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UNITED STATES ARMY
COMMUNICATIONS-ELECTRONICS COMMAND

FORT MONMOUTH, NEW JERSEY

ADVANCE PLANNING BRIEFING FOR INDUSTRY

"POWER SOURCES CHALLENGES TODAY AND TOMORROW"

SHERATON EATONTOWN HOTEL AND CONFERENCE CENTER
SEPTEMBER 13, 1994

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SHERATON EATONTOWN HOTEL AND CONFERENCE CENTER
SEPTEMBER 13, 1994
Ladies and Gentlemen:

On behalf of the Communications-Electronics Command (CECOM), I am pleased to present these proceedings of the "Power Sources Challenges Today and Tomorrow" Advance Planning Briefing for Industry (APBI). The objective of this APBI is to ensure a mutual understanding of our goals and continuing efforts in the power sources arena.

Due to today's limited resources, Government and Industry must continue to communicate and work together as a team to ensure state-of-the-art power sources are provided to our soldiers in the most efficient and cost effective manner.

I welcome your participation in our APBI program.

Sincerely,

Otto J. Guenther
Major General, U.S. Army
Commanding
NOTICE

This publication contains the briefings presented during this Advance Planning Briefing for Industry (APBI). Following the APBI, you may obtain a Proceedings Book for a minimum fee, by contacting the Defense Technical Information Center (DTIC). The telephone number is (800) 225-3842 (Option 5).

We hope that the above publication proves beneficial to your long-range planning efforts. If you have any additional questions and/or suggestions, please contact the Program Analysis and Evaluation Directorate, AMSEL-PE-OD, ATTN: Mari Aufseeser, (908) 532-5054.
DISCLAIMER

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THE OVERALL CLASSIFICATION OF THIS PUBLICATION IS UNCLASSIFIED
ADVANCE PLANNING BRIEFING FOR INDUSTRY

SEPTEMBER 13, 1994
SHERATON EATONTOWN HOTEL AND CONFERENCE CENTER
EATONTOWN, NEW JERSEY

MEETING CHAIRMAN
MR. KENNETH M. MORGAN
DIRECTOR, SYSTEMS MANAGEMENT, CECOM

AGENDA

TUESDAY, SEPTEMBER 13, 1994

0700 REGISTRATION - SHERATON

0815 INTRODUCTORY REMARKS
Mr. Kenneth M. Morgan
Director, Systems Management, CECOM

0825 WELCOMING REMARKS
Mr. Colin F. MacDonnell, Jr.
Director, C3I Logistics and Readiness Center, CECOM

0835 KEYNOTE ADDRESS
Mr. James B. Emahiser
Assistant Deputy Chief of Staff for Logistics
U.S. Army Materiel Command (AMC)

0905 U.S. ARMY TRAINING AND DOCTRINE COMMAND (TRADOC)
FUTURE NEEDS/REQUIREMENTS

BATTERY REQUIREMENTS/MODERNIZATION STRATEGY
CW2 Kenneth Sanborn
Technology Modernization Office
U.S. Army Combined Arms Support Command (CASCOM)

0930 QUESTION AND ANSWER PERIOD

0940 BREAK

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POWER REQUIREMENTS

PORTABLE POWER SOURCES
Dr. Robert P. Hamlen
Electronics and Power Sources Directorate, ARL

1035 POWER EFFICIENT ELECTRONICS
Mr. Robert Heuner
Electronics and Power Sources Directorate, ARL
1055 U.S. ARMY COMMUNICATIONS-ELECTRONICS COMMAND (CECOM)
AMC BATTERY FOCAL POINT

BATTERY PROGRAM
Mr. Richard Rizzo
AMC Battery Focal Point
Systems Management Directorate, CECOM

1130 DIRECT VENDOR DELIVERY
Mr. Robert Pearson
Materiel Management Directorate, CECOM

1140 QUESTION AND ANSWER PERIOD

1150 LUNCH

1315 U.S. ARMY SIMULATION, TRAINING AND INSTRUMENTATION COMMAND (STRICOM)
FUTURE EFFORTS

BATTERY POWER FOR MANWORN PERSONNEL DETECTION DEVICE TRAINING SYSTEM
Mr. Steve Milburn
Deputy Product Manager for Combat Support Training Devices, STRICOM

1350 QUESTION AND ANSWER PERIOD

1400 BREAK

1420 U.S. ARMY TANK-AUTOMOTIVE AND ARMAMENTS COMMAND (TACOM)
BATTERY PROGRAM

POWER AND ENERGY STORAGE REQUIREMENTS FOR MILITARY VEHICLES
Mr. John F. Bush
U.S. Army Tank-Automotive Research, Development and Engineering Center
TACOM

1440 FUZE POWER SUPPLY REQUIREMENTS
Mr. Alan C. Reiter
Armament Research, Development and Engineering Center
TACOM

1505 SMART MUNITIONS BATTERY REQUIREMENTS
Dr. Clifford D. Shook
Armament Research, Development and Engineering Center
TACOM

1535 QUESTION AND ANSWER PERIOD

1545 CLOSING REMARKS
Mr. Kenneth M. Morgan
Director, Systems Management, CECOM
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WELCOMING REMARKS

Mr. Colin F. MacDonnell, Jr.
Director
C3I Logistics and Readiness Center
CECOM
KEYNOTE ADDRESS

Mr. James B. Emahiser
Assistant Deputy Chief of Staff
for Logistics
AMC
OUTLINE

- OVERVIEW OF AMC
  * WHO IS AMC?
  * AMC'S VISION
  * ACHIEVING THE VISION

- POWER SOURCES
  * CONCERNS
  * CHALLENGES
  * INITIATIVES
A COMMON OBJECTIVE

THE ARMY VISION

AMERICA'S ARMY, TRAINED AND READY, A STRATEGIC FORCE, SERVING THE NATION HOME AND ABROAD, CAPABLE OF DECISIVE VICTORY INTO THE 21ST CENTURY

AMC'S STRATEGIC VISION

THE LEADER IN EQUIPPING AND SUSTAINING AMERICA'S ARMY THROUGH SUPERIOR TECHNOLOGY AND RESPONSIVE SUPPORT ASSURING WORLD WIDE POWER PROJECTION AND DECISIVE VICTORY.

DECISIVE VICTORY

ALL THAT WE DO MUST BE DRIVEN BY THIS
AMC's Core Competencies --
A Powerful Synergy... NOT THIS...

- Logistics Power Projection
- Acquisition Excellence
- Technology Generation & Application

A Powerful Synergy That...
- Provides Significant Contribution to the Army
- Cannot be Imitated or Duplicated
- Without Presents Unacceptable Risk to the Army

Supporting America's Army
AMC'S MISSION

★ EQUIP AND SUSTAIN A TRAINED READY ARMY
★ CONVERT USER'S REQUIREMENTS INTO WEAPON SYSTEMS
★ DEFINE, DEVELOP AND ACQUIRE SUPERIOR TECHNOLOGIES
★ DEVELOP AND MANAGE THE ARMY'S INDUSTRIAL PREPAREDNESS PROGRAM
AMC IS ...

PEOPLE
78,285 CIVILIANS
6,707 MILITARY

355 LOCATIONS
66 INSTALLATIONS
40 STATES
6 COUNTRIES

105 ORGANIZATIONS
ARSENALENS
DEPOTS
LABORATORIES
AMMO PLANTS

WITH TROOPS
1,141 PEOPLE
55 OFFICES
WHAT AMC BRINGS TO THE ARMY'S TABLE

USASAC = ALLIED SUPPORT

TECOM = BEST POSSIBLE WEAPONS SYSTEM

STRICOM = TRAINED & READY

TACOM = SUSTAINING BASE INDUSTRIAL OPERATIONS

XX = ALLIED TECHNOLOGY

FUTURE TECHNOLOGY

XX = SOLDIER SUPPORT FOR AMERICA'S ARMY (>1M SOLDIERS)

G3 TRAINING

TRAINED & READY

IOC = SUSTAINING BASE INDUSTRIAL OPERATIONS

XX = MLRS

XX = MICOM

SPT

CECOM

CE+ DEMIL

CBDCOM

USING THE SYNERGY PROVIDED BY ITS CORE COMPETENCIES, AMC PROVIDES 'LIFE CYCLE MANAGEMENT' FOR ALL THE ARMY'S WEAPONS SYSTEMS ORIENTED TO "PROMPT AND SUSTAINED LAND COMBAT"
ARMY - AMC VISION

ARMY
AMERICA'S ARMY, TRAINED & READY,
A STRATEGIC FORCE, SERVING
THE NATION, AT HOME AND ABROAD,
CAPABLE OF DECISIVE VICTORY...INTO
THE 21st CENTURY

AMC
THE LEADER IN EQUIPPING AND
SUSTAINING AMERICA'S ARMY
THROUGH SUPERIOR
TECHNOLOGY AND RESPONSIVE
SUPPORT ASSURING WORLD
WIDE POWER PROJECTION AND
DECISIVE VICTORY.

