Tactical Idle Reduction for Heavy Tactical Vehicles Technology Transition Initiative

Jonathan M. Cristiani

US Army Communications-Electronics Research Development and Engineering Center
Command and Control Directorate – Army Power Division – Power Technology Branch
328 Hopkins Rd, Bldg 1105, Aberdeen Proving Ground, Maryland 21005
Phone: 410-278-1732, Fax: 410-278-8990
Email: jonathan.cristiani@us.army.mil

Abstract

The United States (US) Army Communications-Electronics Research Development and Engineering Center (CERDEC) has been tasked by the Army's Product Manager for Heavy Tactical Vehicles (PM HTV) and the Office of the Secretary of Defense (OSD) to develop and demonstrate a suitable idling reduction auxiliary power and energy system for the next-generation M915 and family of line haul replacement tractor vehicles. Under an OSD-funded Technology Transition Initiative (TTI) program, the CERDEC has been working with the US Army Tank and Automotive Research Development and Engineering Center (TARDEC) to determine the requirements for such an idle reduction system and share those requirements with the idling reduction industry so that an appropriate solution can be developed. Based on CERDEC estimates, the Army could potentially save up to fifteen (15) million gallons of fuel per year by fielding an idle reduction system for the M915 family of vehicles.

In the first year of the TTI program several baseline activities are underway, which are critical to the success of any auxiliary power unit (APU) and auxiliary environmental control unit (ECU) system development. First, the basic hotel loads for the M915, M916, and M917 vehicles have been characterized with the assistance of the US Army Engineer School at Fort Leonard Wood, MO via an on-site power assessment. Operational requirements are to be characterized later in summer 2008, as data loggers are now being constructed for shipment into theater and integration with actual line haul trucks that are performing missions by the Army Materiel Systems Analysis Activity (AMSAA). This in-theater power assessment will validate electrical loads, load profiles, and that the trucks are being idled as significantly as is believed by the Army. The comprehensive requirements generated from these two activities will form the basis of the specification for an M915A5 idle reduction integration demonstration in the second year of the TTI program and for future procurements. Finally, CERDEC has been working with Cummins Power Generation and Dewey Electronics Corporation in year one of the TTI program to develop and demonstrate stand-alone APU and ECU prototypes for developmental test and evaluation. Delivery of these developmental prototypes is expected in November 2008.

Introduction

The US Army CERDEC is responsible for the transition of a variety of communications – electronics technologies from research and development (R&D) into Army Materiel Command (AMC) and Department of Defense (DoD) acquisition programs of record for procurement, fielding, and sustainment. The transition of technologies from laboratory environments to realistic operating environments is an arduous task that involves significant resources. If these resources are not allocated in a timely manner, technologies tend to fall victim to the so-called transition "valley of death," which is depicted visually in Figure 1. In order to ensure a greater percentage of DoD science and technology development programs could be successfully transitioned for acquisition, the US Congress established the Technology Transition Initiative (TTI) Program in the fiscal year (FY) 2003 National Defense Authorization Act. The TTI Program is managed by the OSD Advanced Systems and Concepts Office of Technology Transition (ASC OTT) and is competitively awarded on an annual basis to DoD science and technology development centers such as the CERDEC [1].

