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Bus Efficiency Grant: Hybrid Beltless Alternator Retrofit Program

Final Report

OCTOBER 2019

FTA Report No. 0136
Federal Transit Administration

PREPARED BY

Maryland Department of Transportation
Maryland Transit Administration

U.S. Department of Transportation
Federal Transit Administration

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Federal Transit Administration
Office of Research, Demonstration and Innovation
U.S. Department of Transportation
1200 New Jersey Avenue, SE
Washington, DC 20590

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Metric Conversion Table

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C

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13. ABSTRACT

This report presents the results of an analysis aimed at determining the cost-savings resulting from the installation of a "Hybrid-Beltless Alternator" (HBA) system. The HBA system was installed on 41 Maryland Transit Administration (MTA) buses to reduce alternator maintenance cost and activities, belt-related failures, alternator-related road calls, fuel consumption, and greenhouse gas emissions. Fuel consumption, part-replacement cost, and alternator-related road-call data were obtained from FleetWatch™ and Maximo™; the database management systems used by MTA for bus-related data collection, manipulation, and storage. The results, obtained from analyzing the data gathered, showed that the installation of the HBA on the 41 buses reduced fuel consumption by 6%, reduced CO_2 emission by about 461,000 pounds, and increased the mean distance between alternator-related failure by over 5000 miles. This cost saving was considerably less than the cost saving recorded for the pilot bus (15–20%), possibly due to the variation in route, average speed on route, extended idling due to traffic breakdown, component failure, and maintenance routine between the pilot bus and the 41 retrofitted buses. In addition, the cost saving obtainable from HBA system installation was found to be directly proportional to usage—the higher the miles covered after retrofitting, the higher the cost savings observed.

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Abstract

This report presents the results of an analysis aimed at determining the cost-savings resulting from the installation of a "Hybrid-Beltless Alternator" (HBA) system. The HBA system was installed on 41 Maryland Transit Administration (MTA) buses to reduce alternator maintenance cost and activities, belt-related failures, alternator-related road calls, fuel consumption, and greenhouse gas emissions. Fuel consumption, part-replacement cost, and alternator-related road-call data were obtained from FleetWatch™ and Maximo™; the database management systems used by MTA for bus-related data collection, manipulation, and storage. The results, obtained from analyzing the data gathered, showed that the installation of the HBA on the 41 buses reduced fuel consumption by 6%, reduced CO_2 emission by about 461,000 pounds, and increased the mean distance between alternator-related failure by over 5000 miles. This cost saving was considerably less than the cost saving recorded for the pilot bus (15–20%), possibly due to the variation in route, average speed on route, extended idling due to traffic breakdown, component failure, and maintenance routine between the pilot bus and the 41 retrofitted buses. In addition, the cost saving obtainable from HBA system installation was found to be directly proportional to usage—the higher the miles covered after retrofitting, the higher the cost savings observed.

EXECUTIVE SUMMARY

The Maryland Department of Transportation (MDOT) Maryland Transit Administration (MTA) has 57 model year 2011 New Flyer Xcelsior Low Floor Buses equipped with Allison's second-generation Diesel Electric Hybrid propulsion system, which were delivered with standard belt-driven alternators. These alternators are susceptible to premature failure and cause downtime and road calls due to belt or bearing failure. The expected life of a belt-driven alternator is approximately 3–4 years at MTA, which is the industry standards. On the average, MTA replaces alternator drive belts every 60,000 miles.

In response to changing federal regulations and community pressure, government agencies are increasingly focused on understanding and reducing the environmental impact of their operations. To support this development, MTA's Bus Maintenance initiated aggressive plans to reduce its bus fleet fuel consumption; the Vanner's Hybrid Beltless Alternator (HBA) installation project is one of such plans.

Over 2013 and 2014, Vanner introduced a Hybrid Beltless Alternator (HBA) system that can use power from rooftop hybrid batteries. This product was developed in partnership with Allison, which is the Original Equipment Manufacturer (OEM) for the hybrid propulsion system on all MTA diesel electric hybrid buses. MTA Bus Maintenance retrofitted and tested one pilot unit for over 12 months; the results obtained from the test period showed a 15–20% gain in fuel economy, a reduction in alternator maintenance, belt-related failures, alternator-related road calls, and greenhouse gas emissions. Results obtained from the pilot bus show that its fuel consumption improved by approximately one mile per gallon.

