# Manufacture of Advanced Battery Metal Containers & Components HTTM LLC



<u>Program Coordinator</u> Jeff Lauinger – HTTM LLC



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Project ID: ARRAVT013

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## **Project Overview**

## Timeline:

- Start date: May 1, 2010
- End Date: April 30, 2015
- Project is on time and proceeding as planned

Barriers:

- Materials/processing feasibility
- Rapidly evolving cell technology
- Customer product changes
- Customer/market uncertainty

## Budget

- Total project funding: \$10.2M
- DOF share: 49%
- HTTM share: 51%
- Budget used to date\*: 88%

## Partners:

- **H&T Battery Components**
- Trans-Matic Manufacturing Co.
- **H&T Produktions Technologie**
- Karotech Inc.

\*as of March 15, 2013



## Relevance

## Objectives:

- Produce metal containers and components (such as cover assemblies) for use in advanced (li-ion, NAS, ...) battery cells.
  - ➤ Develop a skilled technical workforce
  - ➤ Add manufacturing equipment and processing capability

## Impact:

- HTTM is currently in production on five new battery container programs with two new customers (US & Europe).
  - ➤ Staffing has included addition of 9 new FT employees + 19 FTE. Hiring is on plan.
  - ➤ Purchased over \$8 mil. in new equipment. Capital procurement is on plan.
- HTTM is developing three new prismatic container programs with these customers.



## Relevance

 HTTM is currently the only US manufacturer of large format, metal battery containers and cover assemblies











# Past Success + New Capabilities = New Business Opportunities

#### Business Approach:

- Form a JV from Heitkamp & Thumann and Transmatic.
  - ➤ Apply 100 years of deep draw experience into development and manufacture of advanced battery containers.
- Leverage existing facilities and assets from both parents. Use ARRA grant funding only on new equipment and technology.
- Leverage existing business relationships with OEM's to successfully penetrate their advanced battery divisions.
- Implement a Business model which calls for producing advanced battery containers, not just li-ion deep drawn cans.
- Demonstrate to customers that metal containers are the preferred construction to ensure safety and durability.
- Utilize flexible equipment and processes. Must accommodate both cylindrical and prismatic metal containers.



## Innovation, Development, Prototyping, Design and Process Validation

#### Product Development Approach:

- Establish JDA's with customers to ensure efficient transfer of manufacturing "know how" into state of the art designs.
  - ➤ Drives "design for manufacturability"
- Advanced battery container concepts are developed in the Advanced Product Development (APD) group
- Sophisticated forming simulation software is run to determine manufacturing feasibility and tooling attributes.
- Rapid prototyping techniques are used to make affordable mockups for design validations.
- In-house prototype and production tool build capabilities ensures customer designs and HTTM techniques are kept confidential.
  - ➤ High level of vertical integration



# Project Phases for each Customer Program

Phase 1



Phase 2



Phase 3



Phase 4



Phase 5

- Establish relationships with leading Battery OEM's. Engage with NDA's, technical meetings, mockups, etc.
- Co-develop the battery container components. Build prototype tooling and produce parts for design and process validation. Secure production purchase order.
- Design and build production component tooling. Build or modify production facilities as required. Hire and train staff.
- Gain customer approval of production product. Ship production orders and ramp-up manufacturing output.
- Add manufacturing capacity as sales volume increases.
   Drive continuous improvement to improve the product quality and reduce cost.



## **Project Accomplishments**

#### Advanced Battery Component Development and Manufacturing

HTTM has successfully entered the advanced battery container market and is in the following Project Phases with several OEM Advanced Battery manufacturers:

Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
5 OEM's	2 OEM's	0 OEM's	1 OEM	1 OEM

HTTM is developing advanced battery containers, cans and covers/assemblies and is becoming an established "go-to" company for battery container systems.

The ARRA Grant project <u>completion level is 41%</u>. It is on schedule and on <u>budget</u>. Project work to date reflects HTTM's success with customers, including our ability to commercialize newly developed products.

