Advanced Li-Ion Polymer Battery Cell Manufacturing Plant in USA

RANDY (JAUP) KOO

LG Chem
Michigan Inc.

May 16, 2012

Project ID : ARRAVT001

This presentation does not contain any proprietary, confidential, or otherwise restricted information
OVERVIEW

TIMELINE

- Start date: 09/01/2009
- End date: 05/31/2013
- Percent Complete: 85%

BARRIERS

- Investment Cost Increase
- Adaptation and application of new technology into a new facility

BUDGET

- Total Project Funding:
  - DOE Share: $151,387,000
  - LG Chem Share: $155,140,000
- Funding Received by 2012.1Q: 123.8M
- Funding for FY2012 Project: 27.5M

PARTNERS

- DOE/NETL
- LG Chem Ltd.
- Architect & Engineering Firm
- Design Builder
- State of Michigan
- City of Holland, MI
- Various suppliers in near Holland

This presentation does not contain any proprietary, confidential, or otherwise restricted information
**PROJECT OBJECTIVE**

: LI-ION BATTERY CELL MANUFACTURING FACILITY

To design, construct, start-up and validate a production facility for Li-Ion Polymer Batteries in Holland, Michigan, USA.

- After starting assembly operations in 2012, the various efforts will be continued through 2013 to stabilize production and to provide quality products to customers. A high volume electrode manufacturing line will also be installed.
- When it reaches full-scale operation in 2013, more than 250 direct employees (Operators, Engineers, Management & Administration staff) will be working at the facility.

### Number of Employee by Year

<table>
<thead>
<tr>
<th>Year</th>
<th>Actual</th>
<th>Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>195</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>350</td>
<td></td>
</tr>
</tbody>
</table>
**MILESTONES I.**

On schedule and no issues.

### Schedule

<table>
<thead>
<tr>
<th>Classification</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phase I (Assembly)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building</td>
<td>6</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment</td>
<td>11</td>
<td>Q2</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Phase II (Electrode)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building</td>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment</td>
<td>6</td>
<td>Q2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Updates

**Phase I : Complete**
- Completed all construction work in 2011
- Completed production equipment installation
- Under process / product verification

**Phase II (Electrode Line) : On-track**
- Construction progress: 100%
- Under equipment installation
MILESTONE II.

2010

08/2009  DOE Grant Award
05/2010  Completion of General Contractor Selection
07/2010  Groundbreaking Ceremony

2011

02/2011  Completion of Enclosure
06/2011  Completion of Equipment Delivery
09/2011  Completion of Equipment Set-up
10/2011  Start to Production Process Verification

2012

01/2012  Achieved the ISO/TS 16949 LOC
03/2012  Under Product and Process Verification

This presentation does not contain any proprietary, confidential, or otherwise restricted information
INTRODUCTION OF UNIQUE TECHNOLOGY

LG CMI introduced the following two unique technologies from Korea to USA.

**SRS™**
- Breakthrough technology to prevent safety issues in the Li-ion battery
- Mechanically, thermally improved separator

![Cross Section of SRS™](image)

- Nano scale Ceramic Particles
- Micro porous Polyolefin film

**Stack & Folding**
- Stack the cut electrodes (bi-cell), then fold the bi-cells with SRS™ to make cells
- Safety, Performance excellence

![Diagram of SRS™](image)

- LG Chem
- Bi-cell
- Folded cell
- Competitors
- <Stacking Type>
- <Winding(Folding) Type>

This presentation does not contain any proprietary, confidential, or otherwise restricted information
MANUFACTURING FACILITY

With the cooperation of various USA partners, the building and its utilities were efficiently constructed and installed to support cell manufacturing technologies.

Regenerative Thermal Oxidizer

Dry and Clean Room

Bird Eye View of LG Chem

Road Expansion by City of Holland

Acetone Tank and Nitrogen Tank

This presentation does not contain any proprietary, confidential, or otherwise restricted information
VERIFIED EQUIPMENT

The verified quality equipment that has been used in Ochang, Korea was duplicated and set-up in Holland, USA.

LG Chem (Ochang, Korea) = LGCMI (Holland, MI, USA)

- **SRS**
  - Mixing Equipment
  - Coating Equipment
- **Assembly**
  - Notching Equipment
  - Lamination Equipment
  - Folding Equipment
  - Packaging Equipment
- **Formation**
  - Charging/Discharging Equipment
  - Aging Equipment
- **QA**
  - Inspection Equipment
  - Test Equipment
- **Electrode**
  - Mixing Equipment
  - Coating Equipment

This presentation does not contain any proprietary, confidential, or otherwise restricted information
REPLICATION OF PRODUCTION PROCESS

Adopted and replicated the most cutting edge Li-ion cell manufacturing process into USA.

