



Advanced Systems Department

NICKEL-HYDROGEN GROUP

# EAGLE-PICHER SPV DEVELOPMENT

## NASA BATTERY WORKSHOP

November 1992

N 9 3 - 2 0 0 1 7



**DEVELOPMENT PLAN**

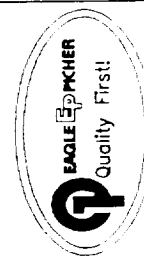
**LICENSING AGREEMENT WITH COMSAT LABORATORIES**

**PARALLEL DEVELOPMENT OF EAGLE-PICHER TECHNOLOGY**



**EAGLE-PICHER HERITAGE - SPV TECHNOLOGY**

- Over 2300 IPV Cells Currently in Flight
- Over 97 Nickel-Hydrogen Batteries in Flight
- Two-Cell CPV Manufacture and Testing
  - > 18000 Cycles at 50% DOD
  - > 9100 Cycles at 30% DOD
- Common Pressure Batteries - Silver Zinc Technology
- Proven Electrode Designs



**SPV UNITS IN PROCESS AT EAGLE-PICHER**

TEN 40 AH CELLS FOR CHARACTERIZATION AND LIFE TESTS, 3 TO BE TESTED AT EAGLE-PICHER AND 7 AT COMSAT LABORATORIES.

5 Currently on test. Balance to be placed on test by 12/1/92.

TWO 10 CELL BATTERIES TO BE DELIVERED TO COMSAT LABORATORIES FOR CYCLE TESTING.

Estimated Completion - January 1993

ONE 22 CELL BATTERY FOR CHARACTERIZATION AND CYCLE TESTING AT EAGLE-PICHER.

Estimated Completion - January 1993

ONE 22 CELL BATTERY FOR DELIVERY TO A PRIME CONTRACTOR.

Estimated completion - May 1993



**DESIGN FEATURES**

10 INCH DIA., 40 AH, 22 CELL BATTERY

WEIGHT                      22.2 KG

LENGTH                      58.4 CM(23.0 IN.)

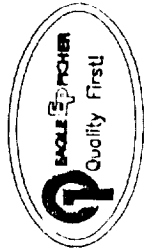
SPECIFIC ENERGY        57 WH/KG

ENERGY DENSITY         60.8 WH/L



**BASIC BATTERY DESIGN FEATURES**

- 10 inch diameter thin-wall pressure vessel, hermetically sealed using two weld rings and proven EB welding methods. Terminal seals use the flight-proven Ziegler compression method.
- Plurality of individually packaged Ni-H<sub>2</sub> cells (half-circle shape), enclosure provided with gas permeable port to hydrogen reservoir.
- Thermally conductive heat fins or rack providing a path from the surface of each individual cell to inner surface of pressure vessel.
- Flexure springs to provide loading of the cell stack radially (for thermal considerations) and axially (for stack compression).
- COMSAT design uses an insulated feedthrough terminal to provide intercell connection of hermetically sealed cell packets.



**CELL DEVELOPMENT CONSIDERATIONS****POSITIVE ELECTRODES:**

- Selection of Type: Slurry vs. Dry Sinter
- Selection of Thickness
- Selection of Target Loading

**NEGATIVE ELECTRODES:**

- Integration of EPI patented substrate design for optimized current collection.

