BOULDER ELECTRIC VEHICLE FIELD VALIDATION PROJECT 2012

Task # 1 - Deliverable Report

for:

New Technology Research and Development Program

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Submitted by:

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Table of Contents

ABSTRACT/EXECUTIVE SUMMARY **4**

INTRODUCTION / BACKGROUND **5**

VEHICLE WEIGHT 5
BATTERY THERMAL MANAGEMENT SYSTEM (BTMS) 6
HIGHWAY CAPABLE ELECTRIC TRUCKS 6

PROJECT OBJECTIVES / TECHNICAL APPROACH **6**

PROJECT OBJECTIVES: 6

TASKS **8**

TASK 1 8
Demonstration partner bailment agreements *8*
Demonstration partner needs assessments *10*
Aerodynamics analysis *10*
Additional CAD and aerodynamic analysis *13*
Demonstration partner charging preparation *15*
Schedule and deliverables *15*

DISCUSSION/OBSERVATIONS **16**

OBJECTIVES VS. RESULTS 16
CRITICAL ISSUES 16
TECHNICAL AND COMMERCIAL VIABILITY OF THE PROPOSED APPROACH 17
SCOPE FOR FUTURE WORK 17

INTELLECTUAL PROPERTIES/PUBLICATIONS/PRESENTATIONS **17**

SUMMARY/CONCLUSIONS **17**

ACKNOWLEDGEMENTS **19**

APPENDICES **20**

APPENDIX A: CITY OF DALLAS BAILMENT AGREEMENT 21
APPENDIX B: CITY OF GALVESTON BAILMENT AGREEMENT 22
APPENDIX C: CITY OF SAN ANTONIO BAILMENT AGREEMENT 23
APPENDIX D: FEDEX EXPRESS BAILMENT AGREEMENT 24
APPENDIX E: UPS BAILMENT AGREEMENT 25
APPENDIX F: FLEET NEEDS ASSESSMENT REPORT 26
APPENDIX G: BOULDER EV SERVICE BODY AERODYNAMIC REPORT 27
APPENDIX H: BOULDER EV FLAT BED AERODYNAMIC REPORT 28
APPENDIX I: BOULDER EV UTILITY VEHICLE AERODYNAMIC REPORT 29

Table of Figures

Figure 1: Service body buildout 11

Figure 2: Service body buildout aerodynamic analysis 12

Figure 3: Flatbed buildout 12

Figure 4: Flatbed buildout aerodynamic analysis 13

Figure 5: Covered service body buildout alternate aerodynamic analysis 14

Abstract / Executive Summary

Boulder Electric Vehicle will produce, deploy and field validate 18 all electric, zero NO_x, advanced zero emissions new vehicle 11,500 GVWR delivery trucks with a patent pending ultra-light-weight aluminum honeycomb composite vehicle frame, a top speed of 65mph and a range of up to 120 miles. Boulder Electric Vehicle will deploy them in three metropolitan non-attainment areas in Texas for a full calendar year. FedEx and UPS will deploy and test a combined total of 9 trucks in the cities of Dallas, Houston and San Antonio. The cities of Dallas, Galveston and San Antonio will deploy and test three vehicles each. The validation of the top speed, range and carrying capacity as well as the heating and cooling of the battery pack will all be validated under real world conditions and duty cycles. Boulder Electric Vehicle has reduced the curb weight of a standard delivery truck from 9,000 lbs. down to near 5,000 lbs. by incorporating patent pending composite aluminum frame technology. Due to the reductions in weight, the size of the battery pack is also greatly reduced, thus lowering the cost of the vehicles and increasing economic viability. Because the ultra-light-weight aluminum honeycomb composite vehicle frames are a departure from the standard steel frame rails, field validations will greatly accelerate the market acceptance and commercialization of this new technology, thereby reducing the NO_x in Texas metropolitan non-attainment areas. The data logged and published from this field validation project will greatly accelerate the market adaptation of this zero emissions vehicle technology as well as validate the potential for great pollution reduction in Texas non-attainment cities.

Introduction / Background

There are three major issues with the performance and therefore market acceptance of large format electric vehicles:

- The vehicles weigh too much and therefore require very large and expensive battery packs.
- The batteries will not perform as well when it is cold (noticeable degradation of range starts at 40 degrees F), and when the temperature goes over 102F the pack starts to "bake" drastically reducing cycle life.
- No one is making a commercially available electric truck that goes faster than 50mph.

Boulder Electric Vehicle has addressed all of these issues in our first prototype 11,500 lbs. GVW vehicle.

Vehicle weight

Boulder Electric Vehicle has filed patents on the ultra-lightweight composite aluminum frame which we think will be a key component in the automotive industry for making vehicles lighter while retaining strength.

