



GoDURHAM TRANSIT VEHICLE MAINTENANCE AUDIT

CONDUCTED
DECEMBER 13 – 17, 2021

PREPARED FOR



PREPARED BY



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EXECUTIVE SUMMARY

The City of Durham, which owns and operates 50 full-size buses, contracted with the Exult Engineering Team, including a maintenance audit inspector from Raul V. Bravo and Associates (RVBA), to conduct a comprehensive evaluation of GoDurham's vehicle maintenance operations. The evaluation consisted of reviewing every major aspect of GoDurham's vehicle maintenance operations including staffing, budget process, maintenance policies, workflow process, an inspection of its fleet and bus records, baseline performance statistics, vehicle fueling and cleaning functions, warranty, and spare parts practices. The on-site reviews took place from December 13-17, 2021.

RVBA made it clear from the start that this would not be a "gotcha evaluation" where the inspector is predetermined to find faults regardless of the existing conditions. Instead, the inspector set out to fairly evaluate GoDurham's maintenance operation and recommend improvements. As with virtually every small transit agency throughout the country, they operate in near isolation without the ability to exchange ideas or learn from others. Having an inspector with many years of experience could help GoDurham improve its maintenance operation.

It was obvious from the start that the GoDurham staff is genuinely dedicated to maintaining the City of Durham's bus fleet and was more concerned with using this assessment as a learning experience rather than being defensive about its current programs. The supervisory staff was very cooperative which made the audit process go smoothly.

A good indication of any maintenance operation is the number and type of defects that an independent third-party inspector can identify on its vehicles. There are certain foundational maintenance practices that must be followed, although practices can vary from one operation to another. An effective maintenance organization is one that properly repairs defects reported by operators and identified through its own preventive maintenance (PM) inspection process. Allowing defects to continue over time increases the likelihood of safety incidents and gradually deteriorates fleet condition over time. Understanding that all defects can never be eliminated, an effective maintenance operation is one where those defects are kept to a minimum.

After inspecting ten City of Durham buses at random, RVBA found an average of 1.5 major defects and 14.0 total defects per bus. Although the industry does not have a standard regarding bus defects, the average found on the City of Durham fleet is similar to that found in other fleet inspections conducted by the RVBA inspector in the past. Of the 140 defects identified, 15 were considered major, requiring repairs to be made before those buses could be sent back into revenue service. The buses were very clean inside and out. Graffiti was non-existent.

The review of bus history files for the same 10 buses selected at random shows that almost all of the scheduled PM inspections were performed on time. Additionally, it appears that when an operator reported a defect through the Zonar system, or defects were noted by technicians during the PM inspection, there was action taken to correct those defects. This indicates that GoDurham is responsive to correcting the deficiencies in nearly all cases.

RVBA found that GoDurham has a very thorough and concise Maintenance Plan, one that outlines maintenance policies and procedures. It covers the PM program in significant detail, is well written, and is easy to understand. It should be noted that most transit systems this size do not have procedures that are as thoroughly detailed. Regarding workflow process, RVBA found adequate procedures in place.

As mentioned above, the true indication of the quality of any PM program is one where a minimal number of defects are allowed to exist on buses. GoDurham has a scheduling system where buses are brought in for mileage-based PM inspections in a timely manner. There is also a seasonal inspection that addresses air-conditioning. The GoDurham PM inspection program includes several predictive maintenance actions at selected maintenance intervals. Drive belts, tensioners, air bags, and shocks are all changed on mileages recommended by the vehicle manufacturer.

Performance indicators are an effective tool for measuring performance against a set of goals. Road call mileage is used as the main performance indicator.

The daily service line and cleaning function was found to be typical of other transit systems. Critical mechanical vehicle systems inspections are made, vital fluids are added as needed, and an automated bus washing system cleans the exteriors. Buses are swept every night. Deep cleaning of the interiors is performed on a calendar basis.

Concerning the maintenance workforce, RVBA found that the skills of the GoDurham technicians vary significantly. The GoDurham supervisory staff has recognized this and is setting up new training programs. They are placing emphasis on technicians acquiring Automotive Service Excellence (ASE) certifications with the goal of the GoDurham shop being named an ASE "Blue Seal" shop. To receive Blue Seal recognition, 75% of the technicians will need to be ASE certified.

