Progress on ARRA-funded Facility & Capability Upgrades for the Battery Abuse/Safety Laboratory

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Sandia National Laboratories

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Overview

Timeline
- Project start
  15-Apr-2011
- Project end
  30-Sep-2012

Barriers & Risks
- Substantial building modifications
- Construction site "turned over to contractors"
- Limited testing activity
- Site returned to "owners"
- ES&H concerns
  - Safety
  - Industrial Hygiene
  - RCRA

Budget
- $4200K (100% ARRA)
- 100% Funded FY10

Partners
- CH2M Hill – Architect Engineers
  (Englewood, CO)
- Engineering Constructors Inc. – General Contractor (Albuquerque, NM)
- JB Henderson – Mechanical Contractor (Albuquerque, NM)
- Del Rio Enterprises – Electrical Contractor (Albuquerque, NM)
- Bridgers & Paxton Consulting Engineers (Albuquerque, NM)
Objectives/Relevance


Challenges and Barriers (pp 2.1-2 - 2.1-3), specifically:

Abuse Tolerance, Reliability and Ruggedness - Section D. (p2.1-3)

The BATLab Upgrades will increase capability by increasing:

- Power (>50KW)
- Voltage (>400V)
- Current (>600A)
- Test throughput
- Test data reliability
  - replace obsolete equipment & instruments
  - provide simultaneous test capability
  - implement current A/V & data capture standards
  - install platforms with standardized processing operations & data formats
  - Safety

For tested cells, modules and packs.
The ARRA-funded BATLab Upgrade Project will meet EERE-VT Multi-Year Program Plan Challenges & Barriers by:

✔ The acquisition of modern equipment & instrumentation

✔ Implementation of standard test protocols & data processing

✔ Upgrade the physical plant (BATLab) to provide:

 ▹ Available Power:
   - 480VAC 3Φ 60A (4X)
   - 208VAC 3Φ 60A (4X)
   - 208VAC 1Φ 30A (8X)
   - 110VAC 1Φ 20A (26X)--6 remotely switched

 ▹ HVAC:
   - Increase Air Evacuation Volume & Scrubbing Capacity
   - Increase Air Evacuation Service Points (8 ⇒ 14)
   - Increase Make-Up Air Capacity

 ▹ Equipment, Instrumentation, & Analysis Capability Increase
   - Replace Obsolete Units
   - Add Ability to Test Units Simultaneously
   - Increase Quality & Quantity of Data Acquired
   - ADC (voltage, temperature, stress/strain)
   - Audio/Video

 ▹ Safety Systems upgrade:
   - Fire suppression
   - Power distribution relocation
   - Intrinsically safe lighting
Accomplishments:
AARA Project/Task Update FY2011

One-Third of timeline completed
- Committed 60% of total funds
- Costed or committed 43% of Facility Upgrade funds
- Costed or committed 80% of Capital funds
- Costed or committed 50% of Capability Upgrade labor
- 55% Facilities upgrades complete

ARRA Projects as of 02/25/2011

<table>
<thead>
<tr>
<th>Project Code</th>
<th>TOTAL SPEND PLAN</th>
<th>FY 10 Costs</th>
<th>FY11 Costs YTD</th>
<th>FY11 Commits</th>
<th>Total FY 2010 Costs &amp; FY 2011 Costs + Commits</th>
<th>Total % Spent</th>
<th>Total Remaining Funds for FY2011 &amp; FY2012</th>
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<tbody>
<tr>
<td>148535 - ARRA Operating Project Labor</td>
<td>400,000</td>
<td>5,614</td>
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<td>179,681</td>
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<td>148634 - ARRA Capital Equipment</td>
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<td>1,014,967</td>
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<tr>
<td>148804 - ARRA Facilities Project</td>
<td>1,200,000</td>
<td>57,278</td>
<td>110,496</td>
<td>336,340</td>
<td>504,114</td>
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<td>Totals</td>
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<td>1,077,859</td>
<td>417,439</td>
<td>1,237,680</td>
<td>2,732,978</td>
<td>65.1%</td>
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### Technical Accomplishments:
#### ARRA Equipment Acquisitions