"STRATEGIC FORCE...DECISIVE VICTORY"
ACHIEVING THE VISION

WORKING AS A TEAM

RESEARCH & DEVELOPMENT

INDUSTRY

THE USER

MATERIEL DEVELOPER

JCS/DOD/DA
AMC CONCERNS

EXTERNAL INFLUENCES

FORCE XXI
LOUISIANA MANEUVERS
ACQUISITION REFORM
SHRINKING BUDGETS
BATTLE LABS

INDUSTRIAL BASE
MAINTAIN SUPERIOR TECHNOLOGY
MODERNIZATION STRATEGY
ARMY WAR RESERVES
INVENTORY REDUCTION PROGRAM
THERE IS NO TIME OUT FROM READINESS OF AMERICA'S ARMY

WITH THE UNITS

LOG ASST REPS: 825
LOG ASST OFF: 41
COUNTRIES: 9

PANAMA, HONDURAS, GERMANY, ITALY, MACEDONIA, KUWAIT, SWA, KOREA, US

UNIT STATUS REPORTS
> 5,200 REPORTING UNITS
= 24 MAJOR COMBAT UNITS
DA 2715
DA 2406 EQUIP SHORTAGES
DA 1352 MAINT STATUS

EQUIPMENT READINESS
ALL REPORTABLE ITEMS: JUNE 94
419,000 (93% FMC)
REPORTABLE LINE ITEMS:
429 (306 MEET GOAL - 71%)
REPORTABLE SYSTEMS:
158 (91 FMC - 56%)
MAJOR WEAPON SYSTEMS:
16 (14 UP [Patriot, UH-60])

TOTAL PACKAGE FIELDING
SYSTEMS FIELDED AS OF APR 94: 2598 EA
LIKE: SINCGARS, RADIC INST, HMMW

MATERIAL MANAGEMENT: JUN 94
SUPPLY AVAILABILITY: 88.2% (GOAL 85%)
NON MSN CAPABLE SPly 9.2% (28K OF 307K
AUTH STOCKAGE LIST % ZERO BAL
12% (GOAL 8% - LAST 6 MO AVG = 12.4%)

NEW EQUIPMENT TRAINING
888 CLASSES FY94
25,414 TRAINED

DEPOT MAINTENANCE
OVERHAUL: (M109 HOW, PATRIOT CHINOOK, BRADLEY)
CONVERSIONS: (M113A2 TO M113A)
REPAIR: (APACHE, BRADLEY, OH-58)
REFURBISH: (BLACKHAWK)
UPGRADE/MODERNIZE: (M1 TO M1A2)
- $716M FUNDED FY94
- WORKLOAD OF $1.28B

LOGISTICS SUPPORT ACTIVITY
MAINTENANCE TROUBLE SHOOTING
PS MAGAZINE 130,000 ISSUES/MO
ARMY OIL ANALYSIS - 28 LABS
91,660/MO (AVG; GRND + AIR)
LOG INTEL FILES (LIF) (459K/MO AVG)
PLL/ASL DEVELOPMENT
MORE...
Indy... Leveraging Technology To Break The “Barriers”

Indianapolis 500 Winning Speed Averages

185.9 in 1990 - Arie Luyendyk
Qualifying time was 223.3 mph

1992: Al Unser Jr. at 134.7 mph
Guerrero Wins Pole Position With 232.48 mph
12 Of 33 Cars finish
10 Crashes Claimed 13 Cars; 13 Drivers injured

1993: New Rules
- Longer Chassis
- Engine “Boost” restrictions
- Carbon Fiber “Tubs” for Drivers
- Apron On Curves Replaced
With Grass

1994 Post Times
228 mph Unser Jr Wins
160 ave

How You Go Fast On A “Slower” Track

4 Tons Of
Lateral G
Force

40 / 60
Weight Dist
Composites “Tub”

Redesign Front & Rear
Wings: 2 Tons Total
Down Force

Smaller Engines
Horsepower
Air Intake
Compression

911 Ray Harroun
Wins (6:42:08 -
74.59 mph)

Peter DePaolo
Breaks
100 mph Barrier 1925

Bridge

Grandstands

FIU5G 501-101.13 P. 15
FIELD CONCERNS

BATTERY COSTS

IMPROVED PERFORMANCE

DISPOSAL

WEIGHT

UNUSED CAPACITY

MAINTENANCE

PROLIFERATION
BATTERY RELATED OPERATION & SUPPORT COSTS

BATTERY RELATED COSTS ARE OF INCREASING CONCERN TO THE FIELD COMMANDERS
AMC POWER SOURCES
CHALLENGES

REDUCE O&S COSTS
DEVELOP IMPROVED, COST EFFECTIVE POWER SOURCES
INFLUENCE END ITEM DESIGN
REDUCE NUMBER OF UNIQUE BATTERIES
DEVELOP/FIELD POWER SOURCES BASED ON DUAL USE TECHNOLOGIES
PRESERVE/BUILD AN INDUSTRIAL BASE
ANSWERING THE CHALLENGE

ARMY BATTERY MODERNIZATION STRATEGY
* PERFORMANCE
* SYSTEM DESIGN
* PROGRAM MGT
* CONTROL PROLIFERATION
* SAFETY

AMC BATTERY FOCAL POINT
* IMPLEMENT STRATEGY
* COORDINATE AMC ACTIONS
* INTERFACE WITH USERS
* INTERFACE WITH INDUSTRY
BUSINESS OPPORTUNITIES

PROVIDE IDEAS/SUGGESTIONS

MEET FUTURE CHALLENGES TOGETHER

LEARN WHERE WE ARE GOING

OPEN COMMUNICATIONS

WHY ARE YOU HERE?
SUMMARY

- POWER SOURCES ARE OF SIGNIFICANT CONCERN TO THE ARMY
- AMC IS BEING PROACTIVE IN RESOLVING THESE CONCERNS
- INDUSTRY ASSISTANCE IS REQUIRED
U.S. ARMY TRAINING AND DOCTRINE COMMAND (TRADOC)

FUTURE NEEDS/REQUIREMENTS
The Land Warrior System

Communication and Computer System
- Computer
- Intrasonic Radio
- Intersquad Radio
- GPS (SAASM)
- Handheld Flat Panel Display
- Video Camera
- Video Capture Software
- Compatible With Combat ID Component
- GFE Software

Integrated Headgear
- Lightweight Helmet With Suspension System
- Head/Helmet-Mounted Display Image Intensifier (I²) With Integrated Flat Panel Display

Weapon System
- Laser Rangefinder
- Digital Compass
- Wiring Harness
- Modular Weapon System
- Thermal Weapon Sight (TWS)
- Close Combat Optic
- AN-PAQ4B - IR Laser Aiming Light
- Other Existing Weapons & Accessories

Protective Clothing and Individual Equipment
- Advanced Load Carrying Capability
- Improved Body Armor
- Laser Detector
- Improved Combat Uniform
- M45 Protective Mask
- Chem/Bio Garment/Glove/Boot
- Ballistic/Laser Eye Protection
- Other Existing CIE
- Combat ID Receiver (PM-CID)

BLACK = LW Development and Integrated Into LW by Contractor
RED** = GFE to K (Still Being Developed); Integrated Into LW System
ORANGE* = GFE to K (Already Type Classified); Integrated Into LW System
GREEN† = Separate Program Interface With LW
THE BATTERY CHALLENGES

MANAGEMENT

System design is done. Now we need a new battery

STANDARDIZATION

$14.3M spent for 6TL batteries annually

OUTDATED TECHNOLOGY

Vented lead-acid automotive batteries are older technology

HIGH USAGE

IN EXCESS OF 250,000 USED ANNUALLY BY TACOM
CG TRADOC

"Fix the Battery Problem"

CG CASCOM

Identified and Assessed Field Cdr’s Concerns
Established an ARMY BATTERY CONFEDERATION
- AMC(CECOM)
- TRADOC(CASCOM)
- FORSCOM

Prepared a Battery Modernization Strategy
Key Players

Providers

Users

...sum of the parts is greater than the whole...
• Formed as a part of the Army Battery Modernization Strategy

• Short term goals established.

• Major short term goal: Establishment of a Program Manager for batteries.