To confirm results obtained from the pilot bus and have a basis for the inclusion of the HBA system in future bus procurements as factory-installed equipment, MTA acquired a grant that allowed for the retrofitting of 41 of its model-year 2011 Xcelsior buses with this new beltless alternator to reduce alternator maintenance, related belt failures, and road calls and improve fuel economy and subsequently, greenhouse gas emissions.

The retrofitting of the system did not void the standard warranty; however, the system is compatible only with the second-generation Allison hybrid propulsion setup. Since the system is 25% lighter than the existing alternator on the hybrid buses, the HBA system is expected to considerably reduce the fuel consumption and the associated emissions of the hybrid buses.

Completion of the retrofit work took approximately 20 months, between May 2016 and December 2017. MTA collected monthly fuel economy data from all buses in the subject fleet. Results of the analysis carried out for the post-retrofit analysis period (January 1, 2018, to April 1, 2019) showed that the Vanner Beltless Alternator Project resulted in some cost savings, but lower than what was initially anticipated. The analysis showed that fuel consumption rate was reduced by 6% after retrofit. In addition, CO_2 emission was reduced by 461,000 pounds, and the Mean Distance Between Failure (MDBF) of belt-related failures increased from 19,258 miles to 26,200 miles (frequency and number of failures per time period dropped).

SECTION

1

Program Details

Project Goal

The project is designed to reduce maintenance costs, energy consumption, and greenhouse gas emissions by investing capital in MTA's legacy fleet with the Vanner HBA setup, an innovative advanced technology that leverages the benefits of a hybrid bus. As a benchmark, the project will also help promote and propagate energy efficiency and emission-reduction considerations at other transit facilities under the jurisdiction of MTA.

Project Participants

MTA, a modal agency under MDOT, is responsible for statewide transit planning and provision of transit service through its various modes, including bus, metro subway, light rail, MARC commuter train, commuter bus, paratransit, and freight. MTA is also responsible for the planning, engineering, project, and retrofit management of transit equipment, facilities, and other capital projects throughout the state.

MDOT has overall responsibility for planning, building, operating and maintaining all transportation and transportation-related facilities within the state. MDOT provides oversight over five modal administrations, which have more direct roles in conducting the planning and implementation for their individual modes.

Completion of the retrofit work on 41 buses took approximately 20 months, between May 2016 and December 2017. Retrofit work was completed by a third-party contractor, Johnson and Towers, located in Baltimore. MTA Bus Maintenance provided oversight and performed a functional test on buses after the retrofit work was complete.

SECTION

2

Project Scope

The scope of this project included to retrofit 41 of MTA's model year 2011 buses with the Vanner HBA setup. The Vanner HBA500-H40EP DC-DC converter uses DC converter technology to replace the traditional alternator and promises to deliver the following benefits:

- 25–30% efficiency improvements over traditional alternator technology
- Fuel economy improvements (approximately 1 mile/gallon) and reduced exhaust emissions
- Stable DC power at all operating temperatures and speeds
- Precise and maintenance-free integrated voltage regulation
- Rugged, reliable performance built to last through bus mid-life and beyond
- Innovative design and installation location that eliminates safety concerns and maintenance problems associated with conventional alternators

The HBA delivers equal or more power than conventional OEM alternators through 85% of the drive cycle. The solid-state design eliminates the reduced or lost power experienced by traditional alternators when internal temperatures increase.

MDOT MTA will eliminate costly downtime and emergency road calls with the Vanner HBA by removing the following high-maintenance parts from a bus:

- Alternator
- V-belts
- Voltage regulator
- Pulleys and idle tensioner
- Hydraulic lines and fittings

Figure 2-1 shows the positioning of the HBA on a bus. Figure 2-2 shows the DC-DC converter.