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit cost</th>
<th>quantity</th>
<th>total</th>
<th>ACTUAL COSTS Loaded</th>
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<tbody>
<tr>
<td><strong>Electrical Test and Abuse Equipment</strong></td>
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<tr>
<td>Bitrode 48W/20A (8 ch)</td>
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<td>Calor Level Meater (Malvern - 12 cm)</td>
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<td><strong>Gas Analysis Equipment</strong></td>
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<td>FTIR</td>
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<td>MS</td>
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<td><strong>Thermal Analysis Equipment</strong></td>
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<td>Thermal Chamber</td>
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<td>Thermal Test Enclosure</td>
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<td>Mechanical Abuse Equipment</td>
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<td>Hydraulic Systerm Controller (Crucl)</td>
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<td><strong>Data Acquisition</strong></td>
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<td>Data Acquisition System</td>
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<td>Data Processing/Display</td>
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<td>Calorimetry, Thermal Characterization</td>
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<td>Laser-based in-situ diagnostic system</td>
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<td>ESRARC</td>
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<td>Sotaram C80 Calorimeter</td>
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<td>Steve Box</td>
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<tr>
<td><strong>Equipment Total</strong></td>
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<tr>
<td>Load</td>
<td>3.9%</td>
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<td>$2,274,000</td>
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<tr>
<td>Total</td>
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<td>Software development</td>
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<td>Staff Support (50:50 Laser diag./2546)</td>
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<td>Facilities</td>
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<td>$1,200,000</td>
<td>$1,200,000</td>
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</tbody>
</table>

- **Costed**
- **Committed (POs Issued--not delivered)**
Accomplishments:
Budget Status

Overall

Capital

Capital Labor
Battery Abuse/Safety Laboratory (BATLab) Before the Upgrade . . .
Accomplishments: Battery Abuse/Safety Laboratory (BATLab) During the Upgrade . . .
Technical Accomplishments:
Equipment: Bitrode Battery Tester

(A Missouri Company)

- 600 VDC
- 30A
- 4 channels
- Modules
- Over-charge
- Over-discharge
- Cycle testing
- Full Packs
- Over-charge
- Over-discharge
- Cycle testing
Technical Accomplishments:
Equipment: Wrightline Work Stations

- Flexible:
  - 61” to 84” high
  - 20” to 42” shelf depth
  - 24” - 72” shelf width

- 1500 lb. load limit
- Shelf adjustment in 1” increments
- Sturdy casters ... easily moved
- On-board power distribution
- Cable control
Technical Accomplishments:
Equipment: Maccor Battery Tester 4200

- 16 channels
- Remote cell sensors
- 5V, 10A
- Formation cycling
- Test cycling
- Complex load profiles
- Control:
  - State of Charge (SOC)
  - Charge/Discharge voltage
  - Charge/Discharge current
  - Charge/Discharge capacity

An Oklahoma Company
Technical Accomplishments:
Equipment: Computed Tomography Xray

North Star Imaging
(A Minnesota Company)

- 0.005mm resolution
- No. 6 size cell capability
- 2D image: real time
- 3D image: 2-3h
- Full visualization:
  - Rotation (3D)
  - Zoom
  - Contrast enhancement
  - ID “Z” number range
Technical Accomplishments:
Equipment: Electrochemical Instrumentation

±100V
±2A
0.1 pA Resolution
EIS:
• 1MHz - 1μHz
• ±100V
• ±2A
• 0.1pΩ Resolution

Subsidiary of Ametek (A Pennsylvania Company)
Technical Accomplishments:
Equipment: Real-Time Microcalorimetry

International Battery Calorimeters
(An Arizona Company)

- Measures heat input/output while charging or discharging cells
- Resolution: $10^{-6}$ calories
- Coin-Cells up to 2032
- Cylindrical cells up to 18650
- Other cell holders available
Equipment: ES- & EV- Accelerating Rate Calorimeters (ARCs)

- Thermal sensitivity
- Thermal runaway onset determination
- Total Enthalpy output
- Quantitative gas evolution
- Coupled with Sample Prep Glovebox:
  - Component contributions
  - Component interactions
  - Mechanism elucidation
Technical Accomplishments:
Equipment: Glovebox

(A California Company)

- Disassembly of fully charged Li-ion cells
- Partitioning of cell components
- Resealing cell components
- Assess cell component contributions (w/ARC)
Technical Accomplishments:
Equipment: Test Control & Data Acquisition/Management System

(A Michigan Company)
Accomplishments:
BATLab Layout . . . After the upgrade
Collaborations/Partnerships

- CH2M Hill - Architect Engineers (Englewood, CO)
- Engineering Constructors - General Contractor (Albuquerque, NM)
- JB Henderson - Mechanical Contractor (Albuquerque, NM)
- Del Rio Enterprises - Electrical Contractor (Albuquerque, NM)
- Bridgers & Paxton Consulting Engineers (Albuquerque, NM)
Future Work

- Complete facilities upgrade
  1 July 2011
- Install & check-out new equipment on hand
  31 July 2011
- Resume unrestricted testing activities
  31 August 2011
- Complete Capital Equipment Acquisition
  30 September 2011
- Initiate upgraded testing productivity
  30 November 2011
Summary

At 33% of the project timeline:

✓ 44% of Capital Labor costed + 45% committed
✓ 44% Capital Equipment costed + 35% committed
✓ 14% Facilities Project costed + 28% committed
✓ 35% Overall Project costed + 30% committed
✓ Limited testing continuing through project upgrades