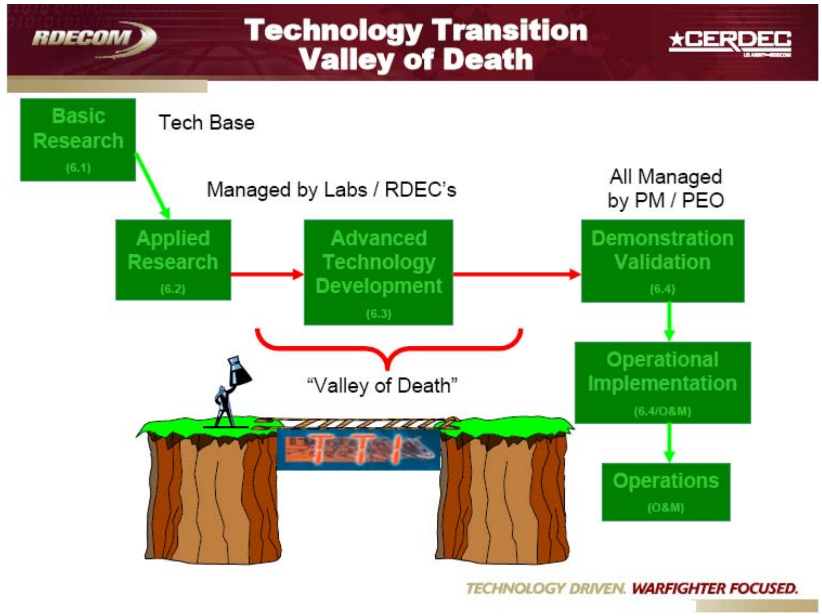

Figure 1 - "Valley of Death" in Department of Defense technology development and transition

In FY2006 the CERDEC Army Power Division formed a strategic relationship with PM HTV, who manages the acquisition of the M915, M916, and M917 line haul truck tractors for the Army. At that time the CERDEC learned that the M915 vehicle fleet consumed more fuel than any other tactical vehicle, and that the M915 vehicles were believed to be idled up to 50% of total operation in the field. While leveraging an existing idle reduction advanced technology development program and pursuing TTI funding for the APU/ECU development in FY2007, the CERDEC assisted PM HTV in writing an initial specification for an idle reduction system for the line haul replacement tractor fleet.

In early FY2008 the CERDEC Army Power Division was selected by OSD among many other proposed TTI projects to develop, demonstrate, and transition a tactical idle reduction system, including an auxiliary power unit (APU) and an auxiliary environmental control unit (ECU), for the Army's fleet of line haul truck tractors. The rationale for the program was simple: based on CERDEC estimates, the Army could potentially save up to fifteen million (15M) gallons of fuel per year by fielding an idle reduction system for the M915 family of vehicles. The Tactical Idle Reduction for Heavy Tactical Vehicles project takes place between October 2008 and August 2010 culminating in the demonstration of a fully-integrated M915, including an idling reduction system, in an operational environment, along with an idle reduction system specification. The targeted seminal transition event of the TTI Program is an engineering-change proposal to the M915A5 production contract using the aforementioned comprehensive idling reduction system specification, thereby accelerating the procurement/fielding of idle reduction technologies by three (3) years.

Development Strategy

In addition to developing a significant capability for the Army and saving fuel, an underlying goal of the Tactical Idle Reduction for Heavy Tactical Vehicles TTI Program is to establish a model development strategy for future APU / ECU system development programs. A proper APU / ECU development program consists of three primary tasks: requirements definition / validation, developmental prototyping, and operational prototyping / demonstration. Correct implementation of each of these major tasks is critical to ensuring the rapid deployment of an auxiliary power and energy system for any ground vehicle application. Before a development program is pursued, however, one must be certain that existing products in DoD inventory cannot meet mission requirements for a given ground vehicle APU/ECU application. Federal power equipment developers are required to contact the DoD Project Manager Mobile Electric Power (PM MEP) to learn more about existing power and energy equipment already being produced [2].

Market research is a key part of any DoD acquisition, and is performed continuously by all members of the acquisition community from R&D through procurement, sustainment, and disposal. Market research is accomplished via the search of websites of relevant companies and trade journals and the publication of a request for information (RFI) / sources sought notice onto the federal business opportunities website [3]. As technical requirements are defined, a validation approach must also be pursued in parallel. The most efficient way to validate the technical requirements for a ground vehicle-mounted APU/ECU is through a power assessment of the fielded fleet of vehicles (using a set of data loggers) to obtain peak loads, nominal loads, load profiles, and engine speed profiles. Using the data gathered from market research and power assessments, a well-defined specification can be written and accurate life cycle cost estimate can be compiled.