RVBA found an adequately administered warranty program that flags each appropriate work order as warranty. The Parts Manager files and tracks all warranty work from the warranty work orders. This system appears to be adequate to collect on 100% of the warranties filed. Any warranty work performed by an original equipment manufacturer (OEM) are arranged by the maintenance supervisor. The paperwork is filed in the bus history files.

GoDurham appears to have sufficient parts inventory, the parts room is well organized and efficiently laid out, and all parts are tracked manually by the stock clerks. RVBA did not find many buses out of service waiting for parts during the week of the audit.

In summary, GoDurham has an extremely solid maintenance operation for its size, staffed by dedicated personnel intent on minimizing defects and protecting the City of Durham's assets. Making some minor adjustments in its program would go a long way to bring its operation to the next level. RVBA made several recommendations based on its evaluation.

RECOMMENDATIONS

- Study a maintenance facility expansion given the City of Durham is planning to diversify to all-electric buses.
- Provide additional PM inspection training for its technicians in an effort to improve the quality of their inspection work.
- Accelerate GoDurham supervisory staff's development and completion of a new training course for performing PM inspections. Also have some of the more experienced A-Mechanics work with the newer mechanics to teach them the proper way to perform PMIs.
- Consider purchasing a web-based data collection system where the technicians are required to perform the initial data entry.
- Start using maintenance cost data to begin reporting maintenance costs per mile on a monthly basis.
- Create a new Electronic Technician's position dedicated to the maintenance of the battery-electric bus.

INTRODUCTION

A comprehensive review of the GoDurham maintenance operation was conducted by Ralph Malec from RVBA on behalf of the City of Durham, focusing on 12 specific areas:

- 1) Overview: Maintenance Operation
- 2) Maintenance Plan, Policies & Procedures
- 3) Workflow Process
- 4) Preventive Maintenance Program Evaluation
- 5) Vehicle Inspections
- 6) Oil Analysis Program
- 7) Review of Vehicle History Files
- 8) Baseline Maintenance Performance Statistics
- 9) Vehicle Fueling & Cleaning Procedures
- 10) Workforce Adequacy and Training
- 11) Warranty Management
- 12) Inventory Practices

This report presents RVBA's findings and offers a series of recommendations based on those findings.

OVERVIEW: MAINTENANCE OPERATION

OBSERVATIONS

The City of Durham owns and operates 50 full-size buses. Maintenance of this fleet is the responsibility of the GoDurham staff which consists of 15 mechanics, 10 service attendants, one clerk, four supervisors, one electronic technician, one technology manager, and one Maintenance Director. All employees except the supervisors, manager, and Maintenance Director are union members. All work is performed at a facility located at 1903 Fay Street in Durham.

The Maintenance Director, Bob Losiniecki, is responsible for all work performed by the GoDurham Maintenance Department. He reports directly to the General Manager, Doug Middleton. There are four Supervisors reporting to the Maintenance Director that oversee the three daily shift operations. All work is assigned by the Supervisors. There is a small staff that works unsupervised on Saturday and Sunday. Most decisions are made by the Supervisors. The Maintenance Director has the authority to sign off on purchases, performs most of the discipline, and directly supervises the facility maintenance work.

DISCUSSION

RVBA interviewed the supervisory staff and a portion of the work force. For the most part, there appears to be cohesiveness between the workers and management. All employees seem dedicated to performing at a high level. Communication between supervision and staff appears to be good. Regular "toolbox" meetings are held to keep the maintenance staff informed on any changes. There is a general feeling by the maintenance staff that additional technical training is needed.

RVBA found the facility to be clean and well organized. The property is quite compact, which requires the GoDurham staff to use every inch of space. There does not appear to be much room for expansion. Most of the equipment appeared to be well maintained. The stock room cannot contain the entire inventory, so some larger components are stored in various other locations throughout the property.

RECOMMENDATIONS

The initial review revealed that the number one issue facing GoDurham is the need for additional technical training, which is addressed later in this report in the section on Workforce Adequacy. The current size of the facility is barely adequate to handle the current fleet. With the City of Durham planning to diversify to all-electric buses, maintenance facility expansion needs to be studied.

