, 1979, Abs. INDE-50.*

RESEARCH, DEVELOPMENT AND DEMONSTRATION OF A NICKEL–ZINC BATTERY FOR ELECTRIC VEHICLE PROPULSION

Yardney Electric Division, Pawcatuck, CT 02891 (U.S.A.)

The objective of this program was to accelerate the development of nickel–zinc batteries for use in electric vehicles. The early R&D portion of the program had the objective of eliminating the technical barriers which limited electrical performance, battery lifetime and the attainment of low cost. The ultimate goal of the program is the emergence of a practical Ni/Zn battery system that has the promise of meeting the performance, economic, and environmental requirements for electric vehicle application.

During the calendar year 1978 and the first five months of 1979 the emphasis was directed in four major areas:

(1) elucidating the Failure Modes of the nickel–zinc battery system;

(2) improving performance of the system;

(3) effecting a cost reduction program;

(4) building full-size (250 A h, 6.4 V) electric-vehicle modules for demonstration at the National Battery Test Laboratory.

(1) The Failure Modes Analysis Program established early that the negative electrode was responsible for capacity degradation during repetitive deep-discharge cycling and was thus the life-limiting component. This capacity degradation was found to result from loss of zinc from the negative compart-