Texas Commission on Environmental Quality
New Technology Research & Development (NTRD) Program
Monthly Project Status Report

Contract Number: 582-11-13472-2019

Grantee: Transportation Power, Inc.

Report for the Monthly period: 05/07/12 – 06/08/12 **Date Submitted:** 06/11/12

Section I. Accomplishments

Provide a bulleted list of project accomplishments as well as a description of their importance to the project.

- Control system development continues on numerous fronts.
    - The VPCC (Vehicle Powertrain Control Center) is now complete aside from 5 signal pathways awaiting specialized connectors. These connectors have been ordered. The control documentation is about 50% complete. This documentation will ultimately become service and repair literature.

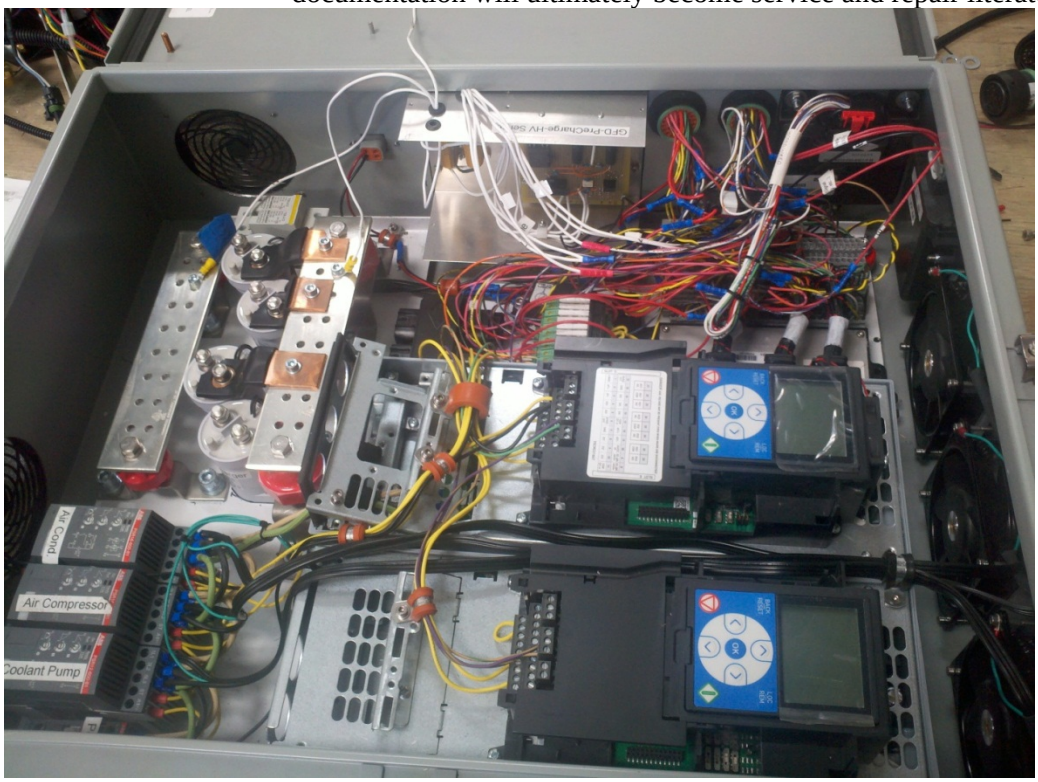

Figure 1: Current state of VPCC just prior to 12V power up.

- Power up procedures are being finalized. The overarching power up process starts with a careful power up on 12V power only. All input/output (I/O) and impacted logic are verified and tested per documentation which will aid service personnel in the field when changes or repairs are made.
- New gauges have been installed to display motor, battery, and DC-DC temperatures. Lights indicating “Vehicle Charging” and “Ground Fault” will be

added when the covers return from the engraver.

Figure 2: Updated vehicle dashboard

- The MasterShift adapter and shift flag are installed onto the transmission. The motor/transmission assembly has been installed into the vehicle.

Figure 3: Shift hardware installed on transmission with entire assembly in the vehicle

- Dynamometer construction continues, but fabrication resources have been directed towards the inverter calibration dyno (as opposed to the powertrain calibration dynamometer). This is discussed further in the Problems/Solutions section.
    - The hardware and software required to operate the dynamometers and log the resulting data continue to be developed

- The ESS suitcase parts are in house and parts for the first tractor have been fabricated and will soon be sent out for painting. A test fitment was performed on the ElecTruck test mule. Modifications to the Yard Truck Chassis are complete to facilitate under-cab ESS integration.

Figure 4: Test mounting on the ElecTruck test mule.

  - The Battery Monitoring harnesses have been manufactured and are ready for installation.
  - Bus bars are here.
  - All other hardware is in house, except for the battery cells themselves, whose delivery is now expected in mid-June 2012. This is discussed further in the Problems/Solutions section.

- TransPower has begun contacting local distribution centers that use yard tractors in order to secure one or more venues for testing the tractors once they are built. These venues will allow TransPower to test the tractors in simulated service.

