Recent publications

1 M. W. Schwartz and E. Lorbeer, Preliminary design analysis of the quasi-electric drive vehicle, *UCRL-52613, 1978.*
2 J. F. Cooper, Mechanically rechargeable metal–air batteries for automotive propulsion, *UCRL-81178, 1978.*
3 E. Behrin, *et al.*, Energy storage systems for automobile propulsion, *UCRL-52553, Vols. I & II, 1978.*

A HAZARD ASSESSMENT OF ZINC–CHLORINE ELECTRIC VEHICLE BATTERIES

Factory Mutual Research Corporation, Norwood, MA 02062 (U.S.A.)

This project is designed to evaluate the potential hazards of zinc–chlorine hydrate batteries for electric vehicles. The consequences of accidental release of chlorine following a vehicle collision and other potential mishaps will be determined from a combination of theoretical modeling, laboratory experiments, and field tests. The laboratory and field tests will determine the rate of chlorine vapor evolution and dispersal following a spill of chlorine hydrate, which is the form of chlorine storage in the charged battery. Theoretical projections of casualty levels will be compared with statistics of current casualties associated with gasoline-fueled engines in conventional vehicles.

During the first half of 1979, seven laboratory spill tests involving 240 - 600 g of chlorine hydrate were conducted. The chlorine content of the hydrate varied from 3 - 34%, simulating the battery charge range from slightly charged to fully charged. The spilled hydrate resembled a slush with a consistency dependent on the simulated state of battery charge. Approximately one-half of the chlorine content in the hydrate vaporized in the first 15 min following the spill in most of the tests.

Another accident scenario involving chlorine vapor release in a longitudinally ventilated road tunnel was theoretically modeled during this reporting period. For a vapor release rate of 30 l/min (the nominal chlorine gas flow rate during charge), the calculated tunnel cross-section averaged chlorine concentrations ranged from 2 to 5 ppm for typical tunnel sizes and ventilation rates. These calculated values are below the threshold for any serious injury during transient exposure. Other tunnel accident configurations are to be modeled during the third quarter of 1979.

The highlight of this project during the third quarter of 1979 will be the field spill tests with a simulated full-scale 50 kW h battery store of chlorine hydrate. Test results will reveal the form of the spilled hydrate and the extent of the downwind danger zone in which chlorine vapor concentrations are capable of producing injuries. Other work scheduled for the last quarter of 1979 are additional vapor dispersal calculations and a preliminary assessment of the insurance implications of the chlorine hazard.

Since commercial battery and vehicle configurations remain to be prescribed, it is anticipated that the results of this study will form the basis of future iterative hazard assessments as opposed to an absolute estimate of the casualties expected with widespread use of zinc–chlorine electric vehicle batteries. For example, the study will provide a means for quantitatively determining the benefits to be derived by incorporating additional safety features into the battery design, but absolute casualty levels will still depend upon how the electric vehicles are used and misused, and, *a priori*, are extremely difficult confidently to predict.

STUDIES OF HIGH ENERGY CATHODES AND ANODES FOR MOLTEN SALT BATTERIES

Department of Chemistry, University of Tennessee, Knoxville, TN 37916 (U.S.A.)

This program deals with research and development of a new rechargeable cell

SCl_3^+ in $AlCl_3$–NaCl/Na^+ ion conductor/Na.

This cell operates at temperatures in the range 180 - 250 °C and has an open circuit voltage of 4.2 V. The research during this period has involved additional electrochemical, spectroelectrochemical, and spectroscopic (Raman and electron spin resonance) studies of sulfur and its oxidation products in chloroaluminate melts.

Laboratory cell development has involved studies with three Na^+ ion conductors: β''-alumina, β-alumina (from NGK) and NASICON. Only the first material was found to be satisfactory in this cell. One of the cells studied underwent 47 deep discharge/charge cycles at current densities of 10 - 50 mA/cm^2 before it failed due to a crack in the β''-alumina tube. The performance of a cell prepared in the discharged state (elemental sulfur in equimolar $AlCl_3$–NaCl) was found to be the same as that of a cell prepared in the charged state (SCl_3AlCl_4 in an $AlCl_3$-rich melt).