• Members
  -- TRADOC(CASCOM)
  -- AMC(CECOM)
  -- Forces Command
BATTERY NEEDS OF THE ARMY
OVERALL BATTERY CONCERNS

- Limited number of uses of primary batteries
- Old battery technology
- Spare batteries must be carried
- Hazardous waste disposal
  - Handling
  - Transportation
  - Costs
- EPA fines
- Constantly changing guidelines
- 3 demands in 90 days to be kept on hand
- Resupply of unique batteries difficult
OVERALL BATTERY CONCERNS

- Too many different types
- Special handling for deployments
- Contingency and wartime surge
  e.g. Chemical Alarm Batteries
- Retrograde Operations
  Desert Shield/Storm
  Operation Restore Hope
- Health Hazards/Fatalities
  Short Term
  Long Term
- State of charge indicators very limited
WATERCRAFT BATTERY NEEDS

- Technology demonstration at Ft Eustis using nickel-cadmium batteries.

- Currently using lead acid batteries.
  -- 6 volt and 12 volt
  -- Changed twice a year.

- Need one standard battery for watercraft
  -- Hot and cold climate capability
  -- Low rate of self discharge
  -- Low or No maintenance requirements.
M1 TANK BATTERIES

- Increased power and mission requirements have made the current 6TL lead-acid batteries ineffective.

- Mounted Battle Lab Under Armor APU designed to meet requirements. Two 6TL batteries cannot start the tank without APU assistance.

- Newer technology battery needed just for the APU and the M1 tank.

- Study done in 1993 shows batteries number one item needing constant attention on the M1 tank.
AVIATION BATTERY NEEDS

- Army aviation is using vented nickel-cadmium batteries.
- High failure rate results in:
  - Excessive down time
  - Effects mission readiness
- Newer technology battery needed to reduce maintenance and increase readiness.
- A standard battery for aviation is needed.
For now need batteries that have high power, longer shelf lifes, increased number of uses (Primary) and cycles lives (Secondary) to do the mission.
Combat Developers emphasis of:

- Multiple adapter configuration to use different primary and rechargeable batteries.
- Insertion of new technology.
- Reduction of military standards in equipment.
- Dual use technology.
- Power reduction circuitry.
- Power management circuitry.
- Direct Vendor Delivery.
- Investigation of technology from agencies such as NASA and DOE laboratories.
Industrial Development of:

- Lighter, high energy, increased cycle life for primary and rechargeable batteries.
- Multi-chemistry/fast/smart battery chargers.
- Environmentally friendly chemistries.
- Reduce battery purchase cost.
- Recycling facilities for newer chemistries
- Batteries and/or cells that can be used in multiple configurations.
ARMY RESEARCH LABORATORY (ARL)

POWER REQUIREMENTS
PORTABLE POWER SOURCES

DR R.P. HAMLEN
Director, Power Sources Division
Electronics and Power Sources Directorate

UNCLASSIFIED
- CONDUCT R&D ON FUTURE BATTERIES
- DEVELOP IN CONJUNCTION WITH CONTRACTORS
- APPROVE NEW TYPES FOR USE
- QC TESTING ON LITHIUM BATTERIES
POWER SOURCES DIVISION
R.P. Hamlen

ENERGY SCIENCES
S. Gilman

RESERVE BATTERY TECHNOLOGY
A. Goldberg

BATTERY DEV/ENGINEERING
H.A. Christopher

BASIC RESEARCH ON:
• Manportable
  - Batteries
  - Fuel Cells
• Batteries & Capacitors for Electric Weapons

Reserve Batteries for
• Smart Weapons
• Standby Uses
• Integral Active (Lithium) (Thermal) (Aqueous)

• Application Eng.
• Lithium Battery
  - safety
  - producibility
  - analyses
• Battery Product Design & Dev.
• Thermophotovoltaic Systems Dev.
# Power Sources Programs

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<th>Pulse Batteries and Capacitors</th>
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<td><em>Electric Gun</em></td>
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<td><em>Soldier System Primary</em></td>
<td><em>Electric Drive Vehicle</em></td>
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<th>Rechargeable Batteries</th>
<th>Fuel Cells</th>
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<td><em>Improved Energy Density</em></td>
<td><em>Soldier Systems</em></td>
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<td><em>Low Cost</em></td>
<td><em>Tank Silent Watch</em></td>
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<th>Alternative Power Sources</th>
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<td><em>Longer Mission Life</em></td>
<td><em>Generation</em></td>
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</table>
KEY BATTERY CONCERNS

I. PERFORMANCE
   - ENERGY, POWER, WEIGHT, TEMPERATURE
   - SAFETY-TRANSPORTATION, USE, DISPOSAL
   - SMART CHARGER, STATE-OF-CHARGE

II. COST
   - PEACETIME TRAINING

III. PROLIFERATION OF BATTERY TYPES
   - PRIOR TO LITHIUM-LITTLE CONTROL
   - NOW - STANDARD FAMILY
IV. DIVERSIFIED APPLICATIONS

- COMMUNICATIONS-ELECTRONICS
- TANK STARTING AND SILENT WATCH
- PULSE POWER
- AIRCRAFT STARTING

V. INDUSTRIAL BASE
# FAMILY OF STANDARD BATTERIES

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<th>CAPACITY CURRENT</th>
<th>NON RECHARGEABLE LOW POWER LI/SO₂</th>
<th>RECHARGEABLE LOW POWER Ni-Cd</th>
<th>NON RECHARGEABLE HIGH POWER LI/SO₂</th>
<th>RECHARGEABLE HIGH POWER Ni-Cd</th>
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<td>VOLTAGE</td>
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<td>BA-5567/U</td>
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<tr>
<td>6</td>
<td>BA-5372/U</td>
<td></td>
<td>BA-5847/U</td>
<td>BB-X847/U</td>
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<tr>
<td>12</td>
<td>BA-5588/U</td>
<td>BB-588/U</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>BA-5590/U</td>
<td>BB-590/U</td>
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ADVANCES IN PRIMARY BATTERIES FOR HIGH POWER DENSITY APPLICATIONS*

* SPECIFIC DATA FOR THE BA-5590/U IN THE SINCGARS RADIO
LITHIUM-MANGANESE DIOXIDE PRIMARY BATTERIES

CYLINDRICAL CELLS

- SMALL CELLS - AVAILABLE: CAMERAS, SMOKE ALARMS
- D CELLS - AVAILABLE: SEARCH AND RESCUE BEACONS (8 Ahrs.)

POUCH CELLS

- MAXIMIZE USE OF AVAILABLE BATTERY VOLUME
- MORE ENERGY PER UNIT OF VOLUME
- EASIER/CHEAPER TO MANUFACTURE THAN SPIRAL WOUND CELLS
- FOIL CONSTRUCTION - NO SHRAPNEL
- POUCH CELL FOR BA-XX90/U 14 Ahrs.

TECHNICAL CONCERNS

SAFETY, LOW TEMP OPERATION, SHELF LIFE
RECHARGEABLE BATTERIES

- TRAINING
- SOF
- TANK STARTING/SILENT WATCH
- AIRCRAFT STARTING
## SINCgars Alternatives Available Today

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<th>BA-5590/U</th>
<th>BB-590/U</th>
<th>BB-490/U</th>
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<tr>
<td><strong>Batt/Mission</strong></td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>(8 hrs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Missions/Batt</strong></td>
<td>3.1</td>
<td>0.79</td>
<td>0.55</td>
</tr>
<tr>
<td><strong>WT/Mission</strong></td>
<td>2.2 LBS</td>
<td>7 LBS</td>
<td>6.8 LBS</td>
</tr>
<tr>
<td><strong>Cost/yr</strong></td>
<td>$4,393</td>
<td>$496</td>
<td>$2675</td>
</tr>
<tr>
<td><strong>Disposal/yr</strong></td>
<td>$238</td>
<td>$3</td>
<td>$0</td>
</tr>
</tbody>
</table>

* (P) Primary  
** (R) Rechargeable
# Comparison of Existing and Future Rechargeable Batteries

BB590/U Size, 2.45"x5"x4.4"-24V.