Aluminum honeycomb composite is well known in the aerospace industry but has never been used in the automotive industry until now. Our primary invention is the placement of key stringers of tubing inside the honeycomb core in order to stiffen and spread out the load inside the vehicle frame and where it attaches to key suspension points. There are three primary advantages in our frame design over the typical steel frame rail truck design.

First is lightness of the vehicle. Batteries for electric vehicles have such a high cost, that a gain in the efficiency of the vehicle pays for itself through a smaller battery pack and less initial costs. On smaller vehicles such as the Nissan Leaf or the GM Volt the batteries might be 20-30% of the price of the vehicle. On larger trucks the battery pack can be fully 50% or more of the costs of materials in the manufacturing of the vehicle. Especially in the delivery market where there is a great deal of stop and go driving, the reduction in weight offers a tremendous increase in efficiency.

Second is safety. By bringing the battery pack to the center of the vehicle it protects the battery pack from accidents, thus protecting the investment in the high cost battery packs and increasing the Factor of Safety. This also places the weight of the battery pack (1,400 lbs. or more) in the center of the vehicle, increasing the stability and drivability of the vehicle.

Third is the reduced energy needed to manufacture the frame, costs, energy and ease of manufacture is all better than a typical steel frame rail truck. The process is vacuum bagging 6 parts instead of plasma cutting, welding and bolting 30 parts or more. Thus costs and energy to manufacture is dramatically decreased.

Battery Thermal Management System (BTMS)

This is different from the usual Battery Management System (BMS) in that the usual BMS is involved in managing the battery cells during charge and discharge in order to keep track of any over or under voltage conditions outside of normal parameters. Our Battery Thermal Management System (BTMS) allows us to use the same heating and cooling system that we use on the cab of the truck in order to heat and cool the battery pack. We have spent the last 24 months in Colorado testing the system in the summer and winter. At 40 degrees F the range of the battery pack is already being reduced without heating the pack. In minus 20F conditions the range is reduced by 80% without heating the pack. Although it is a much more difficult parameter for a customer to quickly quantify, cooling the pack in the heat of the summer is equally important by keeping cycle life in line with manufacturer's spec. Over 102 F the pack is being baked. The cycle life can be reduced by up to 80% just by a few weeks of operations at this higher temperature. The problem is compounded by the necessary placement of the battery pack about 1 foot above the black pavement. Therefore we cool the battery pack. No one else has implemented this in electric trucks.

Highway capable electric trucks

Boulder Electric Vehicle's top speed is 65 mph. We are the only electric truck OEM that offers this speed. From a department of transportation legal perspective any vehicle that gets on an interstate highway *must* be capable of going at least 10 mph *less* than the posted speed limit. Since many states have speed limits of 75 mph this dictates a 65mph speed. For large format electric vehicles this means either a motor/controller with a greater amount of torque and power, or a transmission. This is *not* hard to do. *But* the market dictates that this *must* be done. The only reason we can speculate as to why neither Smith nor Navistar has done this is that both of their designs were finalized in England where this is not a market driven necessity. We have also observed through our own extensive testing of our prototype truck that higher speeds will decrease range and therefore make the trucks even more expensive to produce or else lower in range.

Project Objectives / Technical Approach

Project Objectives:

Within the grant contract language pertaining to Task 1 there were three clear tasks to complete for the deliverables:

- Legal test agreements,
- Fleet demonstration partners needs assessments,
- Engineering aerodynamic analysis.

Boulder Electric Vehicle personnel were assigned and executed the sub-tasks with standard oversight in place to make sure the tasks were completed in a timely manner.

There was the need to draft test/bailment agreements and have them signed by the demonstration partners. This drafting of language area was covered by the PI and Boulder Electric Vehicle CEO Carter Brown, Boulder Electric Vehicle CFO Pete Averson as well as Boulder Electric Vehicle's Law firm. The signing of agreements was implemented by Carter Brown and Boulder Electric Vehicle Texas Fleet Partner Director Gerry Dameron.

There was the need for fleet demonstration partner needs assessments which was completed by Carter Brown with FedEx and UPS and Gerry Dameron with all three Texas City demonstration partners, the Cities of Dallas, Galveston and San Antonio. Then there was the need to determine the effects of turning our vehicles from delivery trucks into flat bed or service bodies. We have previously gotten these specific model variations CARB certified thus the main work involved determining from an engineering standpoint the best way to implement these particular build outs. Dave Gorham, Norm Smith and Zach Tyler, Boulder Electric Vehicle engineers and designers, were tasked with the configuration analysis as well as the aerodynamic studies and weight ratio effectiveness.

The project objectives all tie in to Tasks 2 thru 6 of the grant proposal.