Figure 2-1

Positioning of HBA on Bus

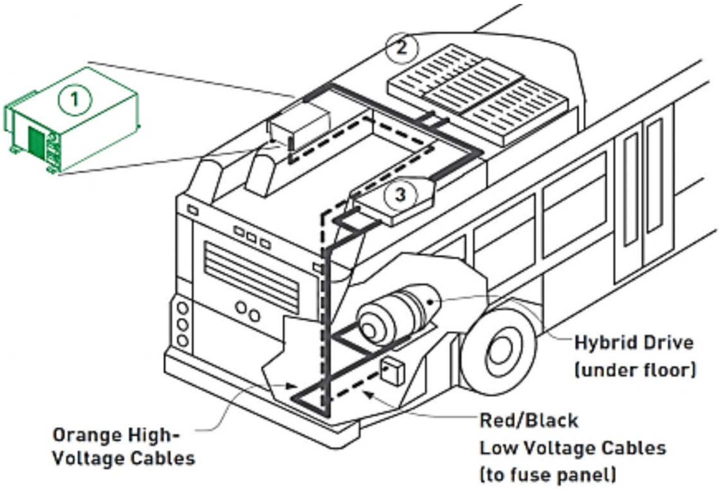
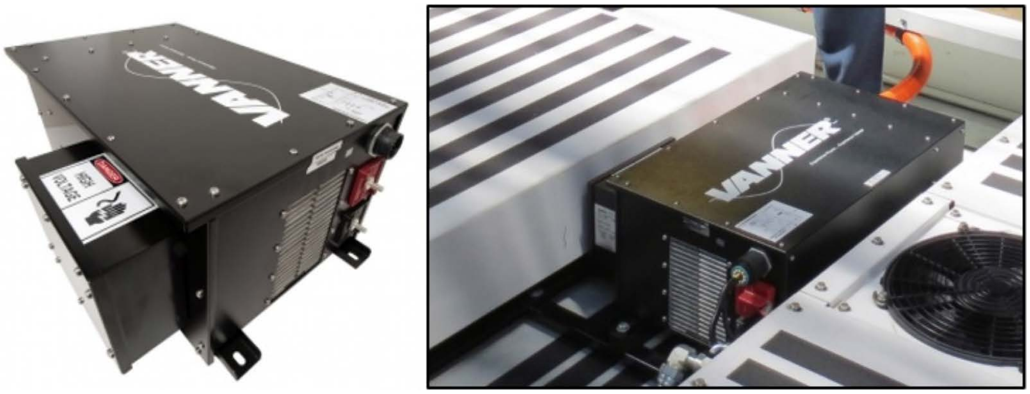


Figure 2-2

Vanner HBA500-H40EP DC-DC Converter



Vanner's standalone battery monitor has a 12-pin Deutsch connector for voltage/current/ temperature signal input, and a Controller Area Network (CAN) Smart monitor that observes and reports the status of several critical functions in the vehicle electrical system. This unit provides real-time fault signals over the CAN bus to the vehicle electrical system controller. It can save data at a specified interval and report later via the CAN. Hence, it is a means of measuring the voltage, current, and health of the battery. To take advantage of these capabilities, MTA installed a Vanner 80-series equalizer with a Controller Area Network (CAN) equipped with temperature, voltage, and current sensors. Coupled with the Vanner HBA, this equalizer monitors and reports the state of charge and state of health of the house batteries. Data collected were plotted to determine the energy demand in time. The monitor was set to record every 10 seconds and had enough memory to record for just over 7 days before overwriting. MTA manually downloaded the data on a weekly basis to ensure that all data were captured.

Figure 2-3

Installation of Vanner HBA

The fuel usage of the bus fleet is structured and well-documented in the MTA's Maximo™ System. The pre and post retrofit fuel consumption for each bus was measured and verified to calculate the savings in accordance with Method A of the International Measurement and Verification Protocol. Fuel consumption for the previous 12-month period was determined by analyzing the data currently in Maximo™. The post retrofit fuel consumption was calculated by analyzing the mileage data in FleetWatch™ on a monthly basis.

Fuel consumption was tracked to demonstrate energy usage reductions resulting from the installation of the HBA unit. MTA used historical data gathered from Maximo™ to establish a baseline.

In addition, this retrofit provided a unique opportunity for MTA to measure the electrical demand of various equipment on the bus. Working with Vanner, MTA installed sensors on the electrical system of selected buses. Vanner's standalone battery monitor has a 12-pin Deutsch connector for voltage/current/temperature signal input and CAN communication and monitors current from two CTs and reports via CAN. It also can save data at a specified interval and report later via CAN. The sensor was capable of measuring voltage, current, and battery health. Data collected were plotted to determine the energy demand in time. The monitor was set to record every 10 seconds and had enough memory to record for just over 7 days before overwriting. MTA manually downloaded the data on a weekly basis ensure that all data were captured.