<table>
<thead>
<tr>
<th>PRODUCTS AVAILABLE</th>
<th>Wh/Kg</th>
<th>AH</th>
<th>SAFETY</th>
<th>CYCLES</th>
<th>COMMENTS/LIMITATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ni Metal Hydride</td>
<td>42</td>
<td>3.4</td>
<td>+</td>
<td>200+</td>
<td>Potential For Improvement</td>
</tr>
<tr>
<td>NiCd</td>
<td>30</td>
<td>2.0</td>
<td>+</td>
<td>250+</td>
<td>Heavy/Low Mission Life</td>
</tr>
<tr>
<td>Lead-Acid</td>
<td>25</td>
<td>1.6</td>
<td>+</td>
<td>100</td>
<td>Heavy/Lower Mission Life</td>
</tr>
</tbody>
</table>
### COMPARISON OF EXISTING AND FUTURE RECHARGEABLE BATTERIES

**BB590/U Size, 2.45"x5"x4.4"-24V.**

Continued

<table>
<thead>
<tr>
<th>FUTURE CANDIDATES</th>
<th>Wh/Kg</th>
<th>AH</th>
<th>SAFETY</th>
<th>CYCLES</th>
<th>COMMENTS/LIMITATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Li-ion</td>
<td>88</td>
<td>4.5</td>
<td>?</td>
<td>200+</td>
<td>Safety in Large Sizes</td>
</tr>
<tr>
<td>Metallic Li</td>
<td>110</td>
<td>5.0</td>
<td>?</td>
<td>50</td>
<td>Safety/Risk</td>
</tr>
<tr>
<td>Metallic Li/Polymer</td>
<td>150</td>
<td>7.0</td>
<td>?</td>
<td>50</td>
<td>Safety/Risk TBD</td>
</tr>
<tr>
<td>Rech. Alkaline</td>
<td>60</td>
<td>4.5*</td>
<td>+</td>
<td>10-30</td>
<td>Power/Temp. Limited</td>
</tr>
</tbody>
</table>

*Low Rates Only*
<table>
<thead>
<tr>
<th>GOAL</th>
<th>IMPACT/APPLICATIONS</th>
<th>FUEL CELLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>RECHARGEABLE LITHIUM BATTERIES</td>
<td>- 1/10 cost of throwaway battery</td>
<td>- Manpack power source for long-duration microclimate cooling</td>
</tr>
<tr>
<td>ELECTROCHEM CAPACITORS</td>
<td>- Over 2 1/2x energy density of secondary battery</td>
<td>- Power Source for special operations</td>
</tr>
<tr>
<td>PULSE POWER BATTERIES</td>
<td>- Reduced logistics if primary charging source available</td>
<td>- Stealth vehicles</td>
</tr>
<tr>
<td></td>
<td>- Hybrid or electric vehicles: acceleration, dynamic braking</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Conventional vehicles: engine starting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Electric guns</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Hybrid or electric vehicles</td>
<td></td>
</tr>
</tbody>
</table>
BASELINE TECHNOLOGY
- Ni/Cd (ENERGY DENSITY = 40 Whr/kg)
- Ni/METAL HYDRIDE (ENERGY DENSITY = 60 Whr/kg)

GOAL
- MATERIALS AND BASIC TECHNOLOGY FOR:
  - ENERGY DENSITY > 100 Whr/kg, ALL-TEMP OPERATION
  - DUAL USE, HIGHEST USER SAFETY

APPROACH
- IMPROVED LIQUID ELECTROLYTES FOR "Li-Ion"
  (I.E. LiC₆ ANODES) BATTERIES
- IONICALLY CONDUCTING POLYMER ELECTROLYTES
  FOR SOLID-STATE BATTERIES
ACCOMPLISHMENTS

- HIGH CONDUCTIVITY LIQUID ELECTROLYTES AVAILABLE FOR "Li-ion" BATTERIES
- NEW POLYMER ELECTROLYTES FORMULATED

FUTURE WORK

- LIQUID ELECTROLYTES: STABILITY WITH Li_x C_6
- POLYMER ELECTROLYTES: FORMULATION/DEMONSTRATION OF PROTOTYPE CELLS
- EXPLORATION OF CARBON FIBER CATHODES
SIGNIFICANT POWER/ENERGY SAVINGS CAN BE ACHIEVED IN ELECTRONIC EQUIPMENT BY:

- Applying emerging device and architectural technologies
  - Low voltage analog/digital microelectronics
  - Reconfigurable parallel and pipelined architectures
- Employing judicious engineering principles throughout the requirements/design/development process
  - Automatic shutdown, adaptive "sleep" modes, etc.
- **CUMULATIVE EFFECT: POWER SAVING RANGING FROM 10% TO 90%**

DEPENDING UPON:

- Willingness to incur moderate increases in NRE and production costs
- System-Specific Performance and Operational Use

- **ACQUISITION COST INCREASES CAN BE EASILY RECOVERED BY SAVINGS IN BATTERY COSTS WITHIN 1 TO 3 YEARS**
KEY OBJECTIVES FOR FUTURE

- IMPROVED PRIMARY BATTERIES FOR SOLDIER SYSTEMS, NEXT GENERATION C4I THROWAWAY, LASER, RADAR AND NV SYSTEMS

- IMPROVED NEAR-TERM (NiMH) AND LONG-TERM (Li-ION) RECHARGEABLE BATTERIES (C4I, SOLDIER SYSTEM, TANK)

- RESERVE/ACTIVE BATTERIES FOR LONGER-LIVED, SMART MUNITIONS
KEY OBJECTIVES FOR FUTURE
Continued

- HIGH RATE BATTERIES AND CAPACITORS FOR ELECTRIC WEAPONS AND VEHICLES

- FUEL CELLS FOR LONG-LIFE PORTABLE USE, TANK SILENT WATCH

- PORTABLE THERMOPHOTOVOLTAIC POWER GENERATORS
SMALL BUSINESS INNOVATIVE RESEARCH (SBIR)

- PHASE I AND PHASE II
- SOLICITATIONS: SEP-OCT 94, MAY 95
- ESTIMATED AWARD DATES: 4 MONTHS AFTER SOLICITATION
- POSSIBLE TOPICS
  - Li / MnO₂ Cylindrical Cell Batteries
  - Li-ion / Polymer Electrolyte Rechargeable Batteries
  - Manportable PEM Fuel Cells
  - Electrochemical Capacitors
  - Thermophotovoltaic (TPV) Devices
  - Pulse Power Batteries
BROAD AGENCY ANNOUNCEMENT (BAA)

- ARL
  - TOPICS: Compact, High Energy Density Reliable Batteries
    Reliable and Efficient Fuel Cells
- EPSD
  - TOPICS TBD Based On Customer Funding
FOREIGN MATERIEL EXPLOITATION (D650)

- ARL / EPSD PROPOSALS SUBMITTED FOR FY95
  - Primary Lithium Batteries
  - Rechargeable Batteries
  - Fuel Cells

- PROPOSAL ACCEPTANCE / REJECTION DUE SEP 94

- TOPICS TBD BASED ON ACCEPTED PROPOSALS

- FUNDING PROVIDED IN 1Q FY95

- ESTIMATED AWARD(S) DATE(S): 2Q FY95
- NIGHT-TIME USE OF SOLAR PANELS
- MULTI-FUEL CAPABILITY
- SILENT OPERATION
- REMOTE BATTERY CHARGING
Batteries vs Fuel Cells

Fuel Cell
Continuous Feed

Battery
Self-Contained

O$_2$ ↔ H$_2$O
H$_2$ ↔ Electrolyte (Solid or Liquid)

Anode Cathode
(+)
(-)
FUEL CELLS

- Battery Charger
- Long-Duration C4I Missions
- Soldier Systems
- Tank Silent Watch
- Silent Vehicles
CURRENT PROGRAM

- IMPROVED MEMBRANES FOR POLYMER ELECTROLYTE MEMBRANE (PEM)

- IMPROVED ELECTROCATALYSTS FOR H2 AND METHANOL FUEL CELLS

- HIGH POWER DENSITY H2/PEM FUEL CELL STACKS
SOLAR PANELS ILLUMINATED BY GAS LANTERN TO PRODUCE POWER AT NIGHT
• Rapid Growth In Various Commercial Sectors

• Systems:
  
  Notebook And Laptop PCs, Cellular Phones, Pagers, ...

• Components

  3 Volt Parts From Multiple Suppliers

  • Gate Arrays, FPGAs, Standard Cell Families

  • High Efficiency Regulators

  • Portable PCs And Telecom
• Wide Spread Information Exchange
  • 1st IEEE Low-Power Electronics Workshop - Jul 93
  • IEEE-IEDM Short Course On Low Voltage/Low Power - Dec 93
  • 1994 ISSCC Focuses On Low Power - Feb 94
  • 1st IEEE Symposium On Low Power - Oct 94
BENEFITS OF REDUCED POWER

- Extend Battery Life, Other Chemistries
- Increase Functionality Of Electronic Systems
- Simplify Heat Sinking And Cooling Requirements
- Reduce Cost, Size, Weight
- Enhance Soldier Capability

• Power Reduction Goal \( \geq 30\% \)
• Power Reduction Techniques
• Maximizing Commercial State-Of-The-Art Use
• Implementing In Portable Army Systems
CMOS POWER DISSIPATION

\[ P = \frac{1}{2} C V_{dd}^2 F + V_{dd} I_L \]

Operating Power  Standby Power

Power Dissipation Reduction Factors

\begin{align*}
C &= \text{Load Capacitance} \\
V &= \text{Supply Voltage (Squared)} \\
F &= \text{Operating Frequency} \\
I &= \text{Leakage Current}
\end{align*}
LOW POWER MUST BE ADDRESSED FROM AN ENTIRE SYSTEM POINT OF VIEW