The tasks are as follows:

- Task 2: Vehicle production
- Task 3: Vehicle deployment
- Task 4: Vehicle demonstration
- Task 5: Post-demonstration vehicle durability analysis
- Task 6: Reporting

There was no specified objectives relating to Task 1 in either the grant application or the grant contract. However the intent of Task 1 was to lay a clear cut line of sight for completion for all of the following tasks, both from a legal point of view as to how the vehicles are insured and disposition of the vehicles after the 1 year test period, as well as from a practical point of view as to how the vehicles would be charged and used once actually delivered to the field validation partners.

This resulted in the sub tasks within Task 1 being met with due diligence and in a timely manner through the above mentioned sub-task assigned personnel. We were able to recognize early in the process that one of the key test partners was not able to live up to the obligations. We then made alternate arrangements for those three vehicles to move to the FedEx fleet, with the fleet managers at FedEx and with the grant managers at TCEQ.

By completing Task 1 we are laying a substantial foundation for success in all of the tasks to follow. The project objectives listed below will all be met during Tasks 2 thru 6 as this project moves forward.

Project Objectives:

1. Build 18 advanced zero emissions electric delivery and work trucks during Q 3 & 4 of 2011.

2. Deploy all 18 trucks in varying climate conditions in non-attainment areas in Texas as follows: 3 for each city fleet of Dallas, Galveston and San Antonio, 6 for FedEx and 3 for UPS. This will take place for the entire calendar year of 2012.
3. Provide high media visibility launch events to educate the public and other potential commercialization partners on the advantages of these new vehicles and their emissions reduction technology.
4. Monitor and collect data on range, charging cycles, temperature and humidity conditions during calendar year 2012. Specifically collect data to validate the effectiveness of Boulder Electric Vehicle's battery pack heating and cooling.

Tasks

Task 1

Within Task 1 there were three clear cut areas of execution, each with their own responsible individuals or teams of individuals within Boulder Electric Vehicle. These areas were:

- Legal test agreements,
- Fleet demonstration partners needs assessments,
- Engineering analysis.

There was the need to draft test/bailment agreements and have them signed by the demonstration partners

Demonstration partner bailment agreements

From the Grant Activities (Scope of Work):

> *Task 1: Demonstration preparation and vehicle design adjustments*
>
> *2.1. Task Statement: The PERFORMING PARTY will coordinate with demonstration partners to prepare for vehicle demonstration and detail the various upper body build outs in accordance with the needs of the demonstration partners.*
>
> *2.1.1. The PERFORMING PARTY will coordinate with the demonstration partners to develop and formalize partnership agreements for the demonstration period. Demonstration partnership agreements must address truck insurance during the demonstration and disposition of the trucks after the grant contract expiration.*

A basic test or bailment agreement was developed from the template of one of the largest public fleets in America. This drafting of language area was covered by the PI and Boulder Electric Vehicle CEO Carter Brown, Boulder Electric Vehicle CFO Pete Averson as well as Boulder Electric Vehicle's Law firm. The signing of agreements was implemented by Carter Brown and Boulder Electric Vehicle Texas Fleet Partner Director Gerry Dameron.

This bailment agreement was submitted to the TCEQ legal department for review. Insurance issues and how they would be addressed were considered and addressed in a phone conference with the TCEQ grant manager, the TCEQ attorney, Boulder EV's Principal Investigator and CEO and Boulder EV's CFO. Bailment agreements were sent to all of the demonstration partners. The Fleet and or City managers forwarded these to their legal departments for review. Upon mark up by the demonstration partner's legal departments the mark ups were sent to the TCEQ attorney for review. Bailment agreements were then signed by both Boulder Electric Vehicle and each of the five demonstration partners.

All agreements address truck insurance and the disposition of the vehicles after the 1 year of testing. All Fleet demonstration partners will maintain full liability insurance on the test vehicles. At least 1 out of 6 vehicles will come back to Boulder EV for post operations analysis and testing. All other vehicles will stay in use in non-attainment cities in Texas by the Fleet Demonstration Partners. Boulder Electric Vehicle will continue logging data on the vehicles for as long as they are in operation.

These agreements are attached as Appendices A thru E.

Key considerations

Boulder Electric Vehicle will provide the Demonstration Vehicles and vehicle training without charge to the Field Validation Partner including:

- Delivery and Pick up of the Demonstration Vehicles
- Providing the SJ 1772 connector and junction box and the vehicle's on board charger and supervising correct wiring of junction box
- Approximately monthly visits during CY 2012 of Boulder EV's service, maintenance and data logging technicians
- Initial on-site driver training by Boulder EV's service engineers
- Initial and Follow Up on-site maintenance training for city auto maintenance technicians and supervisors
- Data logging results to be shared with the Demonstration Partner
- Licensing of the test work vehicles during the test period

The Fleet Demonstration Partners will bear the following obligations:

- Be responsible for running a 220 volt 50 amp AC wiring for a charge outlet.
- Maintain liability insurance for Bailed Vehicles.
- Make sure vehicles are available for pre-scheduled monthly safety, maintenance and data logging inspections.
- Provide and pay for electricity to charge the Bailed Vehicles.
- Park the vehicles outside at all times so as to generate accurate data of weather related performance of the vehicles in accordance with the TCEQ grant which is funding this project.
- Allow Boulder EV's service technicians access throughout the entire test period for downloading data logging information

