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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SBE

ARRAVT029

Overview

Timeline

- **Start date:** Dec 23, 2009
- **End date:** Dec 22, 2012
- **Percent complete:** 90%

Budget

- **Total project funding:** $18,186,367
- **DoE share:** 48.2%
- **SBE Share:** 51.8%

Project Lead

- Ed Sawyer - SBE, Inc.
  - Deputy Project Manager: Tom McBride

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

The Problem

- Insufficient domestic capacity of critical EV components; i.e. DC link capacitors
- Need for critical components to be cost competitive
- Need to fulfill the Recovery Act's purposes to stimulate the economy and to create and retain jobs.

Project Goals and Relevance

- **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 capacitor products to support the manufacture of 100,000 Electric Drive Vehicles (EDVs) per year by 2012.

- **Targets Addressed**
  - – Design and qualify custom manufacturing equipment and attain industry standard TS16949 certification
  - – Scale proven production processes to provide cost competitive DC bus capacitors to the global market place.

- **Relevance and Impacts**
  - – This project will create 80 jobs as part of the Recovery Act's goal to stimulate the economy and to create and retain jobs

Description of Project

We will...

- Permit, design, and build a plant with capacity to produce DC link capacitors for 100,000 EV's
- Obtain necessary industry and key customer approvals
- Achieve cost goals that compete favourably with off-shore competitors, but with greatly improved performance
- Provide quality data and product validation to DoE

Milestone	Month/Year
Local Building Permit Approval	November 2009
Building & Plant Layout Design	March 2010
Finding-of-No-Significant-Impact	March 2010
Winder Design Completion	April 2010
Building Construction Start	April 2010
All Equipment Designed	September 2010
Plant Move – In	November 2010
First Line Set – Up	April 2011
First Line "Production Rate"	May 2011
TS-16949 Certificate of Conformity	December 2012

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 (cont.)

- Obtain Necessary Industry and Key Customers' Approval
  - 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.)

- 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

Areas of Accomplishment

- Building Design
- Permitting and Construction
- Material, Equipment, and Product Activities
- Customer Qualification Activities

Technical Accomplishments to Date

- 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
  - Finalized facility needs and interior design elements – October 2010

Technical Accomplishments to Date

- Permitting and Construction
  - Preliminary site plan/civil engineering designs complete – Late August 2009
  - Permit ready for construction; all state and local land use, zoning, and subdivision permits approved – Mid November 2009
  - 10 Acre plot of land purchased – Early March 2010
  - Federal Environmental Assessment clears public review – March 24, 2010
  - Finding-Of-No-Significant-Impact (FONSI) issued – March 30, 2010
  - Site preparation and formal ground breaking – Early April 2010
  - Municipal road and utility extension completed – Early September 2010
  - Building fully enclosed – Mid September 2010
  - Fire safety and occupancy permits issued – Late September 2010
  - Construction completion – November 8, 2010
  - Formal ribbon cutting ceremony – December 6, 2010

Technical Accomplishments to Date

- Material, Equipment, and Product Activities
  - New industry standard test equipment acquired to aid in product and material qualification
  - Specifications finalized for co-engineered winder from Active Precision, Inc.
  - Developed base-line material specifications
  - Class 10,000 clean room installed in new facility for winding consistency
  - Product architecture finalized with new production methods
  - All first article equipment orders have been delivered
  - Ramp up plans developed and implemented
  - Equipment installation complete
  - New equipment 100% qualified at new production facility

Technical Accomplishments to Date

Technical Accomplishments to Date

- Customer Qualification Activities
  - Design win for 7 automotive OEM EV inverter applications
  - Design win for commercial truck electrification and auxiliary power application
  - Design win for a Hybrid Bus/Truck Power train applications
  - Design win for an electric motorcycle application
  - Engaged with automotive/transportation OEM EV and HEV for capacitor use for inverter applications
    - 10 OEMs: Currently have their systems being tested by their customer; with the Power Ring designed in
    - 10 OEMs: Currently testing the Power Ring
    - 20+ OEMs: SBE having dialogues

Collaborations

- EF Wall – Construction contract signed and construction complete.
- 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

FY12 Approach and Challenges

2011 Oct	Nov	Dec	2012 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Continued Lean Process Refinements and Cost Reductions											
TS-16949 Certificate of Conformity											
Sales Growth and System Level Integration											
										Phase III Capacity Start	

Go No/Go Decision Point: Not Associated

Challenges/Barriers: 1) Scaling of known processes
2) Fully defined customer requirements

FY12 Approach Highlights

- Demonstrate production capacity of DC link capacitors

- Cost competitive, yet long reliability product to the customer

FY12 and Beyond

- FY12
  - Ramp production to follow existing customer demand
  - Increase sales and system level integration to fill capacity of 100,000 vehicles/year
  - TS-16949 qualification
  - Continued cost/reliability/performance optimization

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 adoption of Lean manufacturing to achieve 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

- Two years of $18 million project complete and on schedule
- Manufacturing milestones achieved:
  - Permits obtained
  - Site construction finished
  - Qualification of material/equipment and product 100% complete
  - Hiring in progress
- Customer qualifications ahead of plan