For the projects in Phase 4 and 5, production tooling and equipment are in place and manufacturing has begun. Production shipments are being made to the domestic and global locations of US based OEM's

Job creation has occurred and continues. Personnel have been hired and trained during the development and launch phase of these customer projects.



#### Launch / Manufacturing

- Successful commercialization of metal battery cans and cover assemblies in the US.
  - > Launched five new products with two new customers.
  - ➤ Launched new processes including: swaging, laser welding, helium leak testing, in house aqueous cleaning
  - > New equipment:
    - Manual cover assembly & test cell
    - Automated cover assembly & test cell
    - Aqueous can wash system



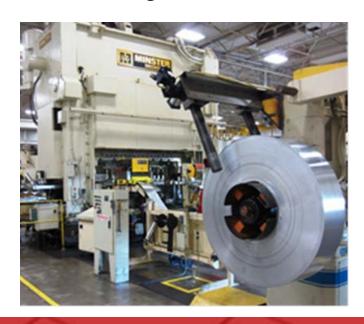




#### **Development / Tooling**

- Development Accomplishments:
  - ➤ Hermetically sealable battery container (with safety vent) and cover assembly that can be automatically assembled by OEM customers.
  - ➤ In-house tool design and manufacturing process for consistently stamping an integral safety vent feature in the can or cover.
    - The tooling/process can be adjusted to achieve specific burst pressure mean values within a controlled range.







#### **Testing and Validation**

- Testing Accomplishments:
  - ➤ Designed and built a high precision digital probe for measuring the thickness of the critical pressure burst disc.
  - ➤ Designed and built a safety vent burst tester that enables ongoing production validation and lot verification testing.







New Manufacturing Techniques – Servo Press

- New design features in Advanced Battery Cell containers:
  - Complex burst disc configurations
  - ➤ Tight corner radii/tolerance control and larger container sizes improve energy capacity for large format cells
- .....make it necessary to invest in new Production Equipment
  - > Full servo capability in a deep draw stamping press
  - > Press is 100% complete and has started production





#### **Project Milestones**

Milestone	Planned Start Date	Planned Completion Date	Status and Comments
DOE Kickoff	6/2/2010	6/2/2010	Completed
Customer Award of Business	4/1/2010	11/1/2010	Completed
Initial Equipment Installed & Validated	10/20/2010	6/1/2011	Completed
SOP on 1st Cylindrical Program	7/1/2010	4/15/2011	Completed
SOP on 2nd Cylindrical Program	8/1/2010	9/15/2011	Completed
Delivery of Servo Press	6/1/2011	8/1/2012	Completed
Prototype Development of New Prismatics	9/1/2011	6/1/2012	Completed
SOP on 1st Prismatic Program	6/1/2011	4/15/2013	In Progress
SOP on 2nd Prismatic Program	6/15/2011	5/1/2013	In Progress
SOP on 3rd Prismatic Program	2/15/2013	9/30/2013	In Progress

HTTM has successfully entered the advanced battery container market and is in the Production phase of several customer projects.



## **Collaborations / Partnerships**

HTTM Joint Venture Parents

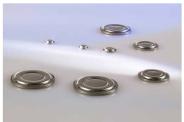


**H&T** Battery Components

http://www.ht-group.com/divisions/ht-battery-components

- Worlds largest producer of consumer battery containers.
- Production from four facilities (US, Germany, China and Singapore) exceeds 8 billion units per year



























http://transmatic.com/

- Global leader in the development and production of precision engineered deep drawn stampings for automotive and other industries.
- Production from three facilities (US and China).

















































## **Collaborations / Partnerships**

#### **HTTM Technical Partners**



http://www.karotechinc.com/

- Experts in deep draw stamping for battery applications.
- Component Development
  - Vent / Burst Disc
  - Current Interrupt Device (CID)
- Short run processing
  - Laser Welding



http://www.ht-pt.com/

- Products include:
  - Conventional Presses
  - Servo Controlled Presses
  - Transfer Systems
  - > Tooling