Demonstration partner needs assessments

From the Grant Activities (Scope of Work):

> *2.1.2. The PERFORMING PARTY will coordinate with the demonstration partners to determine their individual vehicle needs.*

There was the need for fleet demonstration partner needs assessments which was completed by Carter Brown with FedEx and UPS and Gerry Dameron with all three Texas City demonstration partners, the Cities of Dallas, Galveston and San Antonio. Each Fleet demonstration partner was contacted and a needs assessment drafted and determined.

Specific granular detail such as preferred tire size, shelving strength and rear door type was determined for the commercial fleet demonstration partners. These partners FedEx and UPS prefer this information to remain confidential and unpublished.

The city fleet validation partners were contacted and a needs assessment performed. The vehicle types will remain almost identical for all 3 cities with each of them demonstrating a Delivery Van (DV), a Service Body (SB) and a Flat Bed (FB). The main option for the Delivery Vans was whether they needed shelves or an open box. The main options determined were whether the flat beds would need stake sides or remain a pure flat bed and what surface, wood, smooth steel or tread plate was preferred by the fleet manager of each demonstration partner city.

FedEx representatives visited Boulder Electric Vehicle's Lafayette, Colorado plant. In order to best determine the needs of an all-electric work truck within the FedEx Fleet.

Representatives from Boulder EV conferenced with all three Texas City Fleet managers as well as UPS to best determine the needs of the specific fleets.

A needs assessment report was developed for each of the five demonstration partner fleets. This needs assessment report is attached as Appendix F.

Aerodynamics analysis

From the Grant Activities (Scope of Work):

> *2.1.3. The PERFORMING PARTY will perform aerodynamic analysis for the additional needs and considerations inherent in the various body build outs, particularly the service side and flatbed configurations.*

There was the need to determine the effects of turning our vehicles from delivery trucks into flat bed or service bodies. We have previously gotten these specific model variations CARB certified and are determining from an engineering standpoint the best way to implement these particular build outs. Dave Gorham, Norm Smith and Zach Tyler, Boulder Electric Vehicle engineers and designers, were tasked with the configuration analysis as well as the aerodynamic studies and weight ratio effectiveness. Full Reports for this sub task in Appendices G and H.

Service body aerodynamic study

Figure 1 shows the Solidworks model of a Boulder Electric Vehicle all electric truck with a Service Body build out. This is the model that was used for the aerodynamic simmulations.

Figure 1: Service body build out

The study consisted of a service body vehicle being designed in Solidworks based off of files provided by Knapheide Corporation, the leading American made manufacturer of service body build outs. Boulder Electric Vehicle engineers altered the design so that the files would represent solids. This enabled a more accurate aerodynamic analysis within the fluid dynamics computer driven simulations.

A computer model of the service body vehicle was placed in a virtual wind tunnel, with airspeeds at 60mph. Flow Trajectories, Surface Pressures and 3D profiles in both the overhead and side planes were obtained from the results of the simulations.

After analysis of the results of the simulations a hypothesis was developed we concluded that the aerodynamics of the service body itself might be improved by using a different type of service body which has a cover. This covered service body is readily available from Knapheide Corporation and may even offer the end user additional safety features as well as improved aerodynamics. We also theorize that the aerodynamic resistance where the 80 inch wide cab expands to the 94 inch wide service body might be improved by an additional fiberglass flange. These conclusions will warrant a further study and recommendation in relation to Task 2.1.4. We also believe that if it is possible to log the amount of time the service vehicles and flat beds operate at speeds greater than 30 MPH it would be beneficial as to determining the importance of aerodynamics in vehicles of this type.

Figure 2 shows an overhead screen shot of a Boulder Electric Vehicle all electric truck with a service body build out with the devloping air bubble within the service body part of the truck and the truck moving at a forward speed of 60 mph.