MAINTENANCE PLAN, POLICIES, AND PROCEDURES

OBSERVATIONS

The GoDurham Vehicle Maintenance Plan is a very thorough and concise document; it meets all the FTA requirements for a maintenance plan. It summarizes all the responsibilities of the Maintenance Department and lists goals and objectives. The Preventive Maintenance section covers the GoDurham PM inspection program in significant detail. The plan includes detailed instructions on using the inspection checklists to perform the PM inspections. The plan differentiates between the levels of inspections (A, B, C, & D) and lists the various mileage intervals for conducting the inspections. The plan also details the annual Inspection for air-conditioning (A/C) systems and the warranty process. There is also a section on the onboard technical equipment (i.e., farebox, destination signs, radio, cameras, etc.) which is maintained by a separate electronic technician.

DISCUSSION

RVBA feels that the GoDurham Vehicle Maintenance Plan is done very well. It covers all the vehicle maintenance operations and procedures in detail. Extensive flow charts are used to describe the various maintenance workflows. The daily and periodic vehicle cleaning procedures are laid out in detail. There is also a section on handling body repairs.

WORKFLOW PROCESS

OBSERVATIONS

The City of Durham buses needing repair are usually identified either by a bus operator who notes a defect in the Zonar system or by a technician conducting a preventive maintenance inspection (PMI) who identifies the defect on the PMI defect sheet. The technician performing the inspection is expected to repair most of the defects he finds and sign off each repair on the PMI defect sheet. The supervisor enters all defects from the Zonar system on to paperwork order forms. Unrepaired PMI defects may also be entered on a work order form. If there is a question about the defect, the supervisor may perform a preliminary investigation of the defect. Work orders are assigned by a supervisor to a technician.

If any parts are withdrawn from inventory, the technician will note the part number on the work order. Repairs that cannot be completed on a shift may be held until the next day for the technician to complete or may be repaired on the alternate shift. The supervisor and/or the Director of Maintenance will check the work, verify that the work order is completed and sign off on the work order. The supervisor enters the work order information into the FASTER maintenance data system.

DISCUSSION

During RVBA's visit, it was observed that the GoDurham supervisors carefully enter the information from the paperwork order forms into the FASTER system. The supervisors created paperwork orders for all the

defects found by RVBA during the audit. Upon completion of the repairs, the supervisor entered the work order information into the FASTER system.

PREVENTATIVE MAINTENANCE (PM) PROGRAM EVALUATION

OBSERVATIONS

The GoDurham vehicle preventive maintenance program is based on an inspection performed at 6000-mile intervals. There are separate inspection forms for the diesel-powered buses and the battery-powered buses. The diesel form is generic in nature which allows the same form to be used for the different model Gillig buses Durham operates. The inspection forms include additional items to be serviced on the B, C and D inspections. There is a separate checklist for the annual spring A/C system inspection. The technical equipment on the buses (fareboxes, destination signs, radios, cameras, etc.) are maintained by a dedicated Electronic Technician who is under the direction of the Technology Manager. The technical equipment is inspected on a 120-day interval except the cameras which are checked remotely monthly. There is a special Technical Equipment PM checklist.

Inspections are scheduled by a Day Supervisor using a PM Soon Due Report produced by the FASTER data collection system. Mileages are entered each night by the service attendants. The Day Supervisor notes all vehicles nearing their scheduled inspection mileages. All inspections are scheduled on a daily basis. The Day Supervisor creates work orders for each inspection. Depending on the number of buses due for inspection, two to four inspections may be performed each day. Inspections can be done on either the first or second shift. The technician performing the inspection marks each item on the checklist as being okay or needing repair. Defects are noted on a separate PMI defect sheet. The technician doing the inspection is expected to repair as many of the defects as possible. If there are repairs remaining, they are assigned to a technician on the next shift. Engine and transmission oil samples are taken on each PMI. The results of the oil sample analyses are reviewed by the supervisory staff.

A Supervisor reviews the PM workorder and closes it out in the FASTER system. If there are some non-safety related defects remaining the supervisor creates a work order in the FASTER system for follow up repairs. All completed inspection check lists and repair work orders are filed in the bus history file.