## **Future Work**

#### 2013 and beyond...

- Aggressively Market New Capabilities to New Customers
  - Pursuing additional business with Asian Battery Manufacturers
- Launch of 3 new prismatic programs in 2013
  - > 3 different customers; one new to HTTM
  - Products service both the Automotive and Stationary Power Markets
- Continue development of new Products:
  - Energy and Power Cell Prismatic Containers and Cover Assemblies for all markets & applications
- Continue development of a new Manufacturing Process:
  - New, proprietary material joining technology
  - Applications: Terminal assembly, cover-to-can seal
    - ✓ Faster than laser weld, electron beam, ...



## **Summary**

### A Successful Project:

Product



HTTM has developed technically / commercially viable metal container products for the global advanced battery market.

Customer Orders



HTTM has secured production orders with OEM Battery companies and launched high volume production manufacturing.

Funding



The DOE ARRA Grant funds have been utilized for equipment, personnel and other product development and equipment costs.

On Schedule



The Project is on schedule and on budget.

**Equipment** 



Most production equipment is on-site with process validation complete.

Staffing



Personnel have been hired as planned. As the launch progresses, staff will be added according to production ramp-up schedules.





Grev: Non-U.S. manufacturing

Ube Industries (Japan)

## **HTTM Value Chain Position**

## HTTM is an integral link in the Advanced Battery Value Chain

#### Cell components and electronics Integrated systems Vehicles Key materials Other cell Li-lon battery Relevant to Cathode Anode Relevant cell/pack players cathode components automotive Active material Active material **OEMs** 3M Altair Nanotechnologies Lithium compounds Package A123 Systems · ConocoPhillips Aptera Chemetall FMC Lithium A123 Systems BASF Catalysts - Hitachi Chemical (Japan) Steel or · Beijing New AC Propulsion Dow Kokam - Kansal Gas Kagaku (Japan) SQM (Chile) aluminum can Energy All Cell Technologies + L&F (Korea) Automotive - Kureha (Japan) HTTM · Boston Power Nichia Chemical (Japan) Nippon Carbon (Japan) Company Co compounds BYD (China) · Nihon Chemical (Japan) Laminate film · Better Place - Osaka Gas Chemical - Tanaka Chemical Coda Phostech (Canada) (Japan) \* BMW (Japan) - Kansal Catalyst Compact power - Seimi Chemical (Japan) Pyrotek BYD (China) Lead (LG Chem) - Tanaka Chemical (Japan) · Superior Graphite · Chrysler (Fiat) (Japan) Continental Automotive Toda (Japan) · Daimler Insulator -Santoku (Japan) Cu Foil Dow Kokam · Tronox · Fisker NGK (Japan) Furukawa Electric (Japan) Electrovava (Canada) Umicore (Belgium) · Ford Mn compounds Oak-Mitsui EnerDel (Ener1) · Fuji Heavy · Mitsui mining & Safety vent GM GM smelting (Japan) Al Foil G5 Yuasa (Japan) + Honda · Gelon China Arkema Gasket · Hitachi (Japan) Ni compounds + Hyndai - LG Chem (Korea) Johnson Controls Kansai Catalyst + Mitsubishi Zeon (Japan) PTC Polymer binder (PVDF) JCS (Japan) - Sumitomo metal Motor Arkema · Lishen (China) Navistar Carbon electric conductor Center pin LG Chem (Korea) LithChem mining (Japan) Nissan Same firms as cathode Lithium Technology + 5AIC electric conductor Tab Carbon electric conductor Maxpower . Tata Motors Relevant to Energetics Maxwell (japan) Tesla Motors Kanto Denka (Japan) NEC (Japan) anode \* Think Electronic components · Panasonic (Japan) - Nippon Denko (Japan) + Toyota Electronics Purified natural SouthWest Quantum Technologies + VOIVO - Continental(Germany) graphite NanoTechnologies Saft America + VW iCeL Systems Mechanical Sanyo (Japan) Graphitized components Intersil Samsung (Korea) Separator - Magna (Canada) Storage Battery Systems precursor Additional Future Fuel Maxim Integrated Tesla Motors Electrical relevant · Applied materials Products Chemical components Asahi Kasei (Japan) - NEC (Japan) **OEMs** Valence Technology Celgard (Polypore) - Rohm (Japan) Yardney Relevant to DuPont Azure Sanyo (Japan) ENTEK Membranes Dynamics electrolyte Texas Instruments BAE (UK) Evonik Industries Organic solution Bosch (Germany) SK Energy (Korea) U.S. venture capital startups (Germany) DMC/MC /EC/MEC U.S. material recycling . Toray Tonen (Japan) Continental Novolyte ActaCell K2 Energy Solutions Leyden Energy (Germany) TOXCO Technologies. Amprius Eaton Li-Salt (LiPF6) Planar Energy \* Magna Atieva Electrolyte Honeywell · Porous Power U.S. testing motors Contour Energy (Canada) Kanto Denka . Cheil Industries (Korea) Technologies Systems Wanklang and batteries (Japan) · LithChem Dow Kokam · Prieto Battery (China) - Morita (Japan) · Mitsubishi Chemical (Japan) Quallion EnerG2 Argonne Nat'l Lab, Sandia Novolyte · Mitsui Chemical (Japan) · Sakti3 Envia Systems Nat'l Lab, Advanced Vehicle Technologies Seeo Novolyte Technologies · Farasis Energy Research Center Tec-cel · Panex (Korea) Flux Power . Shan Shan (China) Polymer precursor · Shinestar (China) U.S. R&D institutions for polymer battery - Tomiyama Yakuhin (Japan) Argonne Nat'l Lab, Case Western Reserve U., Idaho Nat'l Lab, Lawrence Berkeley Lab, MIT, NC state U., TSC Michigan Northwestern U., NREL, Oak Ridge Nat'l Lab, Sandia Nat'l Lab, Stony Brook U., UC Berkeley, U. of Colorado Boulder, U. of II. at Urbana-Champaign, Univ. of Pittsburgh, U. of RI, U. of UT, U.S. Army Research Lab, U. of TX Black: U.S. manufacturing (TechnoSemichem, Korea)