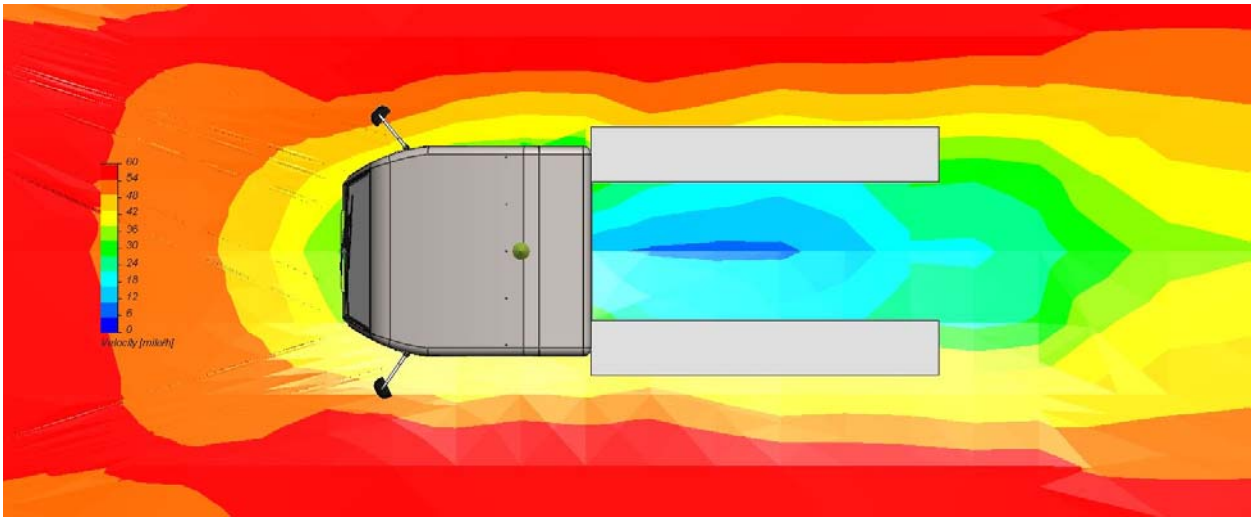

Figure 2: Service body build out aerodynamic analysis

The full Aerodynamic report for the Service Body build out is available as Appendix G.

Flatbed aerodynamic study

Figure 3 shows a Solidworks model of a Boulder Electric Vehicle with a Flat Bed build out. This is the model that was used for the aerodynamic simmulations.

Figure 3: Flatbed build out

A flatbed vehicle was designed in Solidworks based off of a Knapheide model for aerodynamic fluid studies. The study consisted of the flatbed vehicle being placed in a virtual wind tunnel, with airspeeds at 60mph. As expected, there was a vacuum that was formed behind the main cab. The results also show a slight impact in velocity caused by the leading edges of the flatbed at 2 ft. high.

It is recognized that the aerodynamics of a flatbed truck will change dramatically depending on the particular cargo placed on the flat bed. Two hundred folding chairs and a party tent surrounded by a stake side will be dramatically different than a pile of dirt with a tarp strapped down over it. We believe that since the aerodynamics will be so drastically different due to the load an end user places upon the vehicle, that there is no real quantitative improvement that a designer or an OEM can implement. Therefore we conclude that like the service body we would like to monitor and log the amount of time an average city fleet might spend with their flat beds at 30-60MPH. This will determine in the long run whether improving the aerodynamics of these kinds of vehicles will improve the range of electric vehicle flatbed trucks or if it is a non-issue.

Figure 4 is a pressure chart in side profile of aBoulder Electric Vehicle all electric truck designed with a flat bed body build out.

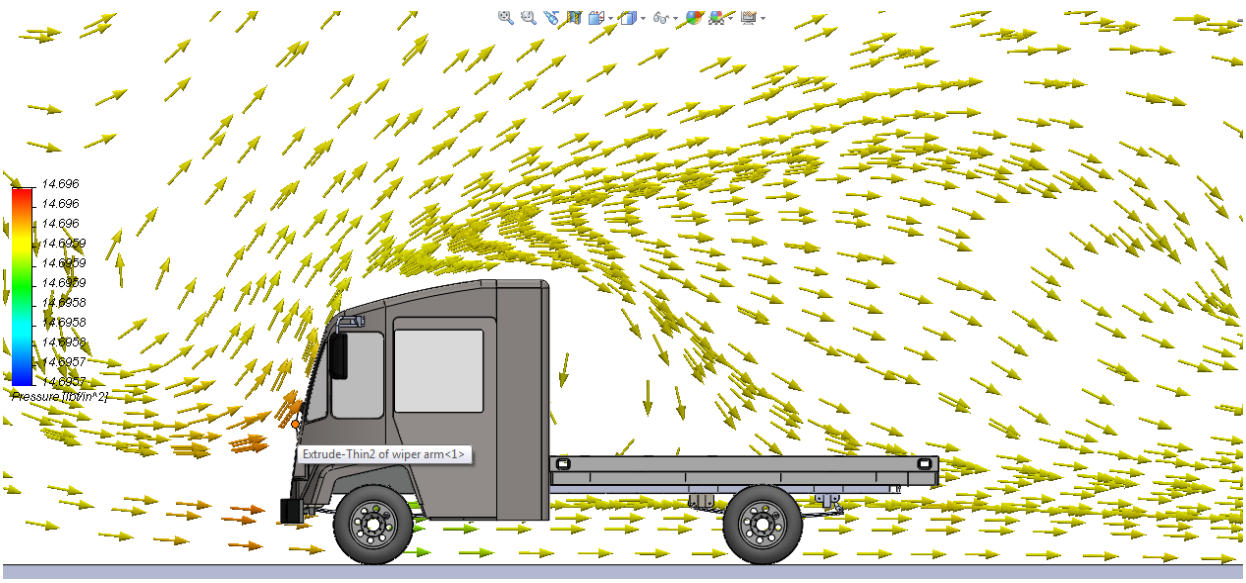

Figure 4: Flatbed build out aerodynamic analysis

The full study is attached a separate document as Appendix H.