LG Chem’s Cell Manufacturing Process

Electrode

Mixing

Roll Press

Slitting

Notching

Vacuum Dry

Formation

Assembly

Dry Room

Package

Electrolyte

Sealing

AL Forming

Folding

Lamination

Anode

Cathode

This presentation does not contain any proprietary, confidential, or otherwise restricted information
SUCCESSFUL HIRING AND TRAINING

Hire Best People
Differentiated and Systematic Training
Core Member Centered Teamwork Building
Stabilization of Operation for MP

2011 Q2
2011 Q3
2011 Q4
2012 Q1

Training Phase
Ramp-up Phase
Process Verification & Skill Level Up

Engineers
- Training in Korea (for 10~12 weeks)
- Training on supplier site
- Equipment set-up
- Prepare for operation
  - Training
  - Daily Report
- Production Validation & operator training
- Preparation for production and indirect preparation
- Implement plan by sections

Senior Operator
- Training in Korea

Operator
- 3 times of Job Fairs (April ~ June)
- GRCC Training
- Basic On-the-Job Training
- Concentrated and in-depth hands-on Training

This presentation does not contain any proprietary, confidential, or otherwise restricted information
STANDARDIZED ISO/TS 16949 SYSTEM


[Image of the Letter of Conformance from Det Norske Veritas]
INTENSIVE PROCESS VERIFICATION

Intensive process and product verification tests are on-going. (Process capability, dimensions, performance, reliability and safety, etc) 

Identically similar results between Korea and USA produced cells

**Ochang Line 3**

<table>
<thead>
<tr>
<th>Capacity</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>15.86</td>
</tr>
<tr>
<td>Maximum</td>
<td>15.94</td>
</tr>
<tr>
<td>Minimum</td>
<td>15.79</td>
</tr>
<tr>
<td>N</td>
<td>60</td>
</tr>
<tr>
<td>CpK</td>
<td>3.39</td>
</tr>
</tbody>
</table>

**Holland Line 3**

<table>
<thead>
<tr>
<th>Capacity</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>15.87</td>
</tr>
<tr>
<td>Maximum</td>
<td>15.92</td>
</tr>
<tr>
<td>Minimum</td>
<td>15.73</td>
</tr>
<tr>
<td>N</td>
<td>60</td>
</tr>
<tr>
<td>CpK</td>
<td>4.82</td>
</tr>
</tbody>
</table>

This presentation does not contain any proprietary, confidential, or otherwise restricted information
COLLABORATIONS & PARTNERSHIPS

Due to the great collaboration and enormous support from various public and private sectors, LGCMI could achieve the current status.

- **DOE/NETL**
  - Clear guidelines for the DOE billing and reporting requirements
  - Quick responses to specific inquiries

- **State of Michigan**
  - Financial incentives (=tax credit) to LG Chem Michigan Inc.
  - Coordination with state agencies (e.g., environmental permits)

- **City of Holland**
  - Support and assistance in various areas (e.g., road expansion, site preparation)
  - Renaissance zone designation in coordination with the State of Michigan

- **Private Sector Partnership**
  - Timely cooperation and excellent support in the various stages of the project
  - Anchor company of Michigan’s SmartCoast Advanced Energy Storage cluster
LG Chem/LGCMi successfully completed project phase I.

- Construction of building and facility were completed.
  - No safety issues and no big troubles.

- Completed the installation of cell manufacturing equipment.
  - Verified equipment used in Ochang, Korea was installed and set-up.

- Successfully replicated the cutting edge manufacturing technologies.
  - Same advanced technologies for Li-ion cell manufacturing process were introduced to USA.

- Process and product verification are under testing.
  - Verification test results have been the same between Ochang, Korea and Holland, USA.

- ISO/TS 16949 system was implemented.
  - Received ISO/TS Letter of Conformance on Jan. 31, 2012
Hired and trained full time employees (195 as of 2011)
- Trained them with differentiated and systematic training program.
⇒ Intensive and repeated practice are being performed to achieve a similar skill level with Korea.

Project phase II step (Electrode) is on-track

Construction of facility for electrode
- Complete

Delivery and installation of electrode manufacturing equipment
- On-going
FUTURE WORKS

To successfully complete the project, LGCMI’s future work shall include:

**Completion of Electrode Process Set-up**
- Successful adoption of most high-end technology for electrode production process
- Need to install and verify electrode equipment
- Continue to hire and train new employees for the electrode process

**Customer Approval for Assembly Line**
- Will receive official customer approval for the newly set-up assembly production line for mass production.
- PPAP and QSB : On-going

**Start of mass production and stabilization of production**
- Raise employee skill levels
- Continue to produce best quality products for our customers

We, as LGCMI, produce the Li-ion cells that will power the electric vehicles of the United States of America.

<LGChem Employees, Feb 2012>