Table 2-1 shows the data items collected on a weekly basis from the test and control buses.

Table 2-1

Data Collection Methodology

Data Item	Description	Notes
Bus monthly utilization report	Report detailing monthly mileage, fuel economy, and road calls for all bus fleets	Report forms baseline for reliability and cost
Schedule/assignment data for each study bus	Actual bus assignment (block) from depot for each day	Data may be used to determine if location is factor in reliability
Voltage, current, battery health	Monitor ON when battery disconnect switch ON	
Fluids consumption	Fuel, engine oil, coolant, transmission fluid consumption by bus for each fueling (or day)	
Work orders	All work orders for all study buses	
Parts costs	Parts cost for each work order above	
Warranty invoices	If vendors conduct work onsite at MTA for warranty, need invoice describing work done	
Road calls and change outs	Each road call/change out for study buses – description of road call/ change and resolution	

From the data collected above, MTA analyzed fuel consumption by bus and reported on a monthly basis to determine if the expected fuel consumption benefits were observed. Actual emission savings were calculated based on the reduction in fuel consumption.

Since the 1980s, the U.S. Environmental Protection Agency (EPA) has acted several times to address tailpipe emissions of criteria pollutants and air toxics from heavy-duty vehicles and engines. During the last 18 years, these programs have addressed emissions primarily of particulate matter (PM) and the primary ozone precursors hydrocarbons (HC) and oxides of nitrogen (NO_x). These programs have successfully achieved significant and cost-effective reductions in emissions and associated health and welfare benefits to the U.S. and have been structured in ways that account for the varying circumstances of the engine and truck industries. As required by the Clean Air Act (CAA), the emission standards implemented by these programs include standards that apply at the time that the vehicle or engine is sold as well as standards that apply in actual use. As a result of these programs, new vehicles meeting current emission standards will emit 98% less NO_x and 99% less PM than new trucks 20 years ago. The resulting emission reductions provide significant public health and welfare benefits. As a result of the most recent EPA regulations, which were fully phased-in in 2010, the monetized health and welfare benefits are projected to be greater than $70 billion in 2030—benefits far exceeding compliance costs and not including the unmonetized benefits resulting from reductions in air toxics and ozone precursors.

Subject buses that were retrofitted under this project use diesel engines built to meet EPA’s 2010 emission standards and use advanced emission reduction technologies such as Selective Catalytic Reduction to reduce NO_x, HC, and PM and Diesel Exhaust Fluid to convert NO_x emissions into levels of pure nitrogen and water vapor.

Specific to heavy-duty commercial vehicles, regulations set by the EPA for 2010 trucks introduce very stringent emission standards, as follows:

- PM – 0.01 g/bhp-hr
- NO_x – 0.20 g/bhp-hr
- NMHC – 0.14 g/bhp-hr

CO_2 emission reductions for diesel engines can be calculated using EPA's Office of Mobile Sources web page at http://www.epa.gov/OMS/climate/420f05001.htm#calculating, which states: "CO_2 emissions from a gallon of diesel = 2,778 grams x 0.99 x (44/12) = 10,084 grams = 10.1 kg/gallon = 22.2 pounds/gallon."

The reduction in CO_2 emissions will be calculated using this information, which will be directly related to the reduction in fuel used.

Post retrofit evaluation was continued up to 12 months to assess the seasonal effects on fuel consumption and reliability. MTA used a team of experienced individuals to manage this project and ensure that all objectives were achieved. This team also oversaw the proposed subcontractors to ensure that the project was completed in a timely manner within the guidelines of this grant. This team comprised MTA employees and consultants with the necessary experience and expertise to successfully achieve the goals of the project. MTA used a similar approach previously on other projects of this size and magnitude to successfully complete projects.

SECTION

3

Project Results

Fuel Consumption

MTA's 2011 bus fleet includes a total of 57 buses, 41 of which were retrofitted under this program and represent the test buses; the remaining 16 buses were selected as control buses to conduct a valid comparison. Mileage and fuel consumption data were collected from FleetWatch™ (fluid usage tracking technology used by MTA). The collected data for the test buses were analyzed to determine the pre and post retrofit fuel consumption rates of each bus-pre-retrofit (May 1, 2015 to April 1, 2016) and post-retrofit (January 1, 2018 to April 1, 2019). Fuel consumption data were collected and analyzed to determine fuel savings. The data are displayed for each bus in Appendix A.