**SEPARATOR:**

- Selection of Type: Asbestos vs. Zircar
- Consideration of alternative types

**GAS DIFFUSION SCREEN:**

- Selection of Type and Number of Layers

**WELDING TECHNIQUES FOR BUS ASSEMBLY**

- Development of EB and Laser Welder Methods



### Early Development Activity

Boilerplate tests run to verify expected plate performance

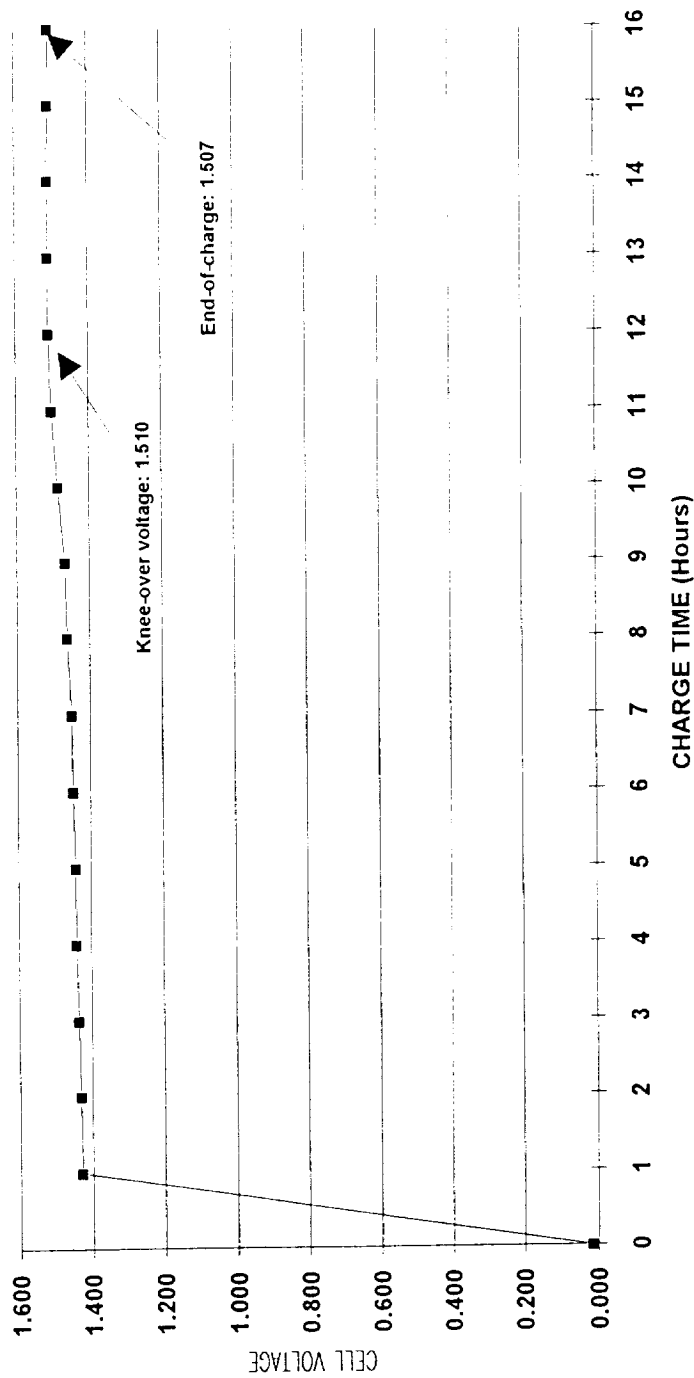
- Full Capacity Cycles at 20 Degrees C
  - Full Capacity Cycles at 10 Degrees C
  - Full Capacity Cycles at 0 Degrees C
- (Boilerplate units were activated with 31% KOH)





