AIR FORCE ELECTROCHEMICAL POWER RESEARCH AND TECHNOLOGY PROGRAM FOR SPACE APPLICATIONS

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An overview is presented of the existing Air Force electrochemical power, battery, and fuel cell programs for space applications. Present thrusts are described along with anticipated technology availability dates. Critical problems to be solved before system applications occur are highlighted. Areas of needed performance improvement of batteries and fuel cells presently used for flight applications are presented. Long range plans and performance goals are outlined including target dates for key demonstrations of advanced technology. Anticipated performance and current schedules for present technology programs are reviewed.

Programs that support conventional military satellite power systems and special high power applications are reviewed. Battery types include bipolar lead-acid, nickel-cadmium, silver-zinc, nickel-hydrogen, sodium-sulfur, and some candidate advanced couples. Fuel cells for pulsed and transportation power applications are discussed as are some candidate advanced regenerative concepts.

TIMELY DELIVERY OF ELECTROCHEMICAL POWER

TECHNOLOGY TO MEET THE REQUIREMENTS OF FUTURE

MILITARY SPACE SYSTEMS

Figure 1. - Program objectives.

- PERFORMANCE LIKE NON-MILITARY SYSTEMS
- AUTONOMY
- SURVIVABILITY

Figure 2. - Program requirements.

* CONVENTIONAL POWER SYSTEMS

- TRANSITION IPV Ni-H_2 TO USERS
- DEVELOP AND DEMONSTRATE FLIGHT QUALITY Na-S CELLS AND BATTERIES
- RESEARCH NEXT GENERATION BATTERY BEYOND Na-S

* SPECIAL POWER SYSTEMS

- HIGH POWER CONCEPTS

Figure 3. - Program emphasis.

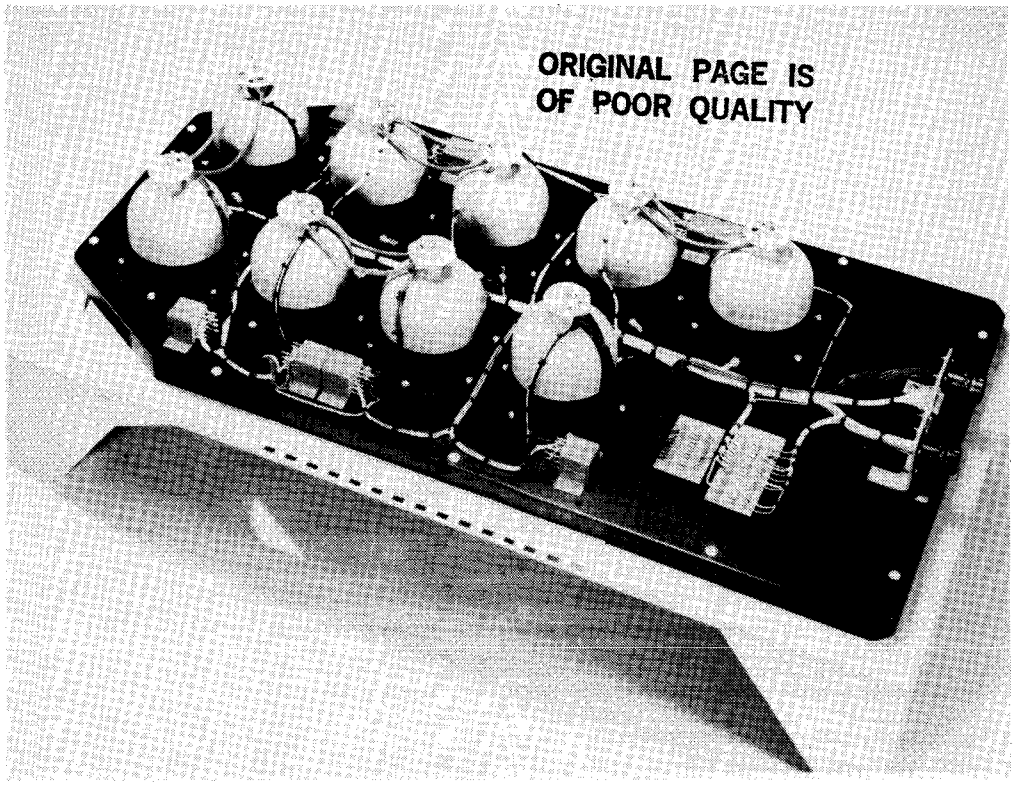

Figure 4. - Nickel-hydrogen battery cell pack.

