Construction, Qualification, and Low Rate Production Start-up of a DC Bus Capacitor High Volume Manufacturing Facility with Capacity to Support 100,000 Electric Drive Vehicles

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ARRAVT029

Overview

Timeline

- **Start date:** Dec 23, 2009
- **End date:** Dec 22, 2012
- **Percent complete:** 10%

Budget

- **Total project funding:** $18,186,367
- **DoE share:** 50%
- **Funding received in FY09:** $0
- **Expected funds expended in FY10:** $8,550,000

Barriers

- **Barriers addressed:**
  - Speed to full capacity
  - Scalability with market
  - Cost competitiveness
  - Automotive qualified

Partners

- **Interactions/collaborations:**
  - EF Wall and Associates, Inc. (EF Wall)
  - Active Precision, Inc. (API)
  - Oak Ridge National Labs (ORNL)
  - Steiner Films
  - Azure Dynamics
- **Project lead:** Ed Sawyer
  - Deputy Project Manager: Tom McBride

Project Objective

- The objective of this project is to construct and qualify a state of the art DC Bus Capacitor manufacturing facility which is capable of supplying enough capacitor products to support the manufacture of 100,000 Electric Drive Vehicles (EDVs) per year by 2012.
  - As part of this objective we will design and qualify custom manufacturing equipment and attain industry standard TS16949 certification.

2009-2010 Milestones

Month/Year	Milestone
Local Building Permit Approval	November 2009
Building & Plant Layout Design	March 2010
Winder Design	April 2010
FONSI – NEPA	April 2010
Building Construction Start	April 2010
All Equipment Designed	September 2010
Plant Move – In Ready	November 2010
First Line Set – Up	January 2011
First Line “Production Rate”	April 2011
TS-16949 Approval	June 2011

Approach/Strategy

- Permit, Design, and Build Plant with 100,000 Vehicle Capacity
  - Qualification of material and equipment
  - Production process and training development
  - Freeze design rules and procedures
  - Secure site and building certification
  - Construction of new facility
  - Hiring new plant workforce
  - Line Setup
  - Move
  - Ramp up to capacity

Approach/Strategy

- Obtain Necessary Industry and Key Customer Approvals
  - Achieve TS16949 Certification
  - Design and product qualification dialogues and necessary associated activities
  - Develop Customer Test requirements and Quality Plans
  - Employ dedicated sales individual with automotive OEM experience to introduce customers to the Power Ring
  - Support the sales team with highly skilled and experienced electrical and mechanical engineers to develop application specific solutions based on customer needs
  - Demonstrate capacity ramp up plans

Approach/Strategy (cont.)

- Achieve Cost Goals that Compete Favorably with Off-shore Competitors but with Greatly Improved Performance
  - Source non-IP sensitive raw materials from Asia to reduce cost
  - Source non-process critical equipment from Asia to reduce cost
  - Open dialogues with materials and equipment vendors to assure specification compliance
  - Retain IP and skill sensitive manufacturing processes in US to oversee quality and limit proprietary information exposure
  - Employ Lean manufacturing, ISO and TS16949 standards to ensure low cost, high quality, consistency, and reliability.
  - Attain appropriate capable ERP system

Approach/Strategy (cont.)

- Provide Quality Data and Product Validation to DoE
  - Open dialogues with materials and equipment vendors to assure specification compliance
  - Conduct ongoing electrical, mechanical, and life testing to assure product specification compliance
  - Work in conjunction with ORNL to define ESR, materials spec verification, and life testing methodologies for inclusion in DOE validation reports
  - Incorporate (yet to be defined) ORNL ESR testing methods into production flow for increased finished goods' reliability and performance consistency
  - Implement item serial numbering and bar-coding to insure traceability

Technical Accomplishments Overview

- Permitting and design
- Material, equipment and product qualifications
- Customer Qualifications

Technical Accomplishments (cont.)

- Site Permitting Construction
  - Preliminary site plan and civil engineering designs complete – Late August 2009
  - Permit ready for construction; all state and local land use, zoning, and subdivision permits approve – Mid November 2009
  - 10 Acre plot of land purchased – Early March 2010
  - Federal Environmental Assessment (EA) clears public review – March 24, 2010
  - Finding-Of-No-Significant-Impact (FONSI) issued – March 30, 2010
  - Municipal road and utility extension begins – March 31, 2010
  - Site preparation begins – April 5, 2010
  - Formal groundbreaking ceremony – April 17, 2010

Technical Accomplishments (cont.)

- Building Design
  - Preliminary civil and electrical engineering designs complete – Late August 2009
  - Building specifications finalized – Late February 2010
  - Ongoing energy efficiency design upgrade qualification – March 2010
  - Phone and internet service provider finalized and contract signed – March 2010
  - Office design and layout complete and finalized – Early April 2010
  - Office furniture contract signed – Early April 2010
  - Plant floor layout and process flow finalized – Early April 2010
  - Weekly building specification and construction update meetings with contractor – Early April 2010

Technical Accomplishments (cont.)

- Material, Equipment, and Product Qualification Activities
  - New industry standard test equipment acquired to aid in product and material qualification
  - All necessary equipment vendors have been chosen
  - Custom co-engineered winder development contract signed with Active Precision, Inc.
  - Specifications for winder qualification have been finalized
  - Class 10,000 clean room installed for initial testing and winding consistency
  - Product architecture being finalized with new production methods

Technical Accomplishments (cont.)

- Customer Qualification Activities
  - Design win for Automotive OEM EV inverter application
  - Design win for commercial truck electrification and auxiliary power application
  - Engaged with Automotive/Transportation OEM EV and HEV for capacitor use for inverter applications
    - 4 OEMs: Currently have their systems being tested by their customer; with the Power Ring designed in
    - 7 OEMs: Currently testing the Power Ring
    - 12 OEMs: SBE having program-specific technical dialogues
    - 17 OEMs: SBE having dialogues

Collaborations

- EF Wall – Construction contract signed and initial site prep begun. Ongoing weekly materials and specifications meetings to ensure parity of information and progress
- API – Contract for continued design and delivery schedule signed for total of 9 custom winding machines. Proprietary winding technology is pivotal to Power Ring success
- ORNL – Federal lab contracted to provide supplemental engineering resources for the development of ESR test methodology, material validation, and life testing
- Steiner – Co-developing film processing technologies for improved reliability
- Azure – Hybrid/electric technology leader will be building a commercial vehicle sized inverter (75 – 100kw) for the purpose of exercising the Power Ring in drive profile environments

Proposed Future Work

- Possible doubling of capacity – A possible phase II could add 47,200 ft^2 of space to our new facility bringing total square footage to 100,000 to accommodate increased market need
    - Pre-permitted for 100,000 ft^2
    - Additional employment growth to accommodate future expansion
- Continuous improvement of cost– Employment of full-time supplier quality and purchasing engineers will work continually to source better and less costly materials. Further refinement of manufacturing processes to limit waste of time, resources, and materials.
- Integrated designs with key customers – For most volumetric, weight and cost efficiency, integrated inverter solutions for next generation Evs are planned

Summary Slide

- First year of $18 million project
- Manufacturing milestones achieved:
  - Permits obtained
  - Site construction initiated
  - Plant floor and office layout finalized
  - Qualification of material/equipment and product in progress
  - Hiring in progress
- Customer qualifications ahead of plan