A two-phased contracted development program with appropriate APU/ECU suppliers allows for the demonstration of multiple designs in an efficient manner. In the first phase, stand-alone developmental APU/ECU prototypes should be designed, fabricated, and delivered within six to eight months by multiple contractors. This will allow government personnel to validate key developmental technical metrics are met, such as APU rating and power quality conformance with Military Standard (MIL-STD-) 1332B, via in-house test and evaluation [4]. In the second phase, several APU/ECU prototypes from a single supplier should be integrated to the target vehicles and verified in several relevant operating environments over a fifteen month to eighteen month period of performance. Limited logistics planning and maintainability analyses should also be accomplished along with these operational demonstrations so that a suitable set of early training material can be created and administered to the first unit equipped (FUE) identified for the initial fielding. Finally, prior to procurement, a waiver must be submitted to the PM MEP for the APU/ECU, as they are the DoD primary procurement agent for power and energy systems who must verify that vehicle product managers are allowed to deviate from DoD standard power sources. This overall strategy is being employed for the Tactical Idle Reduction for Heavy Tactical Vehicles TTI Program, and is described further in this paper.

Requirements Definition and Validation

Upon selection for the TTI Program in FY2008, the CERDEC immediately began assessing the technical requirements for the idle reduction APU/ECU for the M915 fleet. Due to the requirement for both 120-volt alternating current (AC) and 28-volt direct current (DC) power for the M915 fleet in the 3-kilowatt (kW) to 5-kW range, it was determined that power systems in the existing PM MEP inventory would not meet the needs of this application. Simultaneously while extensive market research was conducted during FY2008, the CERDEC constructed fifteen (15) DC data loggers at a cost of only $7,100 per module.

Figure 2 – CERDEC DC data logger

The CERDEC DC data logger, Figure 2, gathers information on the vehicle voltage, alternator output, and current across the batteries. Using these pieces of information, CERDEC can determine the total power requirement for the vehicle at any given point during a mission. This power requirement will vary from mission to mission and vehicle to vehicle; therefore multiple kits are being fielded to monitor a wide range of missions. The data logger draws a negligible amount of power from the vehicle battery to operate and stores 1.5-megabytes of data (equivalent to approximately 30-days) on a local storage drive that can later be downloaded by equipment maintainers via a laptop when the vehicle is not in operation. A schematic depicting the installation layout is pictured in Figure 3.

In April 2008, CERDEC personnel traveled to the US Army Engineer School at Fort Leonard Wood, Missouri to perform a preliminary power assessment on the M915, M916, and

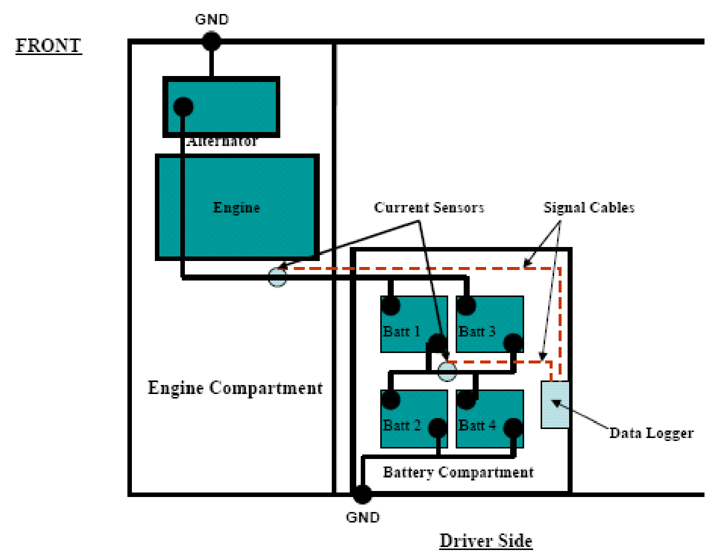

Figure 3 - DC data logger installation layout

M917 vehicles so that data logger installation instructions could be written for the DC data loggers slated for installation on fielded vehicles. During the visit, it was determined that the total electric hotel load profile, not including communications and improvised-explosive device (IED) defeat equipment, for the M915A3 was approximately 21-amps at 28-volts DC, while the total hotel loads for the M916A3 and M917A1 were 45-amps and 40-amps at 28-volts DC, respectively. The primary difference between the individual vehicle loads is attributable to a power take off and flood light on the M916 and a material control system on the M917. A representative load characterization from the Fort Leonard Wood power assessment is pictured in Figure 4.