Additional CAD and aerodynamic analysis

From the Grant Activities (Scope of Work):

> *2.1.4. The PERFORMING PARTY will perform additional CAD simulations to improve aerodynamic effects of the demonstration partners' required upper body designs to enhance the aerodynamic efficiency of the various upper body build outs.*

After the above aerodynamic studies we theorized that a service body build out with an enclosure would reduce the aerodynamic drag and improve efficiency. We modeled what we theorized would be a more efficient build out option for the service body build out. However our theoretical improvements turned out to be less than optimal and were determined to be unsatisfactory.

The study consisted of a utility vehicle body being designed in Solidworks based off of files provided by Knapheide Corporation. Boulder Electric Vehicle engineers altered the design so that the files would represent solids and be compatible with the aerodynamic modeling software. This allowed for the software to recognize the shape of the utility vehicle without taking into account the small cracks like keyholes or hinges.

A computer model of the utility vehicle body was placed in a virtual wind tunnel, with airspeeds at 60mph. Flow Trajectories, Surface Pressures, and 3D Profiles in the Top and Side planes were obtained from the results of the simulations. The hypothesis of this study is that the Utility Vehicle would be more aerodynamic, causing it to be a more efficient vehicle.

After analysis of the results of the simulations, it was clear that the Utility Vehicle not only was less aerodynamic for our vehicle, but would also weigh 1,200 lbs. more. The reason for this is that the service body creates a bubble behind the cab, which allows the airflow to pass over it without causing more drag. Figure 1 shows the Side Cutaway view at 60mph of the Utility Vehicle body, which also has a vacuum behind it. The Utility Vehicle Body from a heads on view also has a much larger surface area than the Service Body, which causes more resistant force. The Service Body experienced 202 lbs. of force whereas the Utility Vehicle Body experienced 250 lbs. of force.

Figure 5 shows a Boulder Electric Vehicle all electric truck with a completely covered version of a service body build out. The aerodynamic drag is greatly increased on the rear of the vehicle as well as the side surfaces.

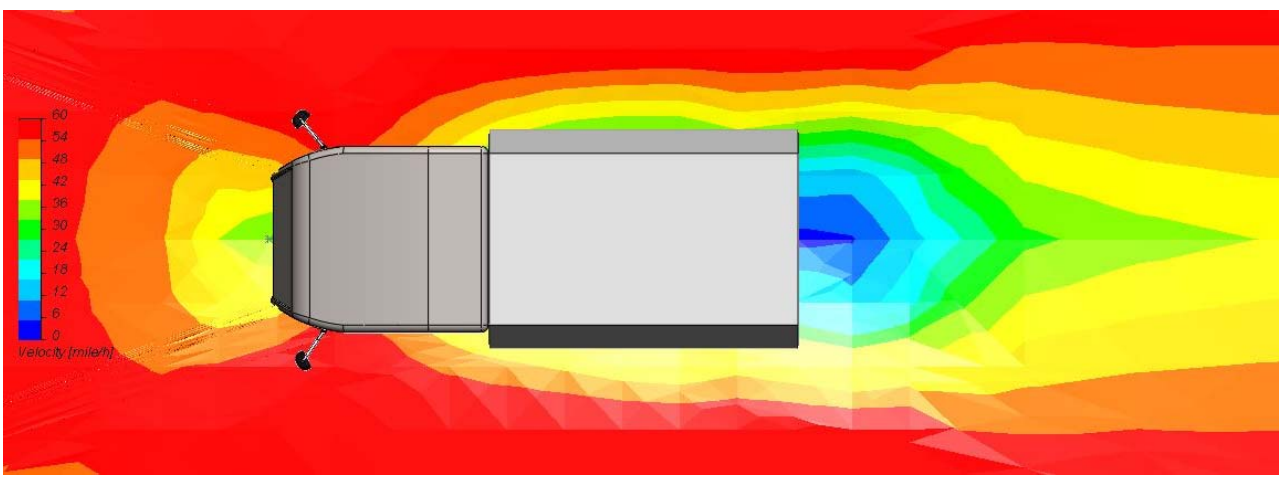

Figure 5: Covered service body build out alternate aerodynamic analysis

The complete study is attached as Appendix I.