DISCUSSION

RVBA found the GoDurham PM program to be complete and well documented. There was no evidence that the repair of defects is being deferred. There was no preponderance of mechanical issues indicating that the PM program was inadequate. However, RVBA has a concern with the quality of some of the inspection work performed by the GoDurham technicians. When reviewing completed PMI checklists and defect sheets for the same bus number, it became obvious that while some technicians were finding a significant number of defects, others found very few defects.

RECOMMENDATIONS

RVBA is recommending that GoDurham provide additional PMI training for its technicians in an effort to improve the quality of their inspection work. GoDurham is currently working on new training programs for supervisors and technicians. This includes a new PM training program. The GoDurham maintenance staff is also planning a visit to Charlotte Area Transit System (CATS) in March to view and discuss their PM training and Q/A programs. GoDurham maintenance staff intends to implement the new PM training program this spring. A detailed response letter from GoTriangle and GoDurham detailing their ongoing efforts related to the findings of this audit can be found in Appendix C.

In addition, GoDurham maintenance is already in the process of implementing other training programs. For example, GoDurham is hosting OEM training in March for technicians on the Lift-U wheelchair ramps/lifts. GoDurham has also extended an invitation to technicians at our partner agencies who wish to attend. RVBA congratulates GoDurham for expediting these additional training efforts.

VEHICLE INSPECTIONS

METHODOLOGY

RVBA conducted inspections of ten buses, 20% of each Durham sub-fleet, selected at random. All defects found were recorded and the defect sheets were reviewed by the GoDurham supervisory staff. RVBA answered any questions the Durham staff had and reviewed the defects with a supervisor or senior technician on the vehicle. The supervisor created a work order to repair the defects found on these inspections the same day the inspection was performed. Specific defects noted during the bus inspections were classified under the following 11 functional categories:

- 1) Brake System
- 2) Chassis
- 3) Driver's Controls
- 4) Doors
- 5) Electrical
- 6) Engine Compartment
- 7) Exterior
- 8) Interior
- 9) Steering
- 10) Tires
- 11) Wheelchair Ramp

Defects noted on the inspection sheets were then entered into a master defect spreadsheet, which is attached as Appendix B. Defects were classified as either Major or Minor.

A Major defect is a serious safety or reliability-related defect that requires the bus to be taken out of service until the defect is corrected. A list of these defects was reviewed and approved by the GoDurham Maintenance Manager prior to the start of the inspections. A Durham supervisor was immediately informed of all Major defects as soon as they were discovered.

Minor defects are non-safety critical defects that requires attention at a later time, but no later than the next scheduled PM inspection. Durham staff chose to repair all defects found by RVBA before the bus was released for service.

A telephone conference took place prior to the start of the inspection with City of Durham and GoDurham representatives to review the inspection process in advance and answer any questions. A meeting also took place just prior to the inspections with the GoDurham Maintenance Manager to review the process. GoDurham assigned a technician to assist with moving buses and operating the hoists.

FINDINGS

OVERALL FLEET CONDITION

The City of Durham fleet was found to have clean interiors and exteriors, although some had some minor exterior body damage. The number of defects identified on the 10 buses inspected totaled 140, an

average of 14 per bus. Although the industry does not have a standard for per-bus defects, the average found on the City of Durham fleet is similar to that found in other fleet inspections conducted by the RVBA inspector in the past.

Cosmetic defects (interior and exterior body issues) accounted for nearly one third of all the defects found. These defects do not typically influence drivability or reliability and are often overlooked during PM inspections because of the age of the fleet. However, they are visible to the riding public. A reduction in the number of these defects would show customers that the City of Durham values their patronage and is an outward indication to the riders that the vehicles are being properly maintained. When cosmetic defects (interior and exterior body issues) are removed from the fleet totals, the number of remaining mechanical defects averaged 9.1 per bus.

MAJOR DEFECTS

Fifteen Major defects were identified during this inspection. A Major defect requires a bus to be taken out of service until corrected. Table 1 shows the nature of those defects. All Major defects identified during the vehicle inspections were repaired immediately by GoDurham, who understood they would not operate buses with any Major defects until repaired. For two of the major defects found, GoDurham decided that the technicians who performed the last PMI on those buses needed corrective action and retraining.