Most of the retrofitted buses (28 of 41) showed fuel savings (see Appendix A). However, 13 buses consumed more fuel, which can be attributed to several factors, such as average speed on route, extended idling due to traffic breakdown, component failure, which can affect the fuel consumption rate of buses. These factors could not be held constant and, as such, played a major role in the observed increased fuel consumption rate.

Fuel consumption analysis for the entire retrofitted fleet is summarized in Table 3-1.

Table 3-1

Average Fuel Consumption Rates for Test Buses – Pre- and Post-Retrofit Comparison

Average gallons of fuel consumed per mile (pre-retrofit)	0.2032 gal
Average gallons of fuel consumed per mile (post-retrofit)	0.1921 gal
Average fuel saving per bus per mile	0.0111 gal
Percent reduction in fuel consumption	6%

Results indicate that the MTA test fleet experienced an approximately 6% reduction in fuel consumption. Figure 3-2 shows the actual fuel consumption of the test buses by month. The greatest fuel saving was observed in November 2018, as the buses covered an additional 10,000 miles relative to other months.

Figure 3-1

Actual Fuel Consumption, Post Retrofit

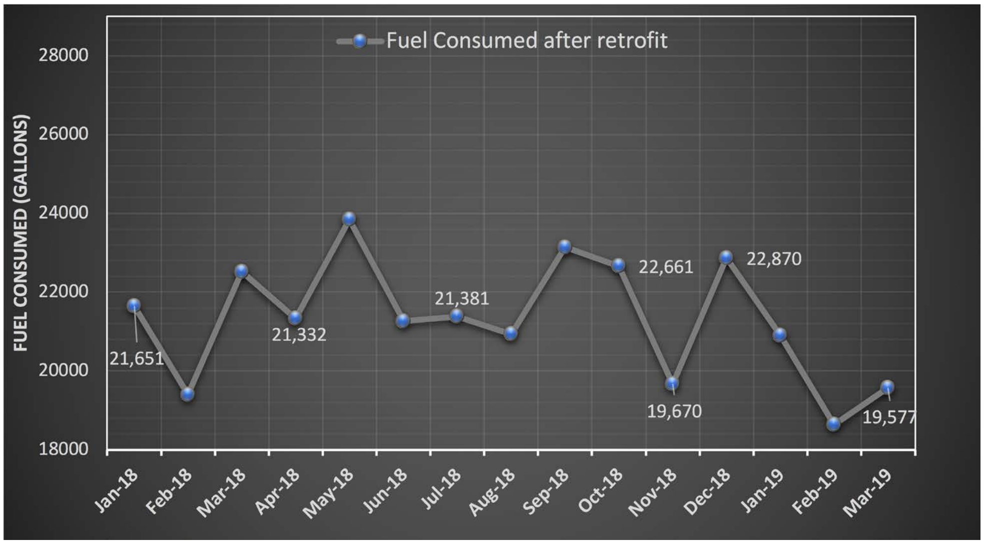


Figure 3-2 shows the cumulative amount of fuel savings for each month within the study period. It is estimated that these 41 test buses collectively saved 19,500 gallons of diesel fuel over the 15 months following the retrofit.

Figure 3-2

Cumulative Fuel Saved, Post Retrofit

Table 3-2 shows a summary of fuel savings resulting from the retrofitting—fuel cost = $3.28 (as of 04/16/2019).