Indicate which part of the Grant Activities as defined in the grant agreement, the above accomplishments are related to:

- All of the accomplishments listed above except for the last one relate to Task 2.2.2, "Tractor 1 Installation."
- The last accomplishment listed above is related to Task 2.3, "Vehicle Durability Testing." Dynamometer testing as an essential step in the vehicle integration process, as it will allow

TransPower engineers to validate the powertrain as a discrete subsystem before the components are integrated into either tractor. In the TransPower Integration Test Plan, this is referred to as subsystem level testing. Additionally, the dynamometer will allow TransPower engineers to fully calibrate the drive system software code required for successful shifting, as well as other software functionality, without having to wait for the tractor to be ready for road testing. Events to be discussed have increased the importance of off board powertrain validation. This additional parallelization is to mitigate the effects of significant supply chain delays.

Section II: Problems/Solutions

Problem(s) Identified: Report anticipated or unanticipated problem(s) encountered and its effect on the progress of the project

a) Energy storage cells will now arrive far later than the promised due dates. Currently they are expected to arrive the week of June 11-15 (versus original expectations that the cells would arrive in mid-May 2012).
b) Months ago TransPower ordered commercial off-the-shelf inverters, to control the tractor motors as an interim solution pending development of TransPower's own Inverter-Charger Unit (ICU). After numerous delays, the first of these inverters arrived at TransPower's facility on June 5, 2012. While this inverter could now be installed into the first yard tractor, the long delay in its acquisition has prevented TransPower from being able to validate its functionality in a previously-built Class 8 on-road truck, an activity which, over the past six months, was expected to mitigate the risk of using this inverter in the yard tractors.
c) The dual component delays (battery cells and functioning inverters) have forced TransPower to change the schedule for building, testing, and delivering the two tractors. To meet delivery deadlines, TransPower has had to change the structure of the test and validation phase of this project. Since key components have been delayed, the full vehicle system will be completed later than originally expected, leaving less time for system-level testing.

Proposed Solution(s): Report any possible solution(s) to the problem(s) that were considered/encountered

a) To mitigate the effects of late cell delivery, TransPower is purchasing off-the-shelf lead acid batteries to power the dynamometer testing in the near term. When the lithium-ion cells to be used in the yard tractors are packaged into modules, they will be qualified on the dynamometer prior to installation in the vehicle. This approach not only supports powertrain calibration but is supporting inverter validation as well.
b) In view of the fact that supplier delays have cost TransPower six months of testing time with the off-the-shelf inverter, a decision has been made to accelerate the development of the ICU, which TransPower has been developing jointly with partner company EPC since mid-2011. Even though there will be risks involved with relying on a brand new product such as the ICU for both motor control and battery charging, this risk is not seen as significantly greater than relying on an off-the-shelf inverter that has not seen more than a few hours of testing with TransPower's drive system. In addition, TransPower expects to receive much better support for the ICU from EPC, as compared with the support received to date from Quantum, supplier of the off-the-shelf inverter.
c) TransPower's solution to having less time for systems-level testing is to increase the amount of component-level and subsystem-level testing, since this testing can proceed before the whole vehicle is complete. The dynamometers that TransPower is building are a key tool that will allow TransPower engineers to maintain a high level of confidence in the vehicles sent to Texas even though TransPower will have less time than originally anticipated for system-level testing.

Action(s) Conducted and Results: Describe the action(s) taken to resolve the problem(s) and its effect

a) TransPower has hired a new part time mechanical technician to accelerate battery module fabrication. This is proving beneficial in upgrading the ElecTruck prototype with the same

components to be installed on the Yard Trucks. This new test capability is helping TransPower qualify powertrain components to the best of our ability given the supply chain issues.

b) TransPower has purchased lead acid batteries as well as control and measurement hardware for the inverter calibration dynamometer. This assembly is now at EPC's facility. TransPower's electrical technician is supporting this dynamometer at EPC's facility to expedite the ICU development. By mid-June, an ICU will be delivered to TransPower and will be validated as part of the terminal tractor powertrain. This will be accomplished with lead acid batteries initially and then with the lithium batteries to be permanently installed into the vehicles.

Section III. Goals and Issues for Succeeding Period:

Provide a brief description of the goal(s) you hope to realize in the coming period and identify any notable challenges that can be foreseen

The next period will see the completion of the following goals.

- Tractor #1 will be mechanically complete; Tractor 2 will be in process.
- Tractor 1 control system integration will begin.
- Both dynamometers will actively support inverter and powertrain calibration.
- Draft 1 training and release documentation will be complete.
- Vehicle charging hardware will be integrated on the bench.

If these goals are achieved, the first tractor will be very close to achieving full functionality, and actual drive testing could begin before the end of July 2012. The major challenge for this period will be labor resource utilization and coordination. TransPower expects several major parts to arrive in a relatively short span of time. TransPower will need to be particularly diligent in scheduling workers and tasks so as to maximize worker productivity in order to complete all of the goals listed above.

Date: 6/08/2012

Authorized Project Representative's Signature

NOTE: *Please attach any additional information that you feel should be a part of your report or that may be required to meet the deliverable requirements for tasks completed during this reporting period.*