Diagram:
- Battery
- DC to DC Converter
- Displays
- Keyboard
- Micro Processor
  - Random Logic
  - Core I/O
- Memory
  - SRAM
  - DRAM
  - PROM
- Analog Circuitry
- Electronic Packaging
- Sleep And Idle Clock Modes
- Power Gating
- Reduced Voltage
- Reduced Load Capacitance
- Advanced Packaging
System should be partitioned to provide power savings thru the use of power cycling or sleep mode circuits. Good partitioning permits most functions to be powered down.
• Microprocessor
  Software Controlled Power Management

• Random Logic
  Adaptive Clocking Schemes
    Clock Idle Mode
    Gated Clock
  Power Cycling
  Design Synthesis For Optimization

• Clocking Schemes
  Gated Clock Distribution
  Clock Frequency Control
  Control Skew To Eliminate Glitches
• Memory
  S-RAM
  Multi-Divided Memory Structure
  Load Optimization
  Functional Block Gating
  D-RAM
  Decrease Required Refresh Frequency
POWER REDUCTION STRATEGY

- Peripherals
  Simplify Peripheral I/O
  Eliminate Keyboard
    Coded Inputs
    Voice Activation
  Eliminate Displays Where Feasible
    Display On-Demand Only
  Shared Displays
  Simplified Visuals

- Analog Circuitry
  Combine With Digital Circuitry
  Use Digital Power Supply
• DC To DC Converter
  Improve Efficiency
  Eliminate Converters Where Feasible
  Direct Battery Operation
  (Watch Applications)
  Combined Digital And Analog Power Supplies
  (Digital +3V, 0V; Analog +3V, -3V)
• Aggressively Scaled Submicron CMOS

• Insulating Substrates

• Dominant Power Mode (Operating vs Standby)
CONCLUSIONS

- Develop And Promulgate A Power Efficient Culture
- Low Power Systems And Components, In General Are More Costly And Probably Less Robust
- Need Comprehensive Design Tools
- Potential Efforts
  Engineering Handbook:
    Applications Guide For Systems, Boards, Modules, Microcircuits
  Pilot Demo Program
- Commercial Spin-On
  Adopt Methods, Architectures, Components
U.S. ARMY COMMUNICATIONS-ELECTRONICS COMMAND (CECOM)

AMC BATTERY FOCAL POINT
BATTERY MANAGEMENT -
THE WAY IT WAS

CECOM
TACOM
MICOM

EVERYONE DOING THEIR OWN THING

ARL
CBDCOM
ATCOM
ACALA
AMC BATTERY FOCAL POINT

- REDUCE O&S COSTS
- COORDINATE AMC BATTERY EFFORTS
- REPRESENT AMC BATTERY PROGRAM
- ARMY MODERNIZATION STRATEGY
<table>
<thead>
<tr>
<th>MSC</th>
<th>POC</th>
<th>TELEPHONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CECOM (CHAIR)</td>
<td>RICH RIZZO</td>
<td>908-532-8941</td>
</tr>
<tr>
<td>ARL</td>
<td>DR. HAL CHRISTOPHER</td>
<td>908-544-4246</td>
</tr>
<tr>
<td>ATCOM</td>
<td>GIL KRENER</td>
<td>314-263-1100</td>
</tr>
<tr>
<td>CBDCOM</td>
<td>TIM PEDRICK</td>
<td>410-671-5601</td>
</tr>
<tr>
<td>IOC</td>
<td>RUTH DELL</td>
<td>717-267-8474</td>
</tr>
<tr>
<td>MICOM</td>
<td>DR. BARRY ALLEN</td>
<td>205-876-3732</td>
</tr>
<tr>
<td>STRICOM</td>
<td>ARCHIE DULEY</td>
<td>407-381-8274</td>
</tr>
<tr>
<td>TACOM</td>
<td>JOHN BUSH</td>
<td>810-574-5297</td>
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<td>TACOM (LOG)</td>
<td>ROSCOE SPENCER</td>
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<td>CLIFF SHOOK</td>
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<tr>
<td>TECOM</td>
<td>MAJ CRAIG KENT</td>
<td>410-278-1329</td>
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</tbody>
</table>

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OVERALL GOALS
CECOM BATTERY PROGRAM

TODAY
- MILITARY UNIQUE TECHNOLOGY
- DEDICATED PRODUCTION BASE
- HIGH O&S COSTS

TOMORROW
1. LOWER O&S COSTS
2. IMPROVED PERFORMANCE
3. DUAL USE TECH
4. STANDARDIZED
5. SAFE
6. REDUCED DISPOSAL COST
FOCUS - REDUCE O&S COSTS

DESIGN SOLUTIONS
STANDARDIZATION
NEW BATTERY CHARGERS
NEXT GENERATION
BATTERIES

CECOM BATTERY PROGRAM
BATTERY COST DRIVERS

USER REQUIREMENTS

MILITARY UNIQUE BATTERIES

DESIGN SOLUTIONS

O&S COSTS
SYSTEM DESIGN INFLUENCES

INDUSTRY

POWER MANAGEMENT

TRADE OFFS

REQUIREMENTS IN ORD

GOVERNMENT

O&S COSTS
C\E BATTERY STANDARDIZATION

YESTERDAY

UNCONTROLLED PROLIFERATION

12 STD LITHIUM BATTERIES

5 PRIMARY LITHIUM BATTERIES

TODAY

15+ RECHARGEABLE BATTERIES

TOMORROW

BA-XXXX
AMC

BATTERY STANDARDIZATION GOALS

REDUCE NUMBER OF BATTERIES

ONE BATTERY PER VOLTAGE

INFLUENCE END ITEM DESIGN

ELIMINATE BATTERY PROLIFERATION

REDUCE BATTERY RELATED O&S COSTS

STANDARD CHEMISTRIES & CONFIGURATIONS
BATTERY SELECTION

COMMERCIAL

OFF THE SHELF

(COTS)

BATTERIES

MILITARY PREFERRED

BATTERY LIST

(BA-5590, BA-5588,
BA-5567, BA-5847, BA-5372,
BB-590, BB-588, BB-2847)

NO

UNIQUES
POWER SOURCES
STATEMENT OF WORK

✓ USE OF POWER MANAGEMENT

✓ USE OF CONSUMER OR MILITARY PREFERRED BATTERIES

✓ BATTERY ASSIGNMENT PROCESS

✓ INCORPORATED IN ALL NEW DESIGN AND PRODUCT IMPROVEMENT CONTRACTS
BATTERY CHARGER MODERNIZATION

GOAL: COST EFFECTIVE MODERNIZATION OF THE BATTERY CHARGER INVENTORY

UNIT LEVEL
* "FLEET" STYLE
* LOW COST
* COTS

BATTERY SHOP
* AUTOMATIC
* PROGRAMABLE
* MULTIPLE BATTERY CHARGE ABILITY
* COTS

UNIT LEVEL
* PORTABLE
* DUAL BATTERY CHARGE ABILITY
* 2 HR CHARGE
* COTS

BATTERY SHOP
* AUTOMATIC
* PROGRAMABLE
* MIN OF 5 BATTERY CHARGE ABILITY
* 2 HR CHARGE
* COTS
AMC

THE NEXT GENERATION

TODAY

* HIGH O&S COSTS
* MILITARY UNIQUE
* DISPOSAL COSTS

TOMORROW

* REDUCED O&S COSTS
* DUAL USE
* REDUCED DISPOSAL COSTS
* INCREASED CAPACITY
* STATE OF CHARGE
THE ROAD TO THE NEXT PRIMARY BATTERY PROCUREMENT

GOALS:
✓ DUAL USE
✓ STATE OF CHARGE
✓ 50% INCREASE IN CAPACITY

1994

4Q96 - 1Q97
MULTIPLE YEAR CONTRACT AWARD

SOLICITATION
* BEST VALUE
* BID SAMPLES
* RFP FORMAT

ANY CHEMISTRY CAN BID

NO NEW LITHIUM PROCUREMENTS PROJECTED UNTIL 4Q96-1Q97
THE ROAD TO THE NEXT RECHARGEABLE GENERATION

GOALS

NICKEL CADMIUM

NICKEL METAL HYDRIDE

LITHIUM

REDUCED WEIGHT
COST EFFECTIVE
IMPROVED PERFORMANCE
LOW COST, PORTABLE CHARGING SYSTEM
1993 APBI
BUSINESS OPPORTUNITES STATUS

AWARDED:  VALUE:
Li/SO2 BUY OUT  $34.8M
AIRCRAFT OMNIBUS  $ 5.0M
VARIOUS MERCURY  $ 0.2M
BA-5372  $13.1M

IN PROCESS:
RECHARGEABLE OMNIBUS
BA-6516
BUSINESS OPPORTUNITY

BB-590, BB-588, BB-503, BB-516, BB-X847 (INCLUDES CHARGER AND POWER SUPPLY)

