ELA NASA BATTERY WORKSHOP PRESENTATION

November 18, 1993

Johnson Controls Battery Group, Incorporated

Douglas C. Pierce

Dr. William O. Gentry

Marshall Space and Flight Center

David Hall

1993 NASA Aerospace Battery Workshop -753- Advanced Technologies Session
JOHNSON CONTROLS, INCORPORATED

Johnson Controls, Inc
$6 Billion in Sales
FY 1993

- Automotive Systems Group
- Battery Group
  $670 Million
- Controls Group
- Plastics Technology Group
TRUE BIPOLAR BATTERY DEVELOPMENT
WPAFB CONTRACT

• GOALS:

Develop a Composite Bipolar Substrate Material with the Following Characteristics:

Resistivity: < 2Ω -cm
Thickness: < 0.064 cm
Weight: < 150 mg/cm
Area: > 400 cm²

The 270 Volt Battery will be Designed to be used in the More Electric Aircraft Program
TRUE BIPOLAR BATTERY DEVELOPMENT
WPAFB CONTRACT

- VALUE:

  Contract Total  1,013.4M
  Spending To Date  636.4M
  Funding For FY'94  377.0M

10% Cost Share to JCBGI
TRUE BIPOLAR BATTERY DEVELOPMENT
WPAFB CONTRACT

• APPROACHES:

Compound Stable Conductive Filler(s) into Plastic or Thermosets to Produce Non-Porous Highly Conductive, Lightweight Substrate Material

Use Compounding Additives Which Enhance Conductivity, and Manufacturability While Eliminating Porosity
TRUE BIPOLAR BATTERY DEVELOPMENT
WPAFB CONTRACT

- PROGRESS:

Conductive Filler Stability Proven
Conductive Filler Supplier Qualified
Composition of Substrate Identified
Project Substrate Thickness of 0.010-0.015"
Numerous Batteries Tested To Date
TRUE BIPOLAR BATTERY DEVELOPMENT
WPAFB CONTRACT

• NEXT STEPS:

  Improved Containment Design Trial

  Improve Present Manufacturing
  Techniques - Mass Production

  Produce Lighter, Thinner, More
  Conductive Substrate

  Test for SLI, EV Applications
## JCBGI LABBM
300 Volt Bipolar Battery System
ELA Program

<table>
<thead>
<tr>
<th>Battery Parameter</th>
<th>Design Specs</th>
<th>WPAFB Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substrate Thickness</td>
<td>0.015&quot;</td>
<td>0.025&quot;</td>
</tr>
<tr>
<td>Substrate Resistivity</td>
<td>2Ω -cm</td>
<td>2Ω -cm</td>
</tr>
<tr>
<td>Substrate Weight/Area</td>
<td>150 mg/cm²</td>
<td>150 mg/cm²</td>
</tr>
<tr>
<td>Substrate Area</td>
<td>1200 cm²</td>
<td>400 cm²</td>
</tr>
</tbody>
</table>
ELA Current Profile

30 amp Base Load, 200 amp Pulse for 0.2 Seconds

Current (amps)

Time (seconds)
<table>
<thead>
<tr>
<th>Battery System</th>
<th>1 Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery Size</td>
<td>15&quot; x 15&quot; x 9&quot;</td>
</tr>
<tr>
<td>Weight</td>
<td>228 pounds</td>
</tr>
<tr>
<td>Number of Cells</td>
<td>140</td>
</tr>
<tr>
<td>OCV</td>
<td>300 Volts</td>
</tr>
<tr>
<td>Cell Thickness</td>
<td>0.063&quot;</td>
</tr>
</tbody>
</table>
JCBGI Bipolar Battery Voltage/Power Profile
20 Amp Background, 310 Amp Spikes

Battery Voltage

Power (kW)

Time (Seconds)

Battery Voltage

Power (kW)
JCBGI Bipolar Lead/Acid
300 Volt Battery System 1
ELA Program

TOP VIEW

END BLOCKS

VENTS/PORTS

15.0"

SIDE VIEW

TERMINAL PAD

ENCASEMENT

END VIEW

9.0"

15.0"

15.0"
**JCBGI LABBM**  
300 Volt Bipolar Battery System  
ELA Program

**Battery System 2 Parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery Size</td>
<td>16.8&quot; x 16.8&quot; x 8.7&quot;</td>
</tr>
<tr>
<td>Weight</td>
<td>273 pounds</td>
</tr>
<tr>
<td>Number of Cells</td>
<td>140</td>
</tr>
<tr>
<td>OCV</td>
<td>300 Volts</td>
</tr>
<tr>
<td>Cell Thickness</td>
<td>0.061&quot;</td>
</tr>
</tbody>
</table>
JCBG1 Bipolar Battery Voltage/Power Profile
30 Amp Background, 400 Amp Spikes

Battery Voltage

Power (kW)

Time (Seconds)
JCBGI Bipolar Lead/Acid
300 Volt Battery System 2
ELA Program

END BLOCKS

VENTS/PORTS

END VIEW

TERMINAL PAD

ENCASEMENT

SIDE VIEW

1993 NASA Aerospace Battery Workshop

Advanced Technologies Session