TABLE 1: MAJOR DEFECTS

Defect Category / Defect	Number
Interior	
Emergency window hard to release	1
Air/Brake Systems	
Hose to air chamber frayed	5
Excessive brake chamber push rod travel	1
Steering	
Steering arm loose	1
Tires	
Bolt in tire	1
Engine	
Fire suppression hose rubbing	1
Hydraulic reservoir leaking	1
A/C compressor belt cracked	1
Air compressor lube line leaking	1
Chassis	
Six bolts missing in drive shaft flange	1
Electrical	
Junction box bracket loose	1
Total Major Defects	15

SPECIFIC DEFECT SUMMARIES

Table 2 shows the defects identified in each functional category. Of particular concern to RVBA were the number of brake defects which were primarily worn hoses on the rear brake chambers. A majority of the 24 engine defects were oil leaks. The number of door defects (16) was high. RVBA found many door panels out of adjustment and many door bearings worn from a lack of lubrication. The five wheelchair ramp defects were all the result of improper stow latch adjustments. All ramps deployed properly.

TABLE 2: DEFECTS BY CATEGORY

Defect Category	Number of Defects
Electrical	11
Brake System	11
Engine	24
Steering	2
Driver's Controls	9
Interior	17
Exterior	32
Tires	1
WC Ramp	5
Doors	16
Chassis	12
Total Defects	140

RECOMMENDATIONS

The new training course for performing PM inspections that GoDurham is implementing this Spring should improve the quality of the PM inspection program. RVBA feels it would also be helpful to have some of the more experienced A-Mechanics work with the newer mechanics to teach them the proper way to perform PMIs.

As part of this training technicians should be shown how to properly route the hoses on the rear brake chambers to prevent hose damage. RVBA is also recommending that GoDurham retrain all technicians how to properly adjust the front and rear door panels. Proper inspection and lubrication of the door bearings should be part of this training. RVBA is also suggesting that GoDurham perform a campaign of all buses in the fleet to make sure that the wheelchair ramp stow latches are adjusted properly.

GoDurham has recently started a program where a supervisor does follow up inspections on random PMIs. RVBA feels this is a great way improve the quality of inspections. RVBA is recommending that GoDurham supervision increase the frequency of its follow-up inspections.

REVIEW OF VEHICLE HISTORY FILES

PMI SCHEDULE ADHERENCE

RVBA examined GoDurham's PMI records for the last three years to determine if PMIs are being performed on time. To do this, mileage between the PMIs for each bus was calculated to determine if the inspections were performed within 10% of the scheduled miles (6,000 + 10% = 6,600 miles).

The examination revealed that all but two PMIs were completed on time, a near perfect record. Table 3 shows the number PMIs completed over the last three years and the number that exceeded the 6,600-mile allowance. Because of the high number of miles accumulated daily by the GoDurham fleet it was not unusual for some buses to have two PMIs in the same month.

TABLE 3: PM SCHEDULE ADHERENCE

Year	PMIs Completed	Number Late
2021	451	1
2020	467	0
2019	496	0

WORK ORDER REVIEW

RVBA reviewed the work orders used by GoDurham to record repairs and account for parts and labor. In doing so, RVBA examined the records for content, accuracy, legibility, and consistency. RVBA found that each work order included a listing of parts, supplies, and materials used during the repair; an indication if the repair order was warranty related; the technician assigned to the repair; the time required to complete the repair; information pertaining to the reason for repair; and a description of repair method used to correct the defect. Information generated from the work order was then entered into vehicle repair history of the FASTER Fleet Maintenance software system by the shift supervisor.

RECOMMENDATIONS

RVBA found that the existing GoDurham work order system does a good job of capturing all the work performed by the GoDurham staff. The FASTER system requires a lot of supervisory time for data entry. RVBA recommends that GoDurham consider purchasing a web-based data collection system where the technicians are required to perform the initial data entry. This would allow the supervisors to do less clerical work and perform more of their supervisory functions.

