

**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. (Transpower)

Report for the Monthly period: 12/08/12 – 01/04/13 **Date Submitted:** 01/09/13

Section I. Accomplishments

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

- Durability testing of Tractor #1 continued. After months of effort, it finally appears our engineering team has overcome the difficulties experienced in perfecting our automated manual transmission (AMT). Several hours of successful drive testing has been performed with the latest generation design of the AMT. During this testing, smooth automatic shifting between two gears has been achieved for the first time. Figure 1 shows the AMT assembly mounted into the tractor.

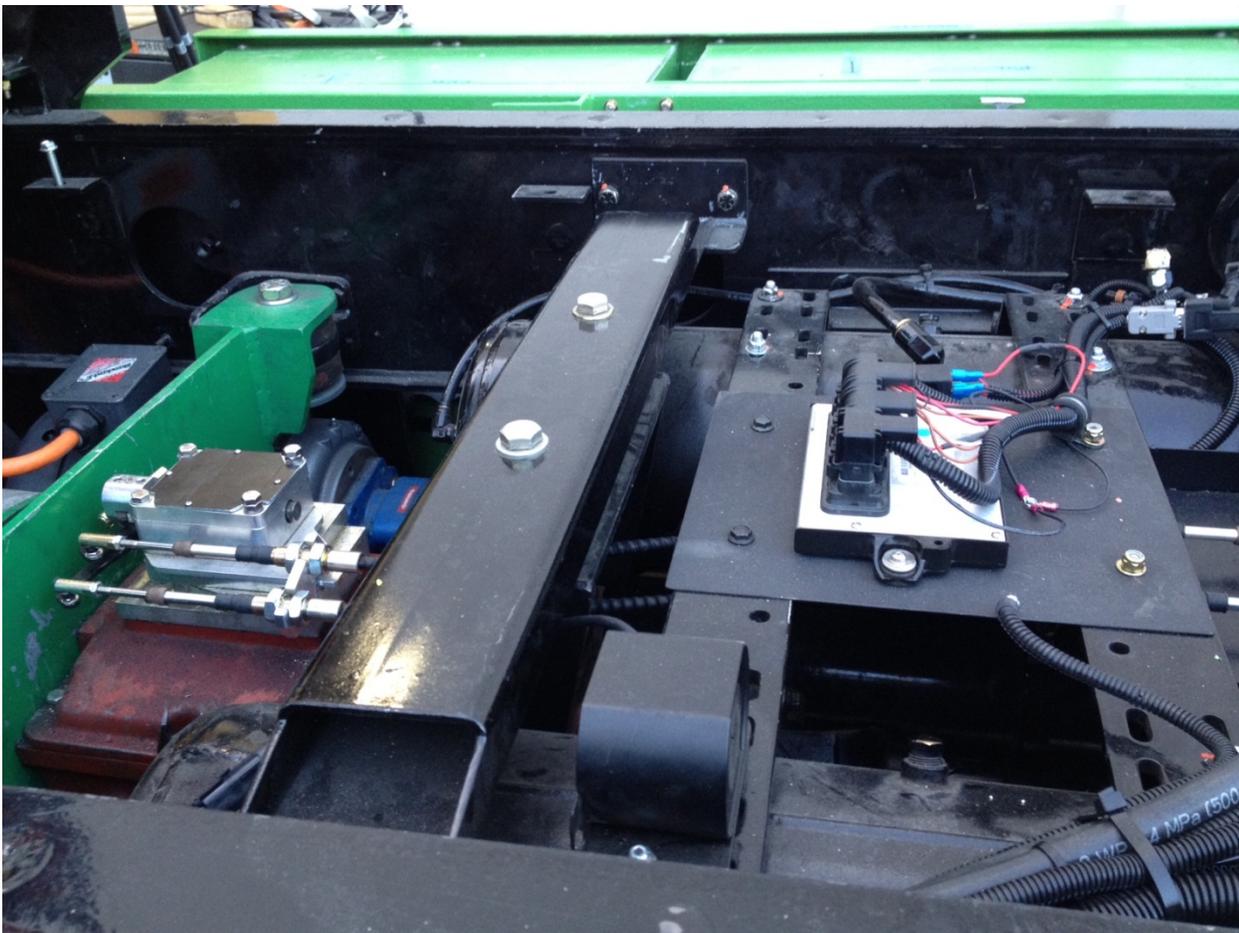


Figure 1: Latest generation AMT installed into Tractor #1.

- Inspection of the batteries in Tractor #1 following about three months of on-and-off durability testing revealed a significant build-up of dust and debris on the tops of the battery modules and on the tops of cells installed into the modules (Figure 2). This is a cause for concern because dust buildup can cause ground faults and other problems. To resolve the issue, it was decided to remove the battery modules from both tractors and seal most of the holes and gaps in the modules that have been allowing dust to enter the modules. Rectangular air holes (visible in Figure 2) were designed into the modules to facilitate air flow and battery cooling, but tractor testing data and battery manufacturer input now suggest that the cells are likely to remain at acceptable temperatures even in sealed enclosures. Sealing of the modules will also provide greater protection against water entry.



