

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

**Contract Number:** 58211111463264

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**Grantee:** Capacity of Texas, Inc.

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**Report for the Monthly period:** July 2011 **Date Submitted:** Aug. 12, 2011

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**Section I. Accomplishments**

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

- Research is on-going regarding the various duty cycles seen in the terminal tractor industry. We have received preliminary data regarding two duty cycles and it is as follows in Table 1.

**Table 1: Preliminary data by duty cycle**

Route Name	Application/Source	Distance Traveled/Shift	Run Time/Shift	Duty Cycle
Distribution	Warehouse/Railyard	34 miles	7.3 hours	50%
Port	Port of Houston	25 miles	7.3 hours	35%

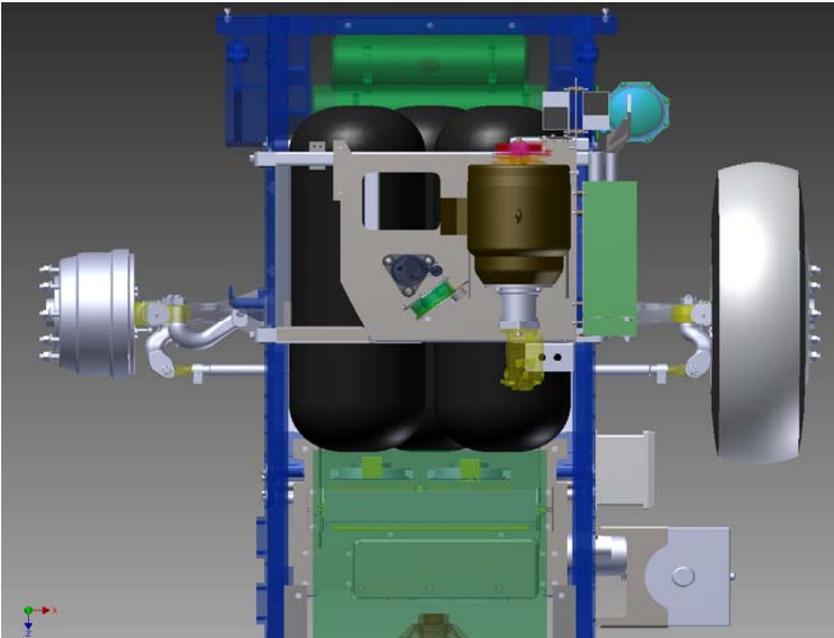
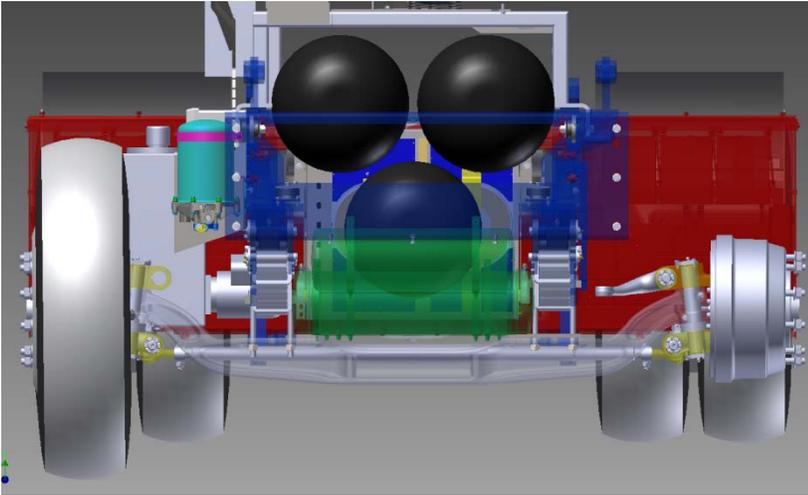
This is fairly consistent in relation to the baseline assumptions. The warehouse/railyard test data was provided by In-Terminal Services. They are a large customer with whom Capacity of Texas has a lengthy relationship. Additionally, the port data was gathered by the Port of Houston in April of 2009. The data from the unit tested was a standard 2009 TJ5000 similar in make and model to what is currently in use today.

- For industrial diesel tractors, the accepted norm is enough onboard fuel for at least one 8 hour shift, and enough for two shifts is generally achieved. For our proposed hydrogen fuel cell yard tractor, the above storage option 1) provides greater than a two shift operation, option 2) provides more than 1 ½ shift operation, and option 3) exceeds a one shift operation, respectively. Additional research has been gathered regarding Hydrogen storage options. For industrial diesel tractors, the accepted norm is enough onboard fuel for at least one 8 hour shift, and enough for two shifts is generally achieved. For the ZETT, the goal is to provide onboard storage that exceeds a one shift operation, and possibly reaches the two-shift ideal.