GoDurham’s FY22 budget includes the purchase or upgrade of the existing maintenance system to a state-of-the-art web-based system. GoDurham will be moving forward with the upgrade in the fourth quarter of FY22. Moreover, GoDurham is currently evaluating proposals for a new CAD/AVL system, which includes an optional Automated Vehicle Monitoring (AVM) component. Once a CAD/AVL system is selected, GoDurham will evaluate options for integrating information between the new CAD/AVL system and the new web-based maintenance system (i.e., pre-trip and post-trip defects sent directly from CAD/AVL to maintenance data system for work order generation, AVM fault data sent directly from CAD/AVL to maintenance system, etc.).

DEFERRED MAINTENANCE

To determine if repairs identified during the PM inspections were performed properly and made promptly, the following procedure was used:

1. PMI sheets going back three previous PMIs (at a minimum) were selected and examined for each of the buses chosen for the audit to determine if and when defects noted during the PMI process were repaired.
2. Defects from the previous two PMIs were then compared to determine if any defects were repeated from one PMI to the next.
3. Defects from the previous two PMIs were then compared to the defects noted by RVBA during the audit inspection to determine if any defects continue to exist.

From this comparison, RVBA was able to determine if the defects were repaired or if they were simply carried over to subsequent inspections. In conducting its investigation, RVBA found evidence showing that in all but a couple cases there was proof indicating that defects noted during the PM inspections were, in fact, repaired.

DAILY DRIVER INSPECTION REVIEW

GoDurham drivers use the Zonar system to report defects found on each bus. Each driver does a pre-trip and a post-trip inspection using the hand-held Zonar device. The defects reported by the drivers go into the Zonar system. The maintenance supervisor downloads the data from the Zonar system and creates a work order to repair the defect. When repairs are completed, the Supervisor signs off on the work order and in the Zonar system. Of the buses selected for the audit, work orders were examined to determine if defects reported by operators had been repaired. A review of the Zonar system revealed that evidence of corrective action was taken in each case where the driver reported a defect.

BASELINE MAINTENANCE PERFORMANCE STATISTICS

OBSERVATIONS

Performance indicators are essential to a maintenance department to properly gauge whether its performance is improving or deteriorating over time. Performance indicators are an effective tool for measuring performance against a set of goals. The GoDurham Maintenance Department uses road call mileage as their main performance indicator. They differentiate between Major Mechanical System Failures and All Mechanical System Failures. Their definition of a Major Mechanical System Failure is when a bus cannot complete its planned route and is removed from service. For all other Mechanical System Failures buses are swapped out with a spare bus when it is convenient. GoDurham reports both the mileage between Major Mechanical System Failures and the mileage between All Mechanical System Failures.

DISCUSSION

The measurement of the miles between road calls is usually a controversial subject among maintenance managers. Because it is used to judge the performance of the maintenance department over a period of time, consistency in the means of measurement is most important. RVBA is not concerned with which measure GoDurham uses to measure road call frequency if there is consistency in the definition followed.

There are some other types of data commonly used by transit maintenance departments to measure maintenance performance. Maintenance costs per mile and the percentage of productive time are some of measures often used as performance metrics.

RECOMMENDATIONS

GoDurham currently collects maintenance cost data as part of its monthly budget analysis. RVBA is recommending that the GoDurham Maintenance Department start using this data to begin reporting maintenance costs per mile on a monthly basis. Worker productivity is also a very useful performance measure. To develop this measure, GoDurham will need to start analyzing work order man-hours. The FASTER software is designed to track man-hours for each work order. GoDurham should consider beginning to calculate productive hours by comparing hours charged to work orders to total hours worked.

GoDurham staff acknowledged that there needs to be clarification on what costs are included, as well as determining a baseline to measure monthly costs. GoDurham will work with GoTriangle and the City of Durham to incorporate this information into the monthly performance monitoring process beginning in FY23.

VEHICLE FUELING AND CLEANING PROCEDURES

OBSERVATIONS/DISCUSSIONS

Vehicle fueling and cleaning functions are performed in the evening by a dedicated crew of service attendants. Engine fluids are checked while the buses are being fueled. Prewash is done before buses enter the automated bus washer, after which buses are parked in their assigned outside storage spots. Buses are swept clean on a nightly basis. The interiors are periodically given a thorough deep cleaning which includes the windows, ceilings, walls, and floors. RVBA found the fleet to be exceptionally clean.