Table 3-2

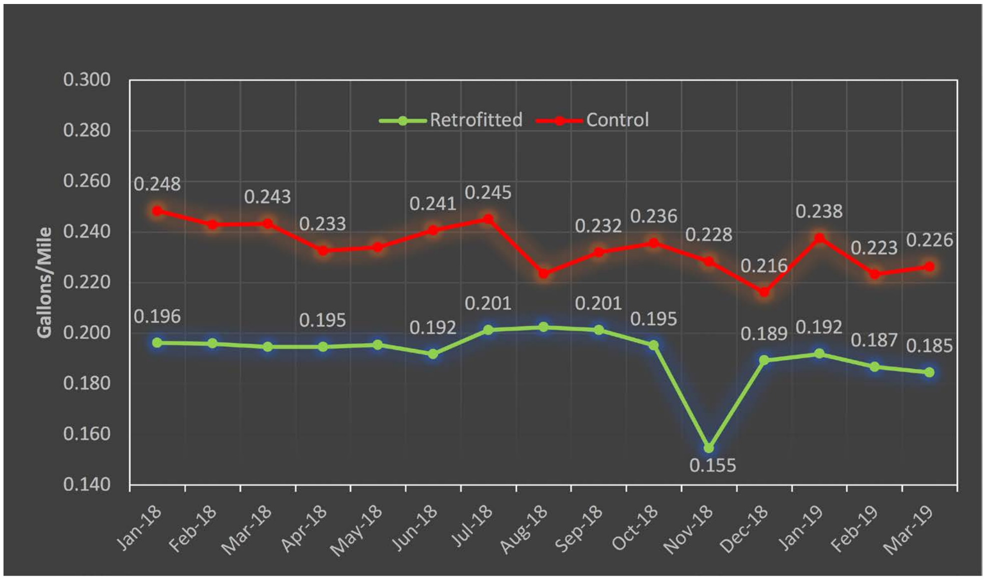
Fuel Cost Saving Analysis for All 41 Test Buses

	Avg Bus Miles/Gal (Pre-Retrofit)	Avg Bus Miles/Gal (Post retrofit)
Miles per Gallon	4.92	5.20
Post Retrofit Analysis for Entire Retrofitted Fleet		
Gallons of fuel saved	19,499.78 (over 15 months)	
Avg monthly savings	$4,264	
Savings (annual)	$51,168	

In total, 41 buses of the 2011 bus series were retrofitted; the remaining 16 (the control group) continued with the belt-driven alternators. Mileage and fuel consumption data from January 1, 2018, to March 31, 2019, obtained from FleetWatch™, were used to calculate the average monthly fuel consumption rate (gallon per mile) of the retrofitted and control buses. The results of the analysis are shown in Figure 3-3.

Figure 3-3

Cumulative Fuel Saved over Post Retrofit Analysis Period



The higher the usage of the retrofitted buses, the lower their overall fuel consumption rate (more fuel saving). Figure 3-3 shows that the most fuel was saved in November 2018, as the retrofitted buses were more used that month, accumulating about 10,000 additional miles relative to other months.

In summary, for the period of analysis, the average fuel consumption of the retrofitted fleet was 0.192 gallons per mile, and that of the control fleet was at 0.234 gallons per mile. Hence, the control fleet consumed 22% more gallons per mile than the retrofitted fleet.

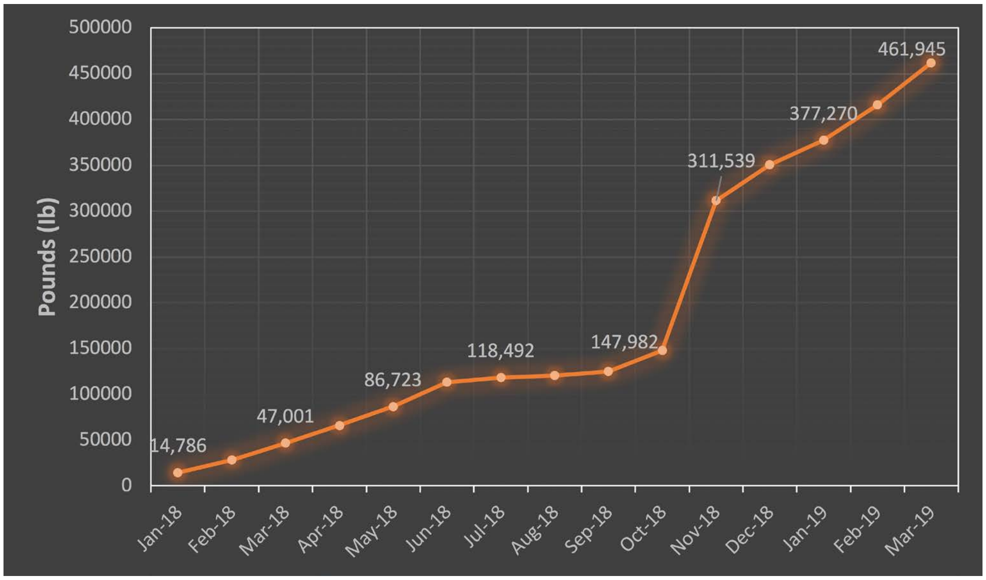
Emissions

MTA's model year buses 2011 use diesel engines that are EPA 2010 compliant. Emission reduction technologies such as Selective Catalytic Converters and a Diesel Exhaust Fluid system are used to minimize the environmental impact of the exhaust gases.