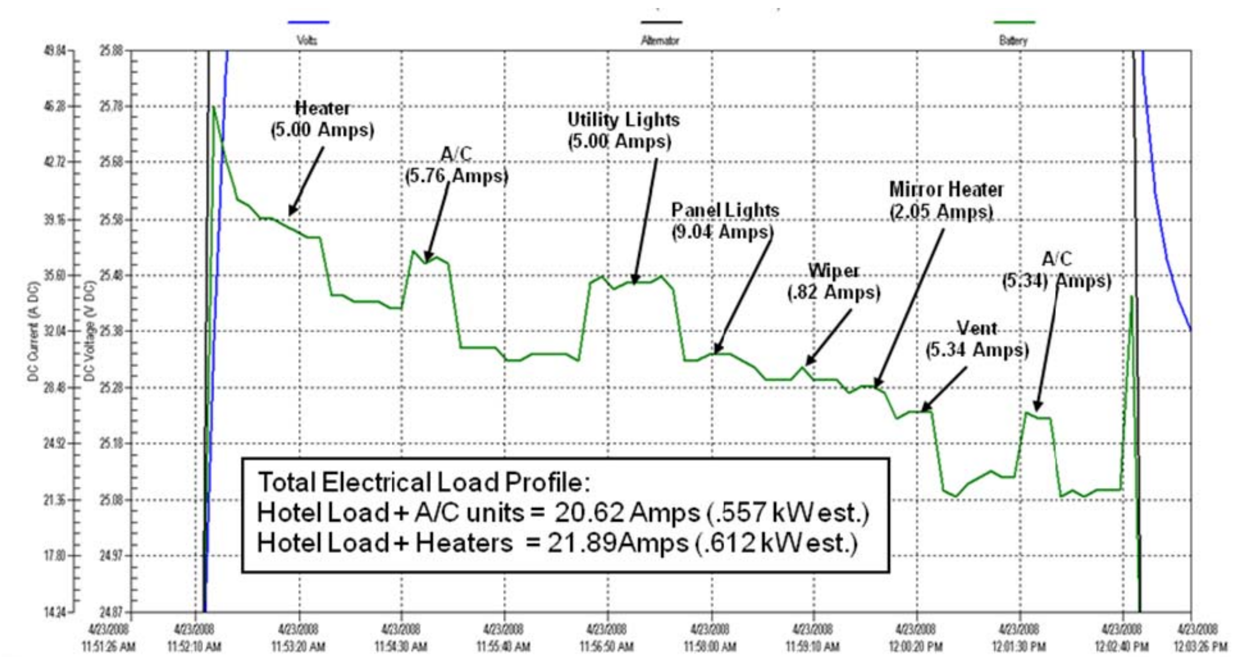

Figure 4 - Representative load characterization for M915A3

An initial set of six (6) DC data loggers were shipped to Kuwait in September 2008 for installation onto four (4) M915's and two (2) M916's by AMSAA. Data collection is underway, and a report for each of the vehicles has been produced as of November 2008 that will be used in the performance work statement development for an operational integrated prototypes and technology demonstration contract. Later in FY2009 another nine (9) data loggers including engine speed sensors will be installed by AMSAA to expand on the electrical data collected to-date and also collect idle time data. This idle time data will give a stronger indication of the extent to which the 15M gallons per year fuel savings can be achieved.

Developmental Stand-Alone Prototypes

At the same time CERDEC was conducting requirements definition and validation two six-month purchase orders were issued to the Dewey Electronics Corporation of Oakland, NJ and Cummins Power Generation of Minneapolis, MN after a competitive source selection based on the initial idle reduction system requirements developed in FY2007. Each purchase order will deliver two (2) stand-alone APU prototypes and two (2) stand-alone ECU prototypes for developmental test and evaluation by CERDEC at Fort Belvoir, Virginia and Aberdeen Proving Ground, Maryland. Dewey Electronics Corp will be delivering a custom 5-kW APU and has teamed with AMETEK Aerospace and Defense of El Cajon, California for development of a unitary 18,000-BTU/hour ECU. Cummins Power Generation will be delivering a variant of their 4-kW commercial product and has teamed with their commercial partner for their ComfortGuard™ idle reduction product, Recreational Vehicle Products (RVP) of Wichita, Kansas, for development of a split-pack commercial 12,000-BTU/hour ECU. The Tactical Idle Reduction for Heavy Tactical Vehicles TTI Year 1 development team is depicted in Figure 5.