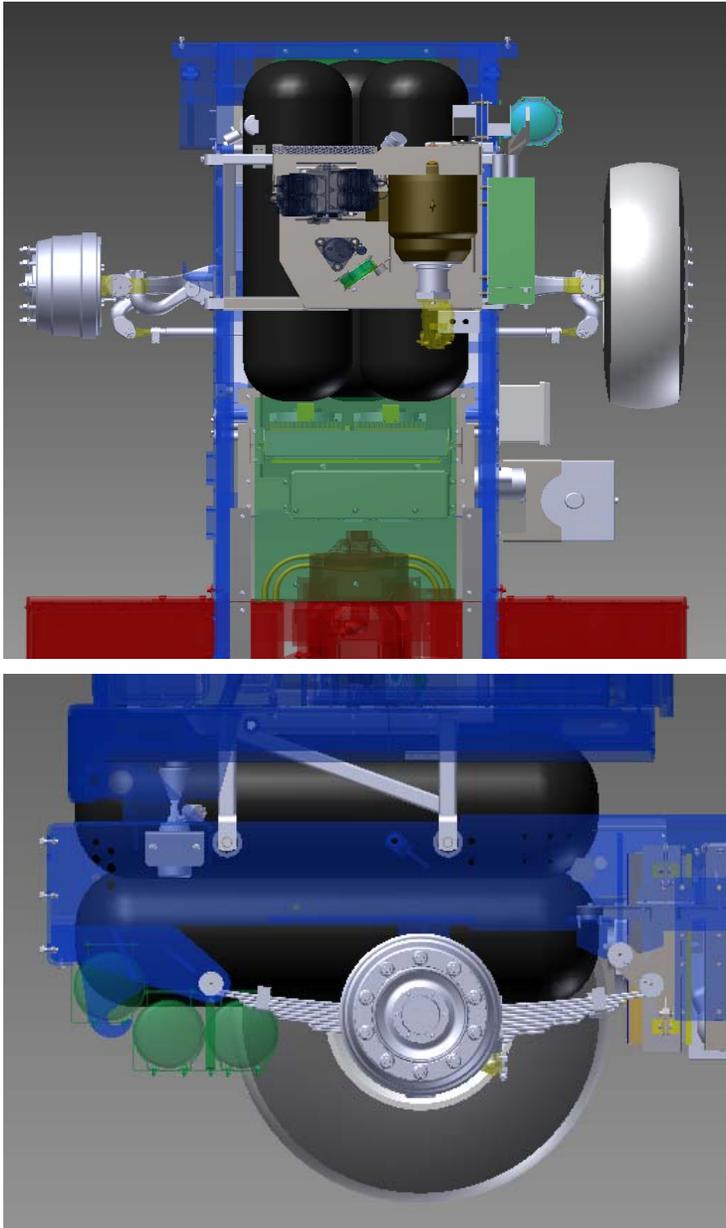
Using the two shift criteria that were provided to Capacity of Texas via customer feedback, a hydrogen storage decision matrix was generated to provide a detailed review of the most promising hydrogen storage technologies for this project. The matrix was heavily weighted

regarding the allowable space in the vehicle platform. A few of the viable options are shown below in Figures 1 and 2.

**Figure 1: Lincoln Composites - Filled to 350 bar is 2.8Kg/ea or 8.5Kg Total**



**Figure 2: Dynetek - W150 (3) f16x60 @ 350 bar is 3.6Kg/ea or 10.8Kg Total**



Attention is focused on a balance between the two goals of maximizing performance and minimizing cost from a commercialization perspective. Most, if not all, industrial refueling utilizes 350 bar infrastructure. On the other hand, with the broader availability of 700 bar storage tanks and advantage of approximately a 70% increase in hydrogen within the same volume, the storage approach is the 700 bar tanks, plumbing circuits and regulators rated for 700 bar use, and a fueling nozzle rated for 700 bar, but downward compatible to work with a 350 bar dispenser. This approach permits safe fueling at the more broadly available 350 bar stations, but provides a low-cost configuration for future retrofit to 700 bar operation (replace the nozzle).

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

- Under Task 1, Duty cycle data has been reviewed for port applications and a heavily used warehouse and distribution application. Item 2.1.1.
- Under Task 2, ZETT design, work continues on task 2.2.1. in the form of solid model design and determining packaging constraints.
- Under Task 2, ZETT design, design and analysis continues on determining on-board hydrogen storage requirements and packaging. Item 2.2.1.2.

## **Section II: Problems/Solutions**

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

- a) Little data has been gathered from rail yard (intermodal) type duty cycles. Fortunately, the ZETT needs to be designed around the most rigorous duty cycle (warehouse and distribution). With that data, the design process can move forward.
- b) Many of the hydrogen storage tank manufacturers advertise certain size tanks, but no longer sell all of the advertised models.

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

- b) Call the individual tank suppliers to ascertain what tanks are available and what tanks are commonly used.

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

- b) Calls were made to the hydrogen tank manufacturers to ascertain what tanks are available and what tanks are commonly used so that the best balance between the two goals of maximizing performance and minimizing cost from a commercialization perspective can be achieved.

### **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 goals for the next month include the following:

- Complete the verification of the duty cycle with our customer base.
- Complete the solid model of the base vehicle.
- Determine the space available for on-board hydrogen storage and batteries.
- Continue to finalize the selection of hydrogen fuel storage tanks.
- Begin to develop a decision matrix for on-board battery storage.

*Date: 8/12/11*

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*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.*