CONTRACT METHOD: INDEFINITE DELIVERY/INDEFINITE QUANTITY (BASIC & 4 OPTION YEARS) BID SAMPLES

QUANTITIES: VARIES BY BATTERY

SCHEDULE: SOLICITATION DATE - 1QFY95
AWARD DATE: FY95

ESTIMATED VALUE: $28,000,000

POC: ROBERT REAGAN
C31 ACQUISITION CENTER
(908) 532-5645
BUSINESS OPPORTUNITY

BB-542 (NiCd) REPAIR PROGRAM

CONTRACT METHOD: REQUEST FOR PROPOSAL

QUANTITIES: 346

SCHEDULE: SOLICITATION DATE - TBD
          AWARD DATE: 2QFY95

ESTIMATED VALUE: $280,000

POC: ROBERT REAGAN
     C31 ACQUISITION CENTER
     (908) 532-5645
HAVE A GOOD IDEA?
CALL

UNSOLICITED PROPOSALS: NANETTE MULLENAX/SANDY VERMONT
VALUE ENGINEERING (908) 532-2671
CHANGE PROPOSALS: AL PALEY
OR (908) 532-2318
OPERATING AND SUPPORT
COST REDUCTION:
WORKING TOGETHER

TO HELP THE SOLDIER
U.S. ARMY COMMUNICATIONS-ELECTRONICS COMMAND

DIRECT VENDOR DELIVERY

Directorate of Materiel Management
Mr. Robert Pearson
UNCLASSIFIED
DIRECT VENDOR DELIVERY

REDUCE COSTS & CYCLE TIME

REQUISITION

SHIP/STORE/SIP

ITEM MANAGER

ASSET

PRODUCER

REQUISITION
Direct Vendor Delivery (DVD)

- Benefits
  - Minimizes transportation costs
  - Reduces inventory at depots
  - Coupled with multiple year, packaged procurements
  - Moving towards use ANSI X.12 Electronic Data Interchange Standards
  - Requires joint effort (industry/government) to implement
• Implemented DVD test with UNICOR (FPI)

• Looking at modifying agreements on existing contracts

• Developing "requirements"
  √ EDI
  √ Inventory levels/storage
  √ Packaging
  √ Inspection and acceptance, etc.
U.S. ARMY SIMULATION, TRAINING AND INSTRUMENTATION COMMAND (STRICOM)

FUTURE EFFORTS
The Army has a Training Device System
ITS NAME IS SAWE/MILES II
(SIMULATED AREA)
WEAPONS
EFFECTS/MULTIPLE
INTEGRATED LASER
ENGAGEMENT
SYSTEM
MISSILES
The SAWE/MILES II system has a manworn component.
ITS NAME IS PDD
(PLAYER DETECTION DEVICE)
THE PDD HAS A BATTERY

ITS NAME IS BA5590/U
THE PDD DEALS

WITH DATA

- Radio Frequency Transmissions
- Laser Reception Processing
- Digital Data Storage
- Position Location Polling Results/Timekeeping

10101010
01100010
10110101
THE DATA IS ABOUT EVENTS AND SITUATIONS

- Position Location (Global Positioning System)
- Direct Weapon Engagement
- Hit/Kill Results (MILES)
- Indirect Weapons, Chemical, Biological and Nuclear Effects (SAWE)
THE SOLDIER WEARS THE PDD IN ADDITION TO ALL OTHER COMBAT EQUIPMENT. THE SOLDIER DOES HIS JOB IN A REALISTIC TACTICAL MANEUVER ENVIRONMENT.
The PDD can "talk" to a CTC*

Data Collection and Analysis

Instrumentation System when a DCI (Data Communication Interface) Device (small transceiver) is added.

The PDD with a DCI makes an "Instrumented Player."
• The DCI gets its power from the PDD.

• The PDD components all draw on the same power source.

• The frequency of events, of position location reporting and event data reporting determine drain on the battery.
* Three Combat Training Centers (CTC):
  Combat Maneuver
  (Germany)
  Joint Readiness
  (FT Polk, LA)
  National Training Center
  (FT Irwin, CA)
• THE BA5590/U IS THE ONLY TYPE CLASSIFIED STANDARD BATTERY CURRENTLY AVAILABLE THAT SATISFIES ALL OF THE MINIMUM ESSENTIAL OPERATING AND COST PARAMETERS
- Power Output = 9.2w
- Size = Not as big as a brick
- Weight = Not heavier than 2.25 lbs
- Instrumented PDD Duty Cycle = 24 hrs minimum
- Cost = Under $55 each
THE PDD IS BEING MODIFIED TO BETTER MEET SOLDIER FUNCTIONAL NEEDS
- Lighter

- Better Component Layout, Including Battery

- More User Friendly (e.g., set-up in MOP-4)
• THE NEW DOWNSIZED PDD'S BATTERY NEEDS TO CHANGE ALSO
- Lighter Weight (high power to weight ratio)
- Longer Power Life (longer amp life in context of "average" demand)
- Lower Cost
  - Function of annual procurement expense, either or both
√ Lower price per battery
√ Longer life in operation

- Smaller Size and Smoother Configuration

▷ Could be size and shape of common item soldier already carries (e.g. ammo magazine, first aid kit)
- Human Engineering Factors (fits the training system)
  - Easier to Handle, Connect, Carry and Dispose
PDD BATTERY
CONSIDERATIONS &
CHALLENGES

"OUR
DESIREMENTS"

• Weight (lighter than 2.0 lbs
each)
• Power (9.2w @ 12v/dc, "standard instrumented use" for MORE THAN 24 hrs)

• Cost (less than $20 EACH)

• Configuration (example: shaped as a 30 Rnd "banana" magazine)

*Cost Impacts
PDD BATTERY
CONSIDERATIONS &
CHALLENGES
"OUR
DESIREMENTS"
Cont'd

• Environment Impact (low or no hazard - "drop and walk")
• Ease of Use and Disposal

- Connection access user friendly
- Transportability (nothing special needed)
- Durability (all weather/rough handling)
- Disposal (simple/inexpensive, with no special handling)
• Safe (very!)

• Shelf Life (many months long and not heat/cold sensitive)

* Cost Impacts
WHAT IS THE MARKET POTENTIAL?

* Figures are Rough Order of Magnitude (ROM) estimates based on planned equipment orders and usage experiences.
How many of our Army "desirements" can industry fulfill, when and to what extent?
U.S. ARMY TANK-AUTOMOTIVE AND ARMAMENTS COMMAND (TACOM)

BATTERY PROGRAM
POWER & ENERGY STORAGE REQUIREMENTS FOR MILITARY VEHICLES

JOHN F. BUSH
APPLIED ENGR & ROBOTICS DIVISION

(810) 574-5297
DSN 786-5297
FAX (810) 574-5008

UNCLASSIFIED
VISION

To become a world class leader for tank-automotive electrical systems and to provide the soldier with the most advanced electrical systems at the lowest cost.
MISSION:
To provide the most reliable and cost effective electrical systems and components. To improve fleet readiness, and reduce operating and support costs related to electrical power generation, regulation, storage, and distribution.
TEAM POWER

BATTERY TECHNOLOGY ORGANIZATION

CECOM AMC's Manager for Battery Modernization

Systems Engineering TEAM POWER Manager

VETRONICS Tech Center Engineering Support

Material Management Logistics Maintenance

Engineering Data & Design Quality Assurance

Cost Analysis
ELECTRICAL POWER REQUIREMENTS FOR MILITARY VEHICLES

* 24 VOLT ELECTRICAL SYSTEMS

* HIGH POWER FOR ENGINE STARTING

* HIGH ENERGY DEMAND FOR SILENT WATCH OPERATIONS

* OPERATE IN EXTREME TEMPERATURES (-40 TO 115 DEGREE F)

* INTERMITTENT OPERATION
TANK-AUTOMOTIVE BATTERY PROGRAM

OVERVIEW

THRUSt

6TL PROCUREMENT STRATEGY

COMMERCIAL BATTERY USAGE

CAPACITOR STARTING SYSTEMS

SOLAR POWERED TRICKLE CHARGERS

PAYOFF

DIRECT VENDOR DELIVERY

IMPROVE AVAILABILITY & DISPOSAL

EXTEND BATTERY LIFE

REDUCE BATTERY SULFATION

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# Battery Modernization Projects