Demonstration partner charging preparation

From the Grant Activities (Scope of Work):

> *2.1.5. The PERFORMING PARTY will coordinate with the demonstration partners' on-site fleet managers to ensure that charge plugs will be ready when the demonstration vehicles are delivered.*

Two documents were created to help facilitate this; first a "Fleet Manager's Guide" to EV charging which details how to wire the charge port, and all of the considerations leading up to that. It is basically a "read and comprehend" type document so that the fleet manager understands what is needed to get ready before the trucks are delivered. This document has a sign off date so that we are aware that each fleet manager has signed off on it. The second document is a checklist for each task a fleet manager has to accomplish in order for the chargers to be hooked up by the time the vehicles arrive. The Fleet manager document is provided as Appendix J. The Checklist document appears as Appendix K.

This will be ongoing and concurrent with Task 2, the completion of which we anticipate will be in place at least 30 days before delivery of the vehicles in January of 2012. We have found it to be an unreasonable request to ask fleet managers to pull permits and wire charge ports before the signing of a Task 2 NTP in which we are sure the remainder of the project will be funded to a successful completion. When the first of the 18 vehicles is complete which we anticipate will be in October of 2011, we plan on bringing it down to Texas for a visit with all of the demonstration partner fleet managers for a ride and drive which will help accelerate the wiring of the charge ports.

Schedule and deliverables

From the Grant Activities (Scope of Work):

> *2.1.6. Schedule: The PERFORMING PARTY shall complete this task within 2 months of the signed Notice to Proceed Date as issued by TCEQ.*

NTP for Task 1 was issued on June 14, 2011, and therefore the date of August 1, 2011 is well within the time limit.

From the Grant Activities (Scope of Work):

> *2.1.6. Deliverables: The PERFORMING PARTY shall submit a report to the TCEQ upon completion of this task. This report will include but is not limited to: copies of agreements with all demonstration partners, a report on demonstration partners' needs, an aerodynamic report on service side and flatbed build outs*

Copies of agreements with all demonstration partners are attached as Appendices A through E. A report on demonstration partners' needs are attached as Appendix F. Aerodynamic reports on service side and flatbed build outs are attached as appendices G through I.

From the Grant Activities (Scope of Work):

2.1.7. Approval to Proceed with Further Tasks: The TCEQ will determine whether additional tasks will be approved and funded depending upon the success of completing this task. The PERFORMING PARTY must receive written approval from TCEQ to proceed with any further tasks, partially or in entirety, in order for those tasks to be eligible for additional funding under this Agreement. The PERFORMING PARTY shall provide TCEQ with a proposed agreement with each of the demonstration partners for review. The TCEQ shall have the right and opportunity to provide comments and suggestions regarding the terms of the agreement. The TCEQ also shall be provided evidence of insurance coverage for each of the demonstration partners and demonstration trucks before proceeding with any further tasks.

. Boulder Electric Vehicle feels that we have completed Task 1 successfully. We are requesting a written Notice To Proceed with Tasks 2 – 6 at the soonest possible time from TCEQ so that we can complete the tasks, goals and objectives of the grant in a timely manner.

Discussion / Observations

Objectives vs. Results

The intent of Task 1 was to lay a clear cut line of sight for completion for all of the following tasks, both from a legal point of view as to how the vehicles are insured and disposition of the vehicles after the 1 year test period, as well as from a practical point of view as to how the vehicles would be charged and used once actually delivered to the field validation partners.

This resulted in the sub tasks within Task 1 being met with due diligence and in a timely manner. We were able to recognize early in the process that one of the key test partners was not going to be able to live up to the obligations. We then made alternate arrangements for those three vehicles to move to the FedEx fleet, both with the fleet managers at FedEx and with the grant managers at TCEQ.

Critical issues

The most critical issue to overcome during Task 1 of this project was the legal questions involved from all sides on drafting agreements between Boulder Electric Vehicle and the field demonstration partners. Not only were the requirements for insurance needing to be addressed but since the 18 test vehicles themselves fall under the category of “equipment” from a budgetary point of view, the disposition of the equipment needed to be addressed in a satisfactory and timely manner by all parties. These issues were all resolved by multiple e mails, phone calls and document mark ups. Legal documents needed to be drafted, reviewed, marked up, re reviewed and signed. The only suggestion the PI has for future endeavors of this type would be to bring all attorneys involved physically to the same table (preferably with barbeque) for negotiations over mutually acceptable language. Unfortunately the project timeline, budget, and the seven attorneys involved (five demonstration partner’s, one each from Boulder Electric Vehicle as well as TCEQ) schedule’s would permit this. None the less the documents were

drafted marked up and signed with great speed and clarity leading to a successful completion of Task 1.