According to the U.S Energy Information Administration, for every gallon of diesel, 22.4 pounds of CO_2 is released. Using this and the fuel consumption data, cumulative CO_2 reduction was calculated and plotted, as shown in Figure 3-4.

Figure 3-4

Cumulative Reduction in CO_2 Emissions



A cumulative CO_2 reduction of 461,945 pounds was achieved over the 15 months following completion of the retrofits.

Overall Maintenance

The Mean Distance Between Failure (MDBF) for belt-related failure was calculated pre and post retrofit. Subsequently, an analysis was conducted to determine the number of belt-related failures that would have occurred had the retrofitting not been done. This was compared with the actual number of belt-related failures, observed after retrofit, to determine if any cost savings occurred. The analysis was conducted for only the retrofitted buses; the results are shown in Table 3-3.

Table 3-3

Maintenance Savings Associated with Belt Failures

	Pre-Retrofit	Post-Retrofit
Mean distance between failure (MDBF) in miles	19,258	26,275
Distance covered in analysis period in miles	1,718,044	
Number of belts changed	89	65
Labor cost	$ 3,345	$ 2,452
Material cost	$ 8,921	$ 6,539
Down time cost	$ 6,691	$ 4,904
Post retrofit cost savings – over 15 months	$ 5,062	

As displayed in Table 3-3, the test fleet collectively saved $5,062 during the analysis period of 15 months. This $100-per-bus per year saving is as a result of reduced belt maintenance and increased MDBF.

The new HBA units will not need to be replaced until the buses are retired. On the other hand, buses with conventional alternators experience one alternator replacement, on average, between ages 7 and 13. Each conventional alternator costs approximately $2,300, and associated hardware such as belts and cable cost an additional $170. On average, it takes four labor hours to replace an alternator. Table 3-4 details these costs.

Table 3-4

Conventional Alternator Replacement Cost per Bus Over 6 Years

	Qty	Unit Cost	Total
Labor	4	$ 75	$ 300
Materials	1	$ 2,467	$ 2,467
Downtime Cost	4	$ 150	$ 600
			$ 3,367

Combined annual maintenance savings for each bus is estimated to be around $659.95 for each bus—$98.78 due to reduced belt maintenance and $561.17 due to reduced alternator replacement costs. Table 3-5 projects the estimated maintenance and fuel savings between the completion of the retrofits and the expected retirement of these vehicles.

Table 3-5

Estimated Average Savings (Projected 2024 Retirement)

Year	Total Mileage	Fuel Savings (gal)	Fuel Savings	Maintenance Savings	Total Savings
2017	655,347	7,332	$24,049	$12,717	$36,766
2018	1,394,356	15,600	$51,168	$27,058	$78,226
2019	1,422,243	15,912	$52,191	$27,599	$79,790
2020	1,450,688	16,230	$53,235	$28,151	$81,386
2021	1,479,702	16,555	$54,300	$28,714	$83,014
2022	1,509,296	16,886	$55,386	$29,288	$84,674
2023	1,539,482	17,223	$56,494	$29,874	$86,368
2024	1,570,271	17,568	$57,623	$30,472	$88,095
					$618,320