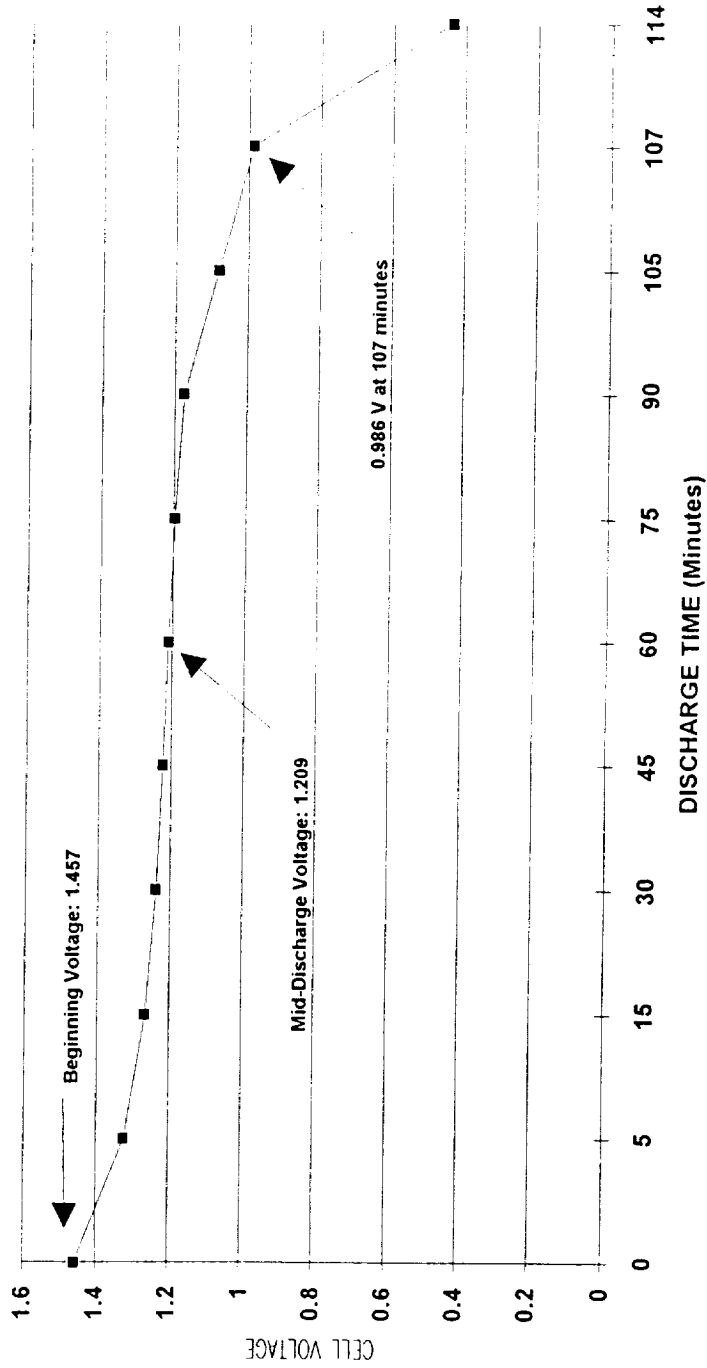
SPV BOILER PLATE CELL

20 Degrees C Rate: C/10



SPV BOILER PLATE CELL

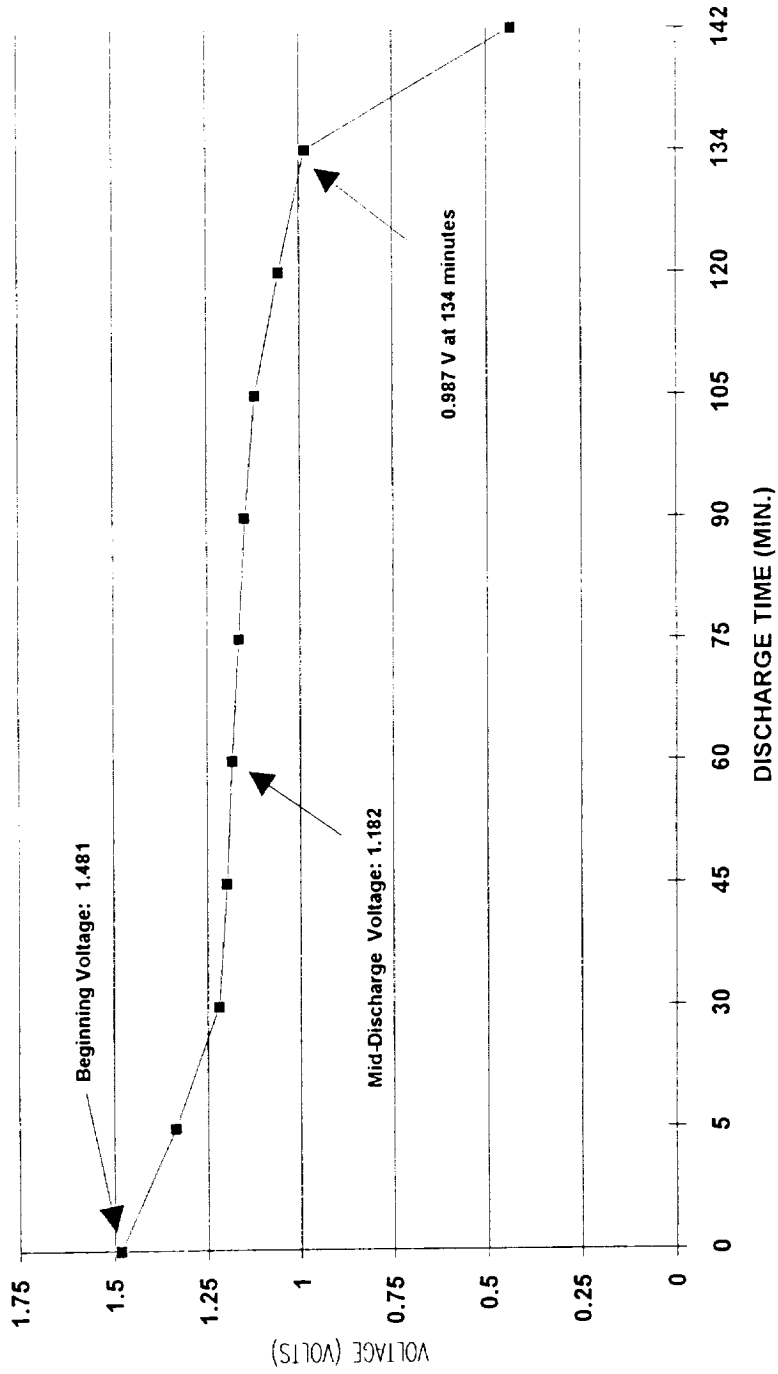
20 Degrees C Rate: C/2