Technical and commercial viability of the proposed approach

After completion of Task 1 of the BOULDER ELECTRIC VEHICLE FIELD VALIDATION PROJECT 2012, we believe even more strongly in the commercialization plan and rapid adoptions of our ultra-light weight all electric trucks. From a commercialization point of view all of the field demonstration partners fully understand and appreciate the value of lighter all electric zero-emissions vehicles which are able to handle the same cargo capacity as heavier diesel burning trucks. Throughout the completion phase of Task 1 our engineers and manufacturing staff have been working on implementing inventory and process control procedures which will result in a timely completion for Task 2 vehicle production. In addition our electrical engineers have been implementing additional data logging features so as to have additional data to draw upon during Task 4 - Vehicle demonstration as well as Task 6 – reporting.

At the moment we do not see any technical challenges in the tasks to follow Task 1.

Scope for future work

The scope of future work will be all 5 of the remaining tasks within this project funded by TCEQ NTRD. The tasks are as follows:

- Task 2: Vehicle production
- Task 3: Vehicle deployment
- Task 4: Vehicle demonstration
- Task 5: Post-demonstration vehicle durability analysis
- Task 6: Reporting

Intellectual Properties / Publications / Presentations

There are no patent filings, invention disclosures, publications or presentations planned or made as a result of our successful completion of Task 1 of the project that we know of, other than TCEQ's possible publication of any of the attached documents as appendices.

Summary / Conclusions

As a result of the aerodynamic studies there is one key piece of data that if possible we would like to collect on the City Flat Bed and Service Body vehicles. This additional data we would like to collect is the amount of miles driven by these types of vehicles above 30 mph. The loads on vehicles are inertia at 0 thru 30 mph and aerodynamic resistance from 30 mph on up. If the

amount of miles at over 30 mph is only a small fraction of the usage miles for this particular type of vehicle then it would suggest that greater emphasis be placed on reducing the weight of the build out features rather than reducing the aerodynamic drag.

Acknowledgements

We would like to thank all of the managers and staff at TCEQ's NTRD division, in particular Kate Williams and Colin Donovan, for processing the grant contract in a very timely fashion and being incredibly responsive to any issues or questions we may have. We would like to thank the TCEQ attorney Steve Talcott for providing guidance and markups with a quick turnaround even when his workload demanded in other parts of the organization was overly substantial. We would like to thank both FedEx and UPS as corporations who share our vision of a zero emissions, zero NO_x transportation future and their commitment to helping improve the "state of the art" in electric vehicles. We would like to thank the Fleet managers and sustainability and environmental policy directors in the Cities of Dallas, Galveston and San Antonio all of whom played a great part in both the writing of the grant but in the incredibly speedy turnaround of the legal documents involved in Task 1. We would also like to thank the engineers at Knapheide Corporation for working so closely with us and providing computerized models of their flat bed and service body build outs. Lastly we would like to thank the engineering interns at Boulder Electric Vehicle who as always offer great help in getting the real work done, Keziah Peterson and Bryan Graves.

Appendices

Appendix A – City of Dallas Bailment Agreement

Appendix B – City of Galveston Bailment Agreement

Appendix C – City of San Antonio Bailment Agreement

Appendix D – FedEx Express Bailment Agreement

Appendix E – UPS Bailment Agreement

Appendix F – Fleet Needs Assessment Report

Appendix G – Boulder EV Service Body Aerodynamic Report

Appendix H – Boulder EV Flat Bed Aerodynamic Report

Appendix I – Boulder EV Utility Vehicle Aerodynamic Report

Appendix J – Fleet Manager Charge Station Install Guide

Appendix A: City of Dallas Bailment Agreement

The information in this appendix can be accessed by contacting the New Technology Research and Development program at:

(512) 239-4950

Or

ntrd@tceq.state.tx.us

Appendix B: City of Galveston Bailment Agreement

The information in this appendix can be accessed by contacting the New Technology Research and Development program at:

(512) 239-4950

Or

ntrd@tceq.state.tx.us

Appendix C: City of San Antonio Bailment Agreement

The information in this appendix can be accessed by contacting the New Technology Research and Development program at:

(512) 239-4950

Or

ntrd@tceq.state.tx.us

Appendix D: FedEx Express Bailment Agreement

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Or

ntrd@tceq.state.tx.us

Appendix E: UPS Bailment Agreement

The information in this appendix can be accessed by contacting the New Technology Research and Development program at:

(512) 239-4950

Or

ntrd@tceq.state.tx.us

Appendix F: Fleet Needs Assessment Report

The information in this appendix can be accessed by contacting the New Technology Research and Development program at:

(512) 239-4950

Or

ntrd@tceq.state.tx.us

Appendix G: Boulder EV Service Body Aerodynamic Report

The information in this appendix can be accessed by contacting the New Technology Research and Development program at:

(512) 239-4950

Or

ntrd@tceq.state.tx.us

Appendix H: Boulder EV Flat Bed Aerodynamic Report

The information in this appendix can be accessed by contacting the New Technology Research and Development program at:

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Or

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Appendix I: Boulder EV Utility Vehicle Aerodynamic Report

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