Figure 2: Dust and debris collected on cell supports and battery cells in Tractor #1.

- In addition to sealing the large oval air holes in the battery modules, it was decided to use silicone sealant to seal the module lids to the modules. This will present minor complications when lids need to be removed to inspect or replace cells (e.g., scraping off of old silicone and reapplying a new coat to reseal the module), but was determined to be preferable to allowing dust or water to creep into the modules through small gaps under each lid (also visible upon close inspection of Figure 2). Figure 3 shows the interior battery modules of Tractor #2 reinstalled into the tractor after being removed for cleaning of the cells and sealing of the air holes and gaps in the modules. Close inspection of the lids shows signs of the silicone sealant. This disassembly, cleaning, sealing, and reassembly of the 14 battery modules on each tractor delayed completion of commissioning of Tractor #2.



Figure 3: Battery modules reinstalled into Tractor #2 following cleaning and sealing.

- A grant modification request was prepared and submitted to allow more time for durability testing, as well as to recognize some of the other schedule changes that have become necessary to accommodate the greater amount of time devoted to developing and demonstrating advanced technologies such as the AMT and inverter-charger unit (discussed in other reports).

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

- All four of the accomplishments described above relate to both *Task 2.3.1, “The PERFORMING PARTY will conduct at least 3 weeks of drive testing of Tractor 1 in simulated and/or actual service,”* and to *Task 2.3.2, “The PERFORMING PARTY will conduct at least 2 weeks of drive testing of Tractor 2 in simulated and/or actual service.”*

Section II: Problems/Solutions

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

- a) The only significant problem encountered during the reporting period was the dust buildup discussed above. Removal, cleaning, and replacement of the battery modules on Tractor #2 delayed the completion of commissioning of this vehicle by about three weeks. Impact on the Tractor #1 schedule was minimal because this tractor was idled anyway to allow for completion of the AMT.
- b) Successful drive testing of Tractor #1 using the latest design of the AMT seems to have solved the greatest problem that was confronting the project for the past few months. Another two weeks of testing of Tractor #1 is planned to fully validate the AMT and to evaluate its improvement in tractor performance. This will be followed by at least a week or two of drive testing of Tractor #2 using the AMT. If this testing all proceeds as planned, both tractors will be ready for delivery to HEB in Texas for in-service testing and evaluation by the end of the next reporting period.

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

- a) Possible solutions to the battery dust problem included leaving the design alone and recommending frequent cleaning to prevent excessive buildup of dust, sealing the existing battery modules, or redesigning the battery modules and building new ones.
- b) Previous problems with the AMT could have been solved by locking the tractors in one gear and forgetting about automated shifting for this project, continuing to pursue a 3-speed shifter, or pursuing a 2-speed shifter that would be somewhat simpler to implement than a 3-speed. The tractors might still have performed adequately in one gear, without any shifting, but it was felt that even just 2 speeds of shifting could offer a significant improvement in tractor performance and efficiency.

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

- a) As discussed previously, all battery modules were removed from both tractors and thoroughly cleaned, and then all holes and gaps in the modules were sealed. This was determined to be a much better solution than doing nothing, and much less costly and time-consuming than redesigning and rebuilding the battery modules. We believe the sealed modules will perform adequately for the two tractors built under this project for the duration of the project and probably for a significant amount of time thereafter. Battery modules for future vehicles will be designed with fewer openings that can allow entry of dust or water.
- b) It was decided to settle for a 2-speed AMT, as the benefits of 3-speed shifting for these vehicles was projected to be only marginal as compared with 2-speed shifting, especially for the duty cycle envisioned in Texas with HEB. Development of capabilities to shift to three or more speeds will be pursued under separate projects, leaving open the possibility of upgrading the two Texas tractors to 3-speed operation once this capability is demonstrated on other TransPower 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

Goals for the next reporting period (ending February 10, 2013) include:

- Complete validation of the AMT, demonstrating a capability for reliable shifting between two gears on both tractors.
- Complete durability testing of Tractor #1, including one week of independent testing with Southern California Edison.
- Complete or nearly complete durability testing of Tractor #2.
- Validate that sealing of the battery modules does not cause battery overheating.
- Begin preparations for delivery of both tractors to HEB before the end of February 2013.

The most notable challenge in completing these objectives, perfecting the AMT, seems to have been resolved. This may enable us to avoid the fallback position of delivering both tractors to HEB locked into a single gear, even though we believe they would meet HEB's minimum requirements in one gear. Given the huge payoff to be potentially gained with the AMT, we are excited that we have succeeded in getting it to work during our most recent tests and look forward to validating that the system is robust and reliable in future testing both in California and in Texas.

Date: 1/9/2013

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.*