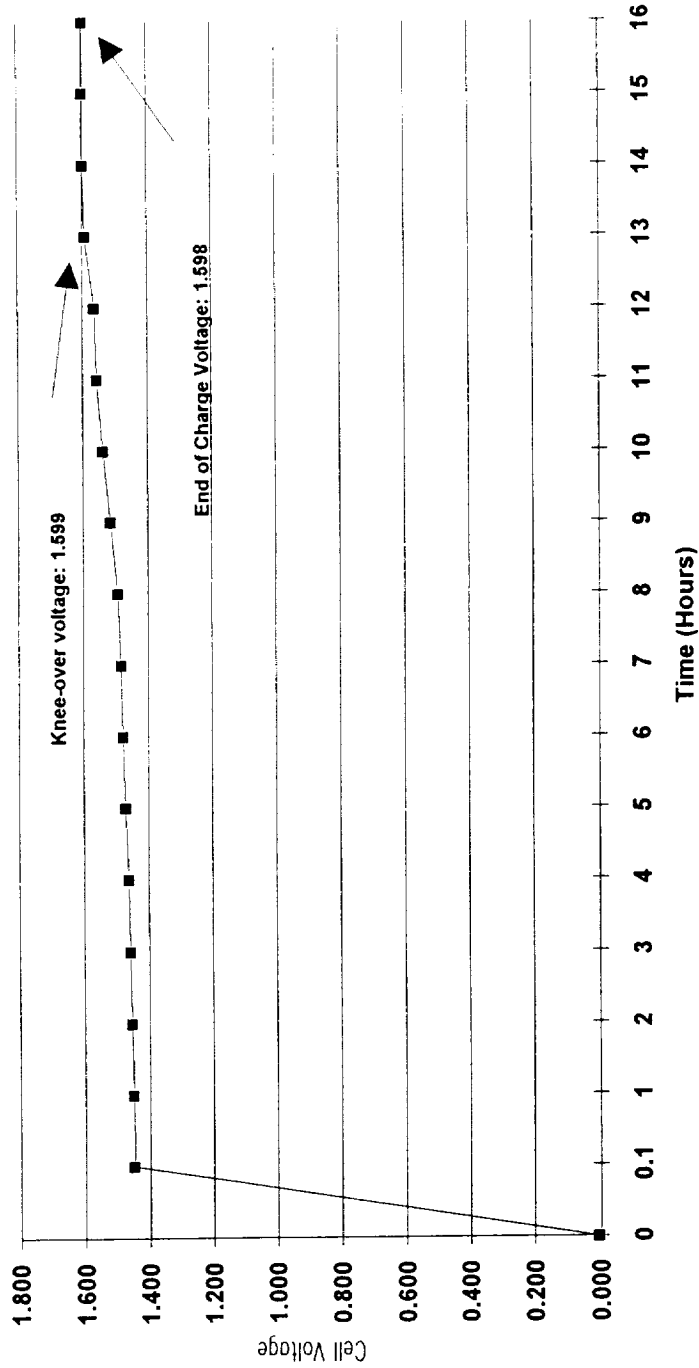
SPV BOILER PLATE DISCHARGE

10 DEG. C Rate: C/2

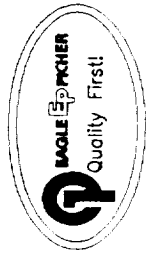
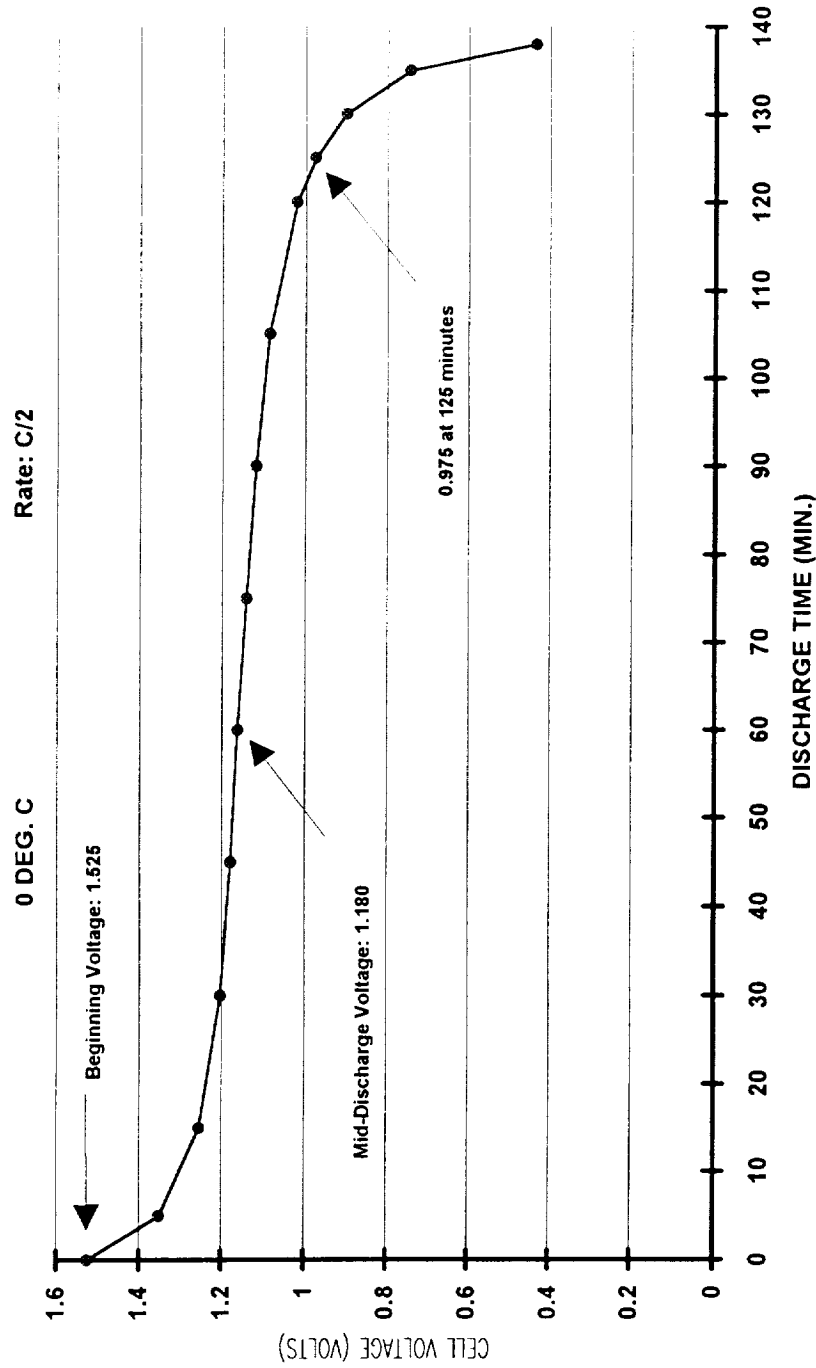


**SPV BOILER PLATE CELL - CHARGE**

0 Degrees C Rate: C/10



SPV BOILER PLATE CELL - DISCHARGE



**CELL DEVELOPMENT ACTIVITY**

10 cells manufactured per the COMSAT design for characterization and cycle tests:

