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:** 80%

Budget

- **Total project funding:** $18,186,367
- **DoE share:** 48.22391%
- **SBE Share:** 51.77609%

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 Approval	December 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 (cont.)

- 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.)

- 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
  - 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
  - Developing and base-lining 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 placed
  - Ramp up plans developed
  - Equipment installation ongoing
  - New equipment 95% qualified at new production facility

Technical Accomplishments to Date

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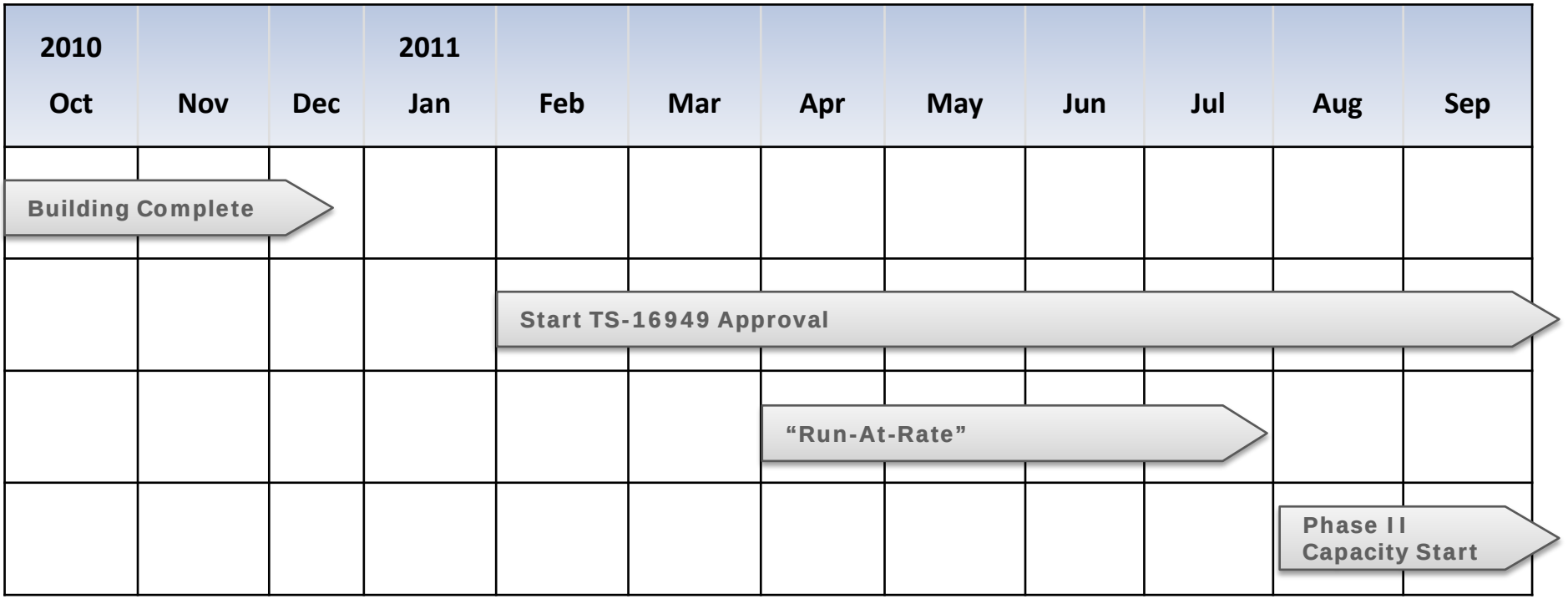
- Customer Qualification Activities
  - Design win for 4 automotive OEM EV inverter applications
  - Design win for commercial truck electrification and auxiliary power application
  - Design win for 2 Hybrid Bus/Truck Power train applications
  - Design win for an electric motorcycle application
  - Engaged with automotive/transportation OEM EV and HEV for capacitor use for inverter applications
    - 8 OEMs: Currently have their systems being tested by their customer; with the Power Ring designed in
    - 12 OEMs: Currently testing the Power Ring
    - 15 OEMs: SBE having program-specific technical dialogues
    - 20+ 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

FY11 Approach and Challenges



Go No/Go Decision Point: Not Associated

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

FY11 Approach Highlights

- Demonstrate production capacity of DC link capacitors
- Cost competitive, yet long reliability product to the customer
- Full preparation for TS-16949 4th Quarter 2011 audit

Beyond FY11

- FY12
  - Phase II and III capacity expansion to reach 100,000 vehicles
  - 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 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 complete and on schedule
- Manufacturing milestones achieved:
  - Permits obtained
  - Site construction finished
  - Plant floor and office layout finalized
  - Qualification of material/equipment and product 95% complete
  - Hiring in progress
- Customer qualifications ahead of plan