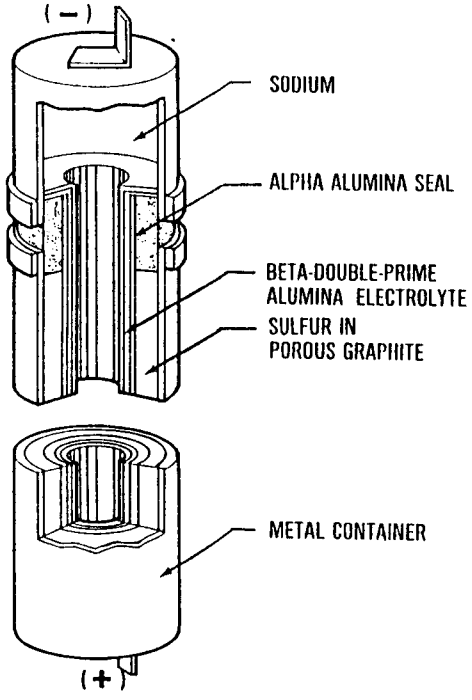

Figure 5. - Sodium-sulfur battery cell. Operating temperature, 350 to 400 °C.

- CONTINUED Ni-Cd USE
- Ni-H_2 USE INCREASING 1980's
- Na-S AVAILABLE- mid 1990's
- ADVANCED SYSTEM AVAILABLE- AFTER 2000

Figure 6. - Timetable.

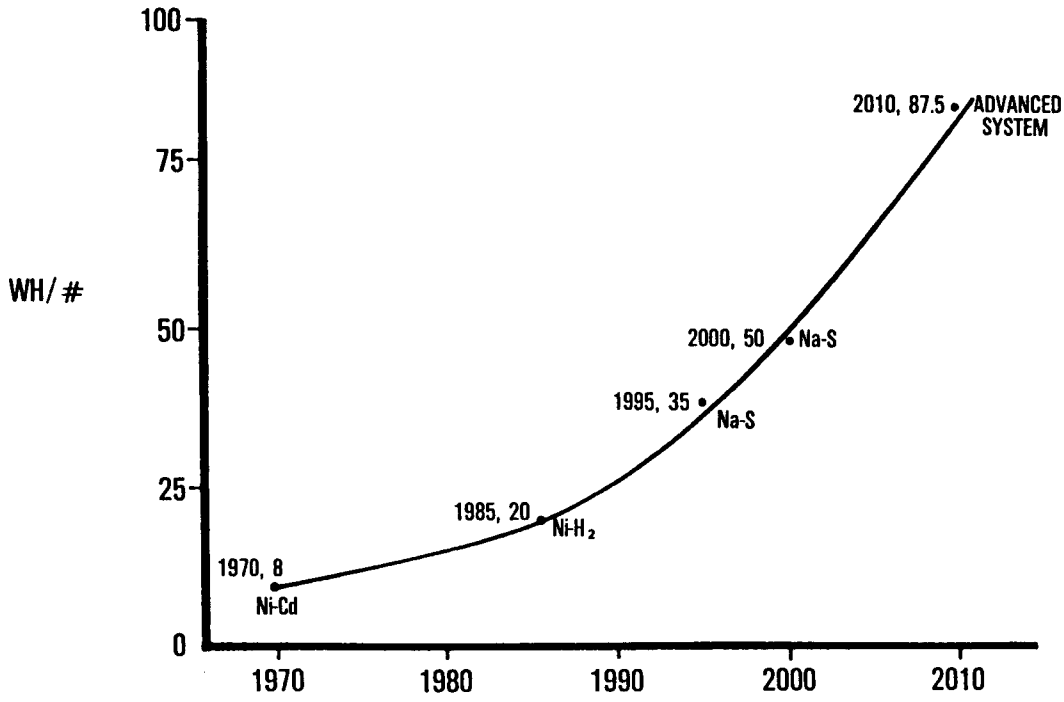

Figure 7. - Specific energy.