3 Cells at EPI - Activated

2 Cells at COMSAT - Activated (31% KOH)  
2 Vented Cycles

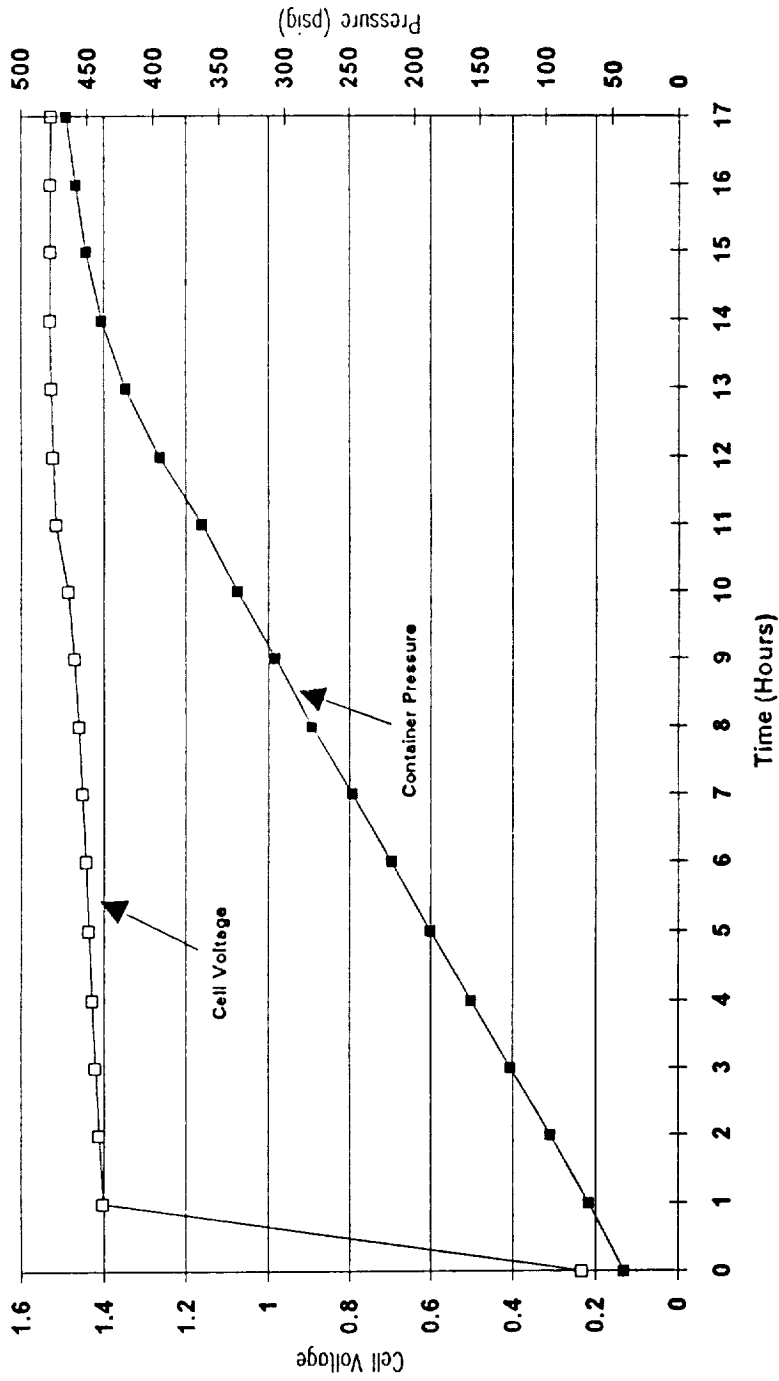
15 GEO Cycles: 10.8 Hr Charge at C/10 - Typical EOCV - 1.492  
72 minute Discharge at C/2 - Typical EODV - 1.205

1 Capacity Cycle: Capacities measured at Room Ambient  
Temperature - 40.2 and 40.3 AH

5 Cells - To be activated later this month



SPV CELL CAPACITY TEST - CHARGE  
10 Degrees C Rate: C/10



Data Provided By Comsat Laboratories, Clarksburg, MD







## CURRENT PLANS

- Completion of units currently in process
- Continue development of alternate design concepts, including rigid case and alternate separator material
- Continue development for and manufacture 5" diameter 15 AH prototype using similar technology



## CONCLUSION

Eagle-Picher is participating in the development and manufacture of a 10 inch diameter SPV Ni-H2 battery. Testing has been completed which verifies electrode performance and cell design.