SECTION

4

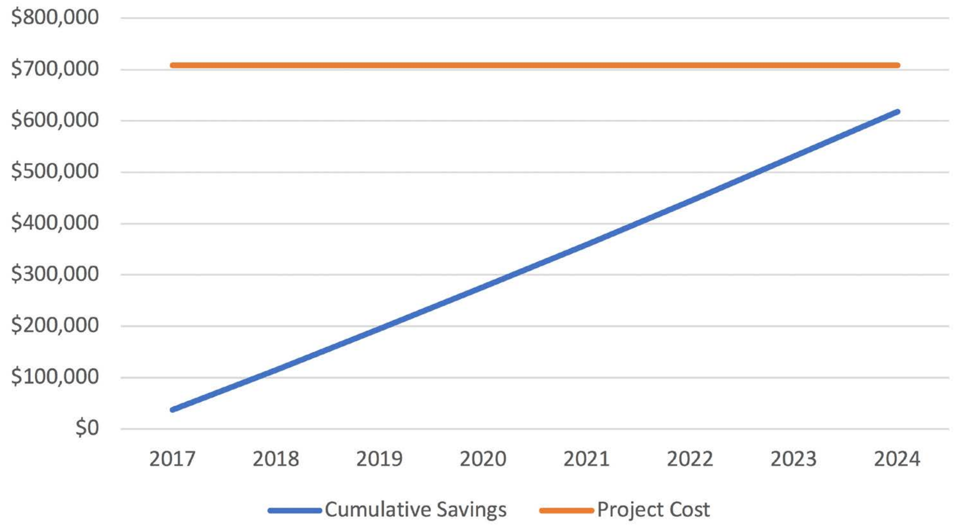
Conclusion

Results of the analysis conducted for the post retrofit analysis period (January 1, 2018, to April 1, 2019) show that, in general, the Vanner Beltless Alternator Project resulted in some cost savings, but lower than what was initially anticipated. The analysis showed that the fuel consumption rate was reduced by 6% after retrofit. In addition, CO_2 emissions were reduced by 461,000 pounds, and the MDBF of belt-related failures increased from 19,258 miles to 26,200 miles (frequency and number of failures per time period dropped).

However, fuel economy was less than the expected 15–20%, as fuel consumption is determined by several factors, such as average speed on route, extended idling due to traffic breakdown, component failure, maintenance routine, etc. The key point to note is that maximum cost savings and fuel reduction can be obtained by optimally using the retrofitted bus fleet. Cost saving/fuel consumption is directly proportional to bus usage. The higher the post retrofit bus usage, the higher the cost savings recorded.

Figure 4-1

Return on Investment Analysis



The total budget for this project was $708,030; it is estimated that 87% of this cost will be captured due to maintenance and fuel savings. Over 13% of the project cost is expected to be recouped in emission savings, and the resultant health benefits resulting from the system installation, between 2017 and 2024.

APPENDIX
A

Fuel Data Collection Results (Test Buses)

Data comparing the fuel consumption rate of the retrofitted buses before retrofit with the consumption rate after retrofit to determine if, indeed, fuel consumption reduced.

Bus	Pre-Retrofit (gal/mi)	Post-Retrofit (gal/mi)	Gallons Saved per Mile*
11002	0.1945	0.2081	-0.0136
11011	0.2282	0.2107	0.0175
11012	0.1914	0.2013	-0.01
11013	0.1872	0.2199	-0.0327
11014	0.2019	0.2141	-0.0122
11015	0.1983	0.2036	-0.0054
11016	0.1995	0.1598	0.0398
11017	0.1909	0.217	-0.026
11018	0.2427	0.207	0.0357
11019	0.1959	0.207	-0.0111
11020	0.1667	0.1667	0
11021	0.2577	0.0967	0.1611
11022	0.2073	0.2004	0.0069
11023	0.213	0.1938	0.0192
11024	0.1988	0.2011	-0.0023
11025	0.1963	0.2065	-0.0101
11026	0.2091	0.1876	0.0215
11027	0.2247	0.1785	0.0462
11028	0.2048	0.1836	0.0212
11029	0.2	0.1944	0.0056
11030	0.1998	0.1843	0.0155
11031	0.2037	0.1898	0.014
11032	0.2033	0.2933	-0.09
11033	0.2149	0.2557	-0.0409
11034	0.2046	0.1855	0.0191
11035	0.1971	0.1893	0.0079
11036	0.2028	0.1953	0.0076
11037	0.2063	0.1942	0.0121
11038	0.208	0.2008	0.0072
11041	0.2126	0.216	-0.0034
11042	0.207	0.1962	0.0108

Bus	Pre-Retrofit (gal/mi)	Post-Retrofit (gal/mi)	Gallons Saved per Mile*
11044	0.2075	0.2023	0.0052
11048	0.1969	0.1845	0.0124
11049	0.1955	0.1903	0.0051
11050	0.1978	0.1947	0.0031
11051	0.2019	0.1866	0.0153
11052	0.2001	0.1864	0.0137
11053	0.2028	0.1815	0.0213
11054	0.2029	0.194	0.0088
11055	0.1988	0.1846	0.0142
11056	0.202	0.1868	0.0151
11057	0.2038	0.1869	0.0168

**Red = control group; green = retrofitted buses showing fuel savings*

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