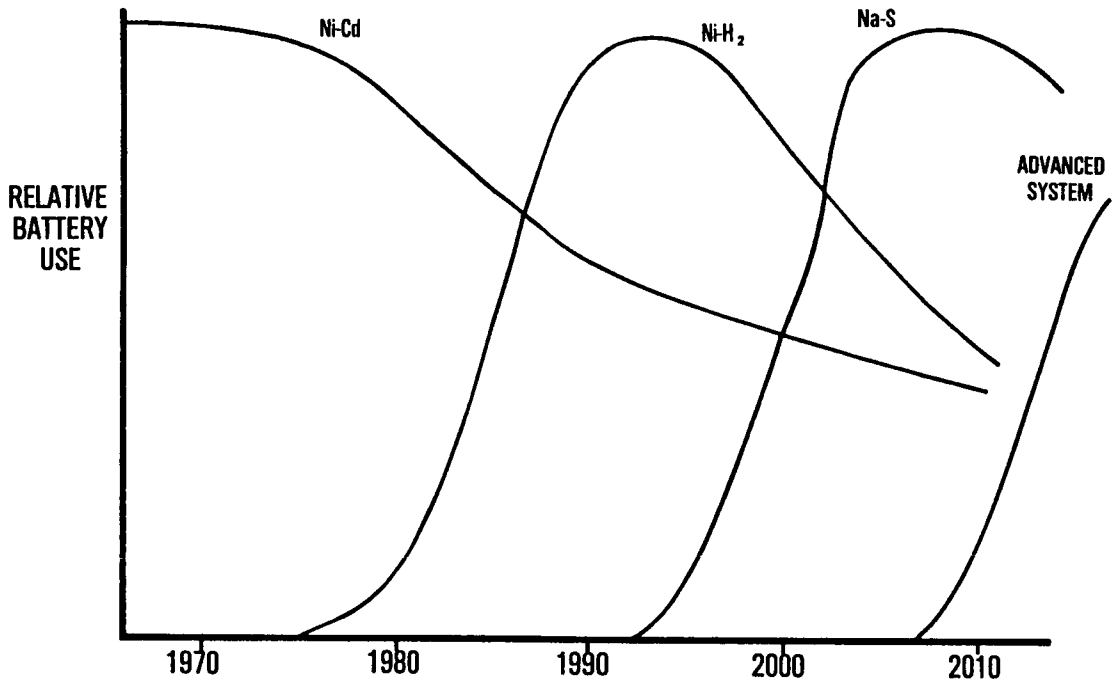

Figure 8. - Use profile.

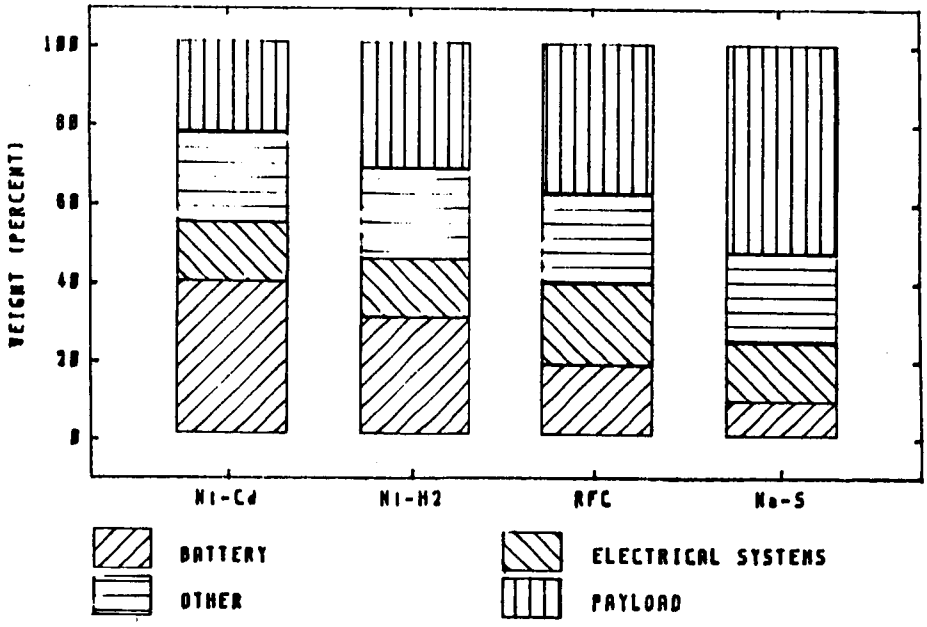

Figure 9. - Radar satellite weight summary.

100 WH/# BATTERY, USEABLE PER CYCLE

5 WH/IN ^{3}

HIGH CELL VOLTAGE, > 3.5 V/CELL

ALL ORBIT CAPABILITY

80% ENERGY EFFICIENCY, 100% COULOMBIC

STATE OF CHARGE

TIGHT VOLTAGE REGULATION

OPERATING TEMP COMPATIBLE WITH EFFECTIVE THERMAL CONTROL

15 YR CALENDAR LIFE; 6000 ONE HR DISCHG, 23 HR CHG CYCLES;
30000, 0.5 HR DISCHG, ONE HR CHG CYCLES

SURVIVABLE

EASILY MODELED, PREDICTABLE BEHAVIOR

100 THERMAL CYCLES

AFFORDABLE, $50K/KWH

NORMAL MECHANICAL AND ENVIRONMENTAL SPECS

Figure 10. - Requirements of advanced systems.

EML PROJECTILE BATTERY (KKV)

HIGH RATE LITHIUM BATTERY

HIGH POWER DENSITY FUEL CELL

BIPOLAR LEAD-ACID BATTERY

BIPOLAR SILVER-ZINC BATTERY

ALKALINE BATTERY

NATIONAL SPACE TRANSPORTATION SYSTEM FUEL CELL

SODIUM-SULFUR BATTERY

Figure 11. - SDI battery and fuel cell technology programs.