## Milestones

<table>
<thead>
<tr>
<th></th>
<th>FY 94</th>
<th>FY 95</th>
<th>FY 96</th>
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<tbody>
<tr>
<td>1.</td>
<td>PROCUREMENT STRATEGY FOR MILITARY BATTERIES (DVD/EDI)</td>
<td></td>
<td></td>
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<tr>
<td>2.</td>
<td>COMMERCIAL BATTERY EVALUATION</td>
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<td>3.</td>
<td>CAPACITOR STARTING EVALUATION</td>
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<td>4.</td>
<td>SOLAR PANEL TRICKLE CHARGERS</td>
<td></td>
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<tr>
<td>5.</td>
<td>INTELLIGENT BATTERY CHARGERS</td>
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<tr>
<td>6.</td>
<td>BATTERY MONITOR SYSTEM</td>
<td></td>
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</tbody>
</table>
## Commercial Battery Procurement Forecast

<table>
<thead>
<tr>
<th>VEHICLE</th>
<th>BATTERY TYPE</th>
<th>FY 95</th>
<th>FY 96</th>
<th>FY 97</th>
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<tr>
<td>TACTICAL</td>
<td>FLOODED</td>
<td>184,000</td>
<td>177,000</td>
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<td>COMBAT</td>
<td>SEALED</td>
<td>58,000</td>
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<td>242,000</td>
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### Lead-Acid Battery Technology
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<thead>
<tr>
<th>FY95</th>
<th>FY96</th>
<th>FY97</th>
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<tbody>
<tr>
<td>* SEALED L-A BATTERIES</td>
<td>* ULTRA CAPACITORS</td>
<td>* ADVANCED BATTERIES</td>
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<tr>
<td>* COMMERCIAL BATTERIES</td>
<td></td>
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<tr>
<td>* BATTERY DVD TACOM DLA</td>
<td>* BATTERY CHARGERS</td>
<td>* STATE OF CHARGE METERS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* SOLAR CHARGERS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* EV COMPONENTS</td>
</tr>
</tbody>
</table>
FUTURE REQUIREMENTS

* HIGH POWER AND ENERGY DENSITY
* EXTENDED BATTERY SERVICE LIFE
* MAINTENANCE FREE
* ENVIRONMENTALLY SAFE
Fuze Power Supply Requirements

MR. ALAN C. REITER
TACOM / ARDEC / FUZE DIVISION
ADELPHI MD

UNCLASSIFIED
Outline

- Fuze Environment
- Fuze Power Supply Requirements
- Reserve Power Supplies Descriptions
- Growth Technology Areas
- Business Opportunities
Fuze Environment

GENERAL: One-shot after storage @ -51°C to +71°C

ARTILLERY: High spin rate & g-forces; short mission time

MINE: No acceleration forces; long mission time

MISSILE: Low spin rate & g-forces; moderate mission time
Fuze Power Supply Requirements

• Integral, Not Replaced

• 10 to 20+ Years Shelf Life

• Quick Response/Rise Time
  Typically Milliseconds,
  Depending on Application

• Typical Operational Range
  -40°C to +60°C
Types of Reserve Batteries

• Liquid Electrolyte Artillery Mines

• Thermal Mortars Rockets Missiles (G&C, too)
Liquid Electrolyte
Conventional Reserve Batteries

- 30+ Years Shelf-Life
- Pb/HBF₄/PbO₂ Electrochemistry
- Bipolar Plate Cells, Unique Material
- Electrolyte in Separate Ampule
- Setback and Spin Activated
Thermal Reserve Batteries

- 30+ Years Shelf-Life

- Solid Salt Electrolyte
  LiCl-KCl or LiBr-LiCl-LiF Eutectic Binder (Kaolin, SiO₂, MgO)

- Various Electrochemistries

- Activation by Inertial Starter, Electrical Match, and/or Primer

- Heat Paper (28% Zn, 72% BaCrO₄ mixed with glass and Fiberfrax fibers) or Pellets (14-16% KClO₄, balance Fe powder)
SCHEMATIC THERMAL CELL

HEAT SOURCE

ANODE
ELECTROLYTE
INSULATION
CATHODE

STARTER

INERT
INITIATION
ACTIVATED
Growth Technology Areas for Fuze Applications

- Lithium Liquid Reserve Batteries
- Family of Reserve Batteries
- Spin Thermal Batteries
- Active Batteries
- Alternate Energy Sources
Lithium Liquid Reserve Batteries

- No Significant Mech. Design Changes
- Electrode Material Widely Available
- Technical Challenges: Passivation, Hazards, Etc.
Family of Reserve Batteries

• Family of Batteries Versus Unique Battery for Each Application (Follows British Model):
  - Standard Range of Power/Size Batteries
  - Fuzes Designed to the Standard Battery

• Challenges:
  - Unknown Purchase Quantities
  - Identifying Family Members:
    size, voltage, power, energy
Spin Thermal Batteries

- Started with Nuclear Artillery Fuze Program...
  - Current Application Ballistic Test in Fall '94

- Heat Management

- Cell Design

- Technical Challenges:
  - Heat Retention for Extended Range in Small Package
  - Mechanical Design to Contain Molten Salt at High Spin
Active Batteries

- Existing Broad Manufacturing Base

- Use Active Cells for Short-Term Mobilization
  - Successful SBIR Air Gun Test

- Technical Challenges:
  - Shelf Life (10+ Years)
  - Passivation (response time)
Alternate Energy Sources

- Capacitors (charged prelaunch)
- Piezoelectric (launch shock excited)
- Air Breathing Generators
- Vibration Converters

Technical Challenges:
- Cost & Volume Restrictions
- Power Requirements
Conclusion

- **Niche Market:**
  Dependent on Weapon Procurements
  - potentially large quantities
  Fuze is Sub-Component
  Power Supply is Sub-Sub-Component

- **Shrinking Manufacturing Base:**
  1 Liquid Electrolyte (from 8)
  1 Thermal (from 9)
Army Cooperative R&D Agreement Opportunities

ARMY RESEARCH LABORATORY POC:  
Mike Claffy  (301) 394-3098

FUZE POWER SUPPLY TECHNICAL POC:  
Allan Goldberg  (301) 394-3114
ARL BAA

Opportunities

Solicitation #: DAAL01-95-R-ARL-BAA

All Non-technical Questions:
Ms. K. Wishnow
(301) 394-3690

All Technical Questions (on batteries):
Mr. A. Ballato
(908) 544-4308
SBIR
Business Opportunities

- DoD SBIR Solicitation:
  Defense Technical Information Center
  ATTN: DTIC/SBIR
  Building 5, Cameron Station
  Alexandria, VA 22304-6415
  (800) 225-3842

- ARL SBIR Information:
  Dean Hudson
  (301) 394-4808
SMART MUNITIONS BATTERY REQUIREMENTS

MR. CLIFFORD D. SHOOK
CHIEF, MINES AND DISPENSER ELECTRONICS SECTION
ARMAMENT RESEARCH, AND DEVELOPMENT CENTER
TANK AUTOMOTIVE AND ARMAMENTS COMMAND

UNCLASSIFIED
SMART MUNITIONS BATTERY REQUIREMENTS

INTRODUCTION

SMART MUNITIONS ARE GUIDED TO A TARGET EITHER AUTONOMOUSLY OR WITH AN OPERATOR OR THEY SENSE A TARGET AND FIRE A WARHEAD.
SMART MUNITIONS BATTERY REQUIREMENTS

CONCERNS

• PRESENT RESERVE AND THERMAL BATTERY PRODUCERS ARE VERY LIMITED IN NUMBER.

• ONE PRODUCER HAS MOVED OFF-SHORE.
SMART MUNITIONS BATTERY
REQUIREMENTS

UNIQUE REQUIREMENTS

- WOODEN ROUND (NONREPLACEABLE / NONTESTABLE)
- STORAGE (UNPROTECTED) - 10 YEARS REQUIRED; 20 YEARS DESIRED
- SURVIVE CANNON LAUNCH: 20K G's SETBACK, UP TO 240 RPS.
- HIGH RELIABILITY
- WORLD WIDE USE
- MINIMUM VOLUME
- HIGH POWER DENSITY
SMART MUNITIONS BATTERY REQUIREMENTS

SADARM (SENSE AND DESTROY ARMOR)
SMART MUNITIONS BATTERY REQUIREMENTS

SADARM

• SENSE AND DESTROY ARMOR (SADARM)

• SADARM SUBMUNITIONS ARE DELIVERED TO AN AREA ABOVE THE TARGETS BY A VARIETY OF DELIVERY SYSTEMS. PRESENTLY, THESE DELIVERY SYSTEMS ARE THE 155 mm HOWITZER AND THE MULTIPLE LAUNCH ROCKET SYSTEM (MLRS).
SMART MUNITIONS BATTERY REQUIREMENTS
SADARM

• SADARM SUBMUNITIONS ARE DESIGNED TO AUTONOMOUSLY LOCATE AND DESTROY ENEMY STATIONARY ARMORED VEHICLES, PRINCIPALLY SELF PROPELLED HOWITZERS, FROM ALTITUDES OF 150 TO 300 METERS ABOVE THE TARGET AND AT RANGES OUT TO 30Km.