## **Contact Information**

#### **Jeff Lauinger**

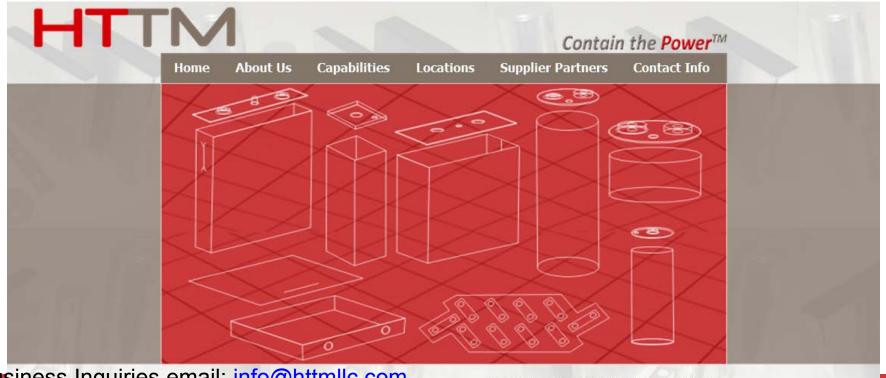
HTTM General Manager jeff.lauinger@httmllc.com 616.820.2462



Corporate Headquarters 300 East 48th Street Holland, MI 49423 616.820.2500

#### Ron Dalessandro

**HTTM Business Development** ron.dalessandro@httmllc.com 616.820.2404



Business Inquiries email: info@httmllc.com

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