Figure 5 - Tactical Idle Reduction for Heavy Tactical Vehicles TTI Year 1 development team

Planned test activities for the APU include fuel consumption, controls, extreme high- / low-temperature operation, maximum power, electrical characterization, safety/protective device verification, sound level, and 1000-hours of endurance testing, all performed per MIL-STD-705C [5]. Planned test activities for the ECU include capacity, controls, air flow, high-temperature, sound level, and 1000-hours of endurance testing. The major demonstration objectives for these stand-alone prototypes include conformance of APU rating and power quality to MIL-STD-1332B and conformance of ECU to applicable industry environmental control standards (such as ASHRAE Standard 37 for unitary systems). The APU/ECU prototypes from each team will be delivered in November 2008 and tested by CERDEC until approximately April 2009.

Operational Integrated Prototypes and Demonstration

Solicitation #W909MY-08-R-TIR on the federal business opportunities website describes the goals for FY2009 for development and demonstration of two (2) fully-integrated M915 truck tractors including idle reduction systems [6]. A single contractor will integrate their idle reduction APU/ECU technology onto two government-furnished M915A5 vehicles. The fully-integrated M915 truck tractors will then be subjected to limited operational tests in rigorous environments and demonstrations at relevant user-community venues. Critical metrics to transition such as a maintenance ratio of 150-maintenance-man-hours per 1000-hours of operation and a 100-hour maintenance cycle will be demonstrated as well. Interested parties should contact the author as soon as possible for further information if interested in learning more about the program.

Transition and Conclusion

Demonstration of all aforementioned developmental and operational metrics is necessary prior to transition of the idle reduction APU/ECU to PM HTV for procurement. Three separate potential procurements are envisioned: in the near-term as an engineering change to the M915A5, retrofit kits for the existing fielded fleet of M916/917 vehicles and M915A3/A4 vehicles (pictured in Figure 6), and finally for the Line Haul Replacement Tractor in the out years as its requirements are established. In each case, there are significant approvals that need to be cleared prior to a procurement action moving forward. This includes a waiver from PM MEP. Pending successful procurement decisions in all cases, the idle reduction application will be fully-developed in the US Army and a potential of up to 15M gallons per year of fuel savings could be realized.

Figure 6 - M915 Family of Vehicles (FOV)

The TTI Program funds administered by OSD have been critical to the success of developing, transitioning, and deploying idle reduction systems three (3) years sooner than originally planned. Without programs like TTI, a greater number of DoD science and technology programs would undoubtedly fall victim to the transition “valley of death.” In the case of the Tactical Idle Reduction for Heavy Tactical Vehicles TTI Program, not only is a vital capability being developed and its transition accelerated, but the resultant fuel savings will ultimately yield significant life cycle cost savings. Such budget savings a can be applied to more critical near-term technology development needs such as IED-defeat. Furthermore, this program serves as a model development strategy for other APU/ECU developers and vehicle product managers in DoD. Finally, the Tactical Idle Reduction for Heavy Tactical Vehicles Program fully develops an application in which high-cost, fuel-efficient, alternative power technologies, such as liquid-fueled fuel cell power sources, can be successful in the future when they are at an acceptable technology readiness level.

References

1.) http://www.acq.osd.mil/ott/tti/

2.) http://www.pm-mep.army.mil/reference/dodd.htm

3.) http://www.fbo.gov

4.) http://www.pm-mep.army.mil/reference/1332.htm

5.) http://www.pm-mep.army.mil/reference/705c.htm

6.) https://www.fbo.gov/index?s=opportunity&mode=form&id=4ce2f38ebe56e40a342ad7252f6865c0&tab=core&_cview=1