• SADARM SUBMUNITIONS ARE PRESENTLY IN THE FINAL STAGES OF ENGINEERING AND MANUFACTURING DEVELOPMENT.
SMART MUNITIONS BATTERY REQUIREMENTS

SADARM BATTERY

• THERMAL BATTERY (1.5 IN. D. X 1.25 IN. L)
• MINIMUM ACTIVE LIFE = 82 SECONDS
• VOLTAGE BETWEEN 7.5 VOLTS - 11.0 VOLTS
• CURRENT - 3.0 AMPERES FOR FIRST 47 SECONDS
  - 6.0 AMPERES FOR REMAINING 35 SECONDS
  (3 AMPERE SURGE FOR 40 MILLISECONDS AT TRANSITION POINT).
• POC- MIKE SCHIKSNIS- COM: 201 - 724 - 4552.
SMART MUNITIONS BATTERY REQUIREMENTS

SADARM CONTRACT OPPORTUNITY

- LOW RATE INITIAL PRODUCTION IS SCHEDULED TO BEGIN IN FY95.
- SYSTEM FUNDING: TBD
- SYSTEM CONTRACT TO BE AWARDED.
- POC: HOWARD BRUNVOLL, TELEPHONE: COM. 201-724-4044.
SMART MUNITIONS BATTERY REQUIREMENTS

STAFF

(SMART TARGET ACTIVATED FIRE & FORGET)
SMART MUNITIONS BATTERY REQUIREMENTS

STAFF

- SMART TARGET ACTIVATED FIRE & FORGET (STAFF)
- STAFF IS A 120mm TANK FIRED SMART ANTIARMOR PROJECTILE.
- STAFF USES A FORWARD LOOKING MILLIMETER WAVE (MMW) RADAR TO DETECT ARMORED GROUND VEHICLES OR HELICOPTERS. AFTER A TARGET IS DETECTED AND VALIDATED, DOWNWARD LOOKING RADAR IS USED TO ROLL THE LETHAL MECHANISM UNTIL IT IS POINTED AT THE TARGET. AS THE PROJECTILE PASSES OVER THE TARGET, AN EXPLOSIVELY FORMED PENETRATOR IS FIRED INTO THE TARGET.
- STAFF IS PRESENTLY IN ENGINEERING AND MANUFACTURING DEVELOPMENT.
SMART MUNITIONS BATTERY REQUIREMENTS

STAFF BATTERY

- TWO(2) THERMAL BATTERIES: A= 1.63 IN.D. X 2.85 IN.L.
  B= 1.44 IN.D. X 2.25 IN.L.

- MINIMUM ACTIVE LIFE = BATT. A = 15 SEC, INOPERABLE IN 30 MIN.
  BATT. B = 11 SEC, INOPERABLE IN 30 MIN.

- VOLTAGE: BATT. A = 60 - 100 VOLTS.
  BATT. B = DUAL OUTPUT OF 10-25 VOLTS & 15-36 VOLTS.

- CURRENT: BATT. A = 2.0 AMPS NOMINAL WITH SURGES TO 40 AMPS
  BATT. B = UP TO 5 AMPS.(10-25V) & UP TO 7 AMPS.(15-36V).

SMART MUNITIONS BATTERY REQUIREMENTS

STAFF CONTRACT OPPORTUNITY

- STAFF SCHEDULE : CLASSIFIED
- SYSTEM CONTRACT
- POC: DAVID PANHORST, TELEPHONE : 201-724-7258.
SMART Munitions Battery Requirements

WAM (Wide Area Mine)
SMART MUNITIONS BATTERY REQUIREMENTS

WAM

- WIDE AREA MINE (WAM)

- WAM IS HAND EMPLOYED ON THE GROUND AND AUTONOMOUSLY SEARCHES FOR THREAT VEHICLES USING ACOUSTIC AND SEISMIC SENSORS AT RANGES UP TO 100 METERS.
SMART MUNITIONS BATTERY REQUIREMENTS

WAM

- Once a target is located, a smart sublet equipped with a sophisticated infrared sensor is launched over the target. The top of the target is attacked with a highly lethal explosively formed penetrator.

- The WAM is deployed by a foot soldier.

- WAM is presently in engineering and manufacturing development.
SMART MUNITIONS BATTERY REQUIREMENTS

PRESENT WAM BATTERY

- LITHIUM THIONYL CHLORIDE RESERVE (3.95 IN. D. X 2.87 IN. L.)
- VOLTAGE: 8-15 VOLTS
- CAPACITY (400 ma DISCHARGE LOAD)
  13 AMPERE-HOURS @ 145 F
  14 AMPERE-HOURS @ 72 F
  11 AMPERE-HOURS @ -25 F
- DEPASSIVATION PULSE REQUIRED.
SMART MUNITIONS BATTERY REQUIREMENTS

NEAR TERM WAM BATTERY

- LITHIUM COBALT DIOXIDE RESERVE (3.95 IN.D. X 2.87 IN.L.)
- RECHARGEABLE (10 CYCLES TO 80% INITIAL CAPACITY)
- VOLTAGE: 10 VOLTS MINIMUM
- CAPACITY: (400 ma DISCHARGE LOAD)
  17 AMPERE-HOURS @ 145 F, 72 F, AND -25 F.
- DEPASSIVATION PULSE NOT REQUIRED.
SMART MUNITIONS BATTERY REQUIREMENTS

FUTURE WAM BATTERY

- UNKNOWN / TBD CHEMISTRY RESERVE (3.95 IN.D. X 2.87 IN.L.)
- RECHARGEABLE (10 CYCLES TO 95% INITIAL CAPACITY)
- VOLTAGE: 10 VOLTS MINIMUM
- CAPACITY (400 ma DISCHARGE LOAD)
  25 AMPERE-HOURS @ 145 F,
- DEPASSIVATION PULSE NOT REQUIRED.
SMART MUNITIONS BATTERY REQUIREMENTS

WAM CONTRACT OPPORTUNITY

- WAM SCHEDULED FOR LRIP IN FY96
  - SYSTEM CONTRACT

- NEAR TERM BATTERY DEVELOPMENT EFFORT WILL BE ACCOMPLISHED THROUGH A GOVERNMENT CONTRACT OR THROUGH THE SYSTEM CONTRACTOR.
  - CONTACT AWARD TENTATIVELY SCHEDULED FOR FY95.

- FUTURE WAM BATTERY DEVELOPMENT TBD.

SMART MUNITIONS BATTERY REQUIREMENTS

OTHER SMART MUNITIONS

- PRECISION GUIDED MORTAR MUNITION (PGMM)
  - DEMO PROGRAM USING GUIDED 81mm & 120mm MORTARS TO DEFEAT TARGETS.

- X - ROD
  - DEVELOP A 120 mm TANK FIRE & FORGET AUTONOMOUSLY GUIDED KINETIC ENERGY ROUND.

- AUTONOMOUS INTELLIGENT SUBMUNITION (AIS)
  - DEVELOP A TACTICAL SUBMUNITION WITH A WIDE SEARCH AREA AND CAPABLE OF MANEUVERING TO ATTACK TARGETS.

- ARMICIDE - AIR DEFENSE WEAPON
  - GUN LAUNCHED SMART MUNITION TO ATTACK ACTIVE RADARS.

- BATTLEFIELD IMAGING PROJECTILE SYSTEMS (BIPS)
  - CANNON LAUNCHED REAL TIME BATTLE ASSESSMENT SYSTEM.
SMART MUNITIONS BATTERY REQUIREMENTS

SUMMARY

- SMART MUNITIONS GIVE THE ARMED FORCES THE ABILITY TO MAKE SURGICAL STRIKES AGAINST STRATEGIC AND TACTICAL TARGETS.

- SMART MUNITIONS REQUIRE A BATTERY THAT IS CAPABLE OF BEING STORED UP TO 20 YEARS IN THE MUNITION AND THEN FUNCTION RELIABLY WHEN USED.

- THE NUMBER OF BATTERY MANUFACTURERS FOR SMART MUNITIONS NEEDS TO BE INCREASED TO PROVIDE A STABLE BASE.

- FUTURE SMART MUNITIONS WILL REQUIRE BATTERIES WITH HIGHER POWER DENSITIES.
CLOSING REMARKS

Mr. Kenneth M. Morgan
Director
Systems Management
CECOM
SUMMARY

- REDUCE O&S COSTS
- IMPROVE PERFORMANCE
- ENVIRONMENTALLY FRIENDLY
- ARMY-WIDE TEAMING
- ENHANCE THE ROLE OF INDUSTRY
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