WORKFORCE ADEQUACY

OBSERVATIONS

GoDurham has thirteen full-time technicians assigned to three shifts working seven days per week to handle all maintenance work on the fleet. There is also one designated body shop technician who normally does not perform mechanical repairs. The GoDurham bus-to-technician ratio is 3.8 (discounting the body technicians). Most of the technicians came to GoDurham with basic automotive repair knowledge, although several also had some heavy-duty diesel background.

New technicians are generally assigned to a more experienced technician to learn the job. There is no formal on-the-job training. Instead, GoDurham takes advantage of manufacturer's training when new equipment is purchased. Most of the technicians will receive this training when it is offered. Safety and other mandated training are done electronically in a training lab. The Maintenance Director has recognized the need for additional training. He recently hired a new supervisor who has an extensive background in training. This supervisor is developing several training programs. The first of these covers PM inspections. GoDurham recognizes the benefits of ASE certification. All A-Mechanics must be ASE certified. It is GoDurham's goal to be named an ASE "Blue Seal" shop. To receive Blue Seal recognition, 75% of the technicians will need to be ASE certified.

DISCUSSION/RECOMMENDATIONS

RVBA is concerned that several the technicians lack the training and skills to perform the work assigned to them. The GoDurham supervisory staff has recognized this and is taking measures to ensure all technicians receive adequate training. Their efforts to set up formal in-house training programs will improve the skill levels of all the technicians. RVBA is recommending that GoDurham accelerate its training efforts and continue to encourage its technicians to seek ASE certifications.

RVBA is also concerned about GoDurham's intent to incorporate battery-powered buses into its fleet. The battery powered buses will require technicians with new skill sets to keep them running. RVBA is recommending that GoDurham create a new Electronic Technician's position dedicated to the maintenance of the battery-electric bus.

GoDurham is submitting a request to include this position in the FY23 budget. In addition, GoDurham is also submitting a request for an additional supervisor who will be responsible for implementing and monitoring a new Quality Control program in FY23.

WARRANTY MANAGEMENT

OBSERVATIONS

The warranty program is administered by the Parts Manager. He uses the FASTER system to provide a current list of all buses covered by warranty, which indicates what systems are covered and when the warranty coverage expires. The shift supervisors use the list to flag a work order as warranty. When the repair is completed the work order is given to the Parts Manager before it is entered into the FASTER system. The Parts Manager approves the warranty work and files a claim with the bus builder or vendor.

It is the responsibility of the Parts Manager to track open warranties until they are paid. Some of the engine and transmission warranty work is done by the local Cummins and Allison dealers. A maintenance supervisor schedules the vendor work and the paperwork is placed in the bus file with a notation in the FASTER system. GoDurham appears to collect on most of the warranties filed. In the case of warranties disputed by the vendor, the Parts Manager and Maintenance Director will meet with the vendor representative to resolve.

DISCUSSION

The GoDurham warranty system appears to be working well. The success of the system is a result of the diligence of the Parts Manager and Maintenance Supervisors. When RVBA audited the maintenance records, it did not find any unfiled warranty claims. There was also no warranty history report available listing all warranties filed and the value of the claims.

INVENTORY PRACTICES

OBSERVATIONS

GoDurham has \$750,000 in its parts inventory. The parts room is manned by parts room clerks who cover all three shifts. The parts room is well organized and efficiently laid out. All parts are identified by the manufacturer's part number when received and are entered into the FASTER system. Technicians request parts from the parts room clerk. Any parts removed from inventory are recorded on a work order. All parts used on a work order are entered in the FASTER system. The FASTER system adjusts inventory for the parts used on each work order. Inventory cycle counts are performed monthly by the parts room clerks and Parts Manager. Monthly inventory reports are run and the value of the parts in the FASTER system must be reconciled with the value the Accounting Department has on the books.

DISCUSSION

The Parts Manager uses the FASTER system to track inventory levels. The FASTER system is set up with Maximums and Minimums. The system uses the minimums to determine when parts need to be ordered. The Parts Manager can override the system if special needs require additional parts to be purchased. The Parts Manager attempts to get three quotes from vendors before determining where to source the parts. Purchase orders are manually prepared by the clerk and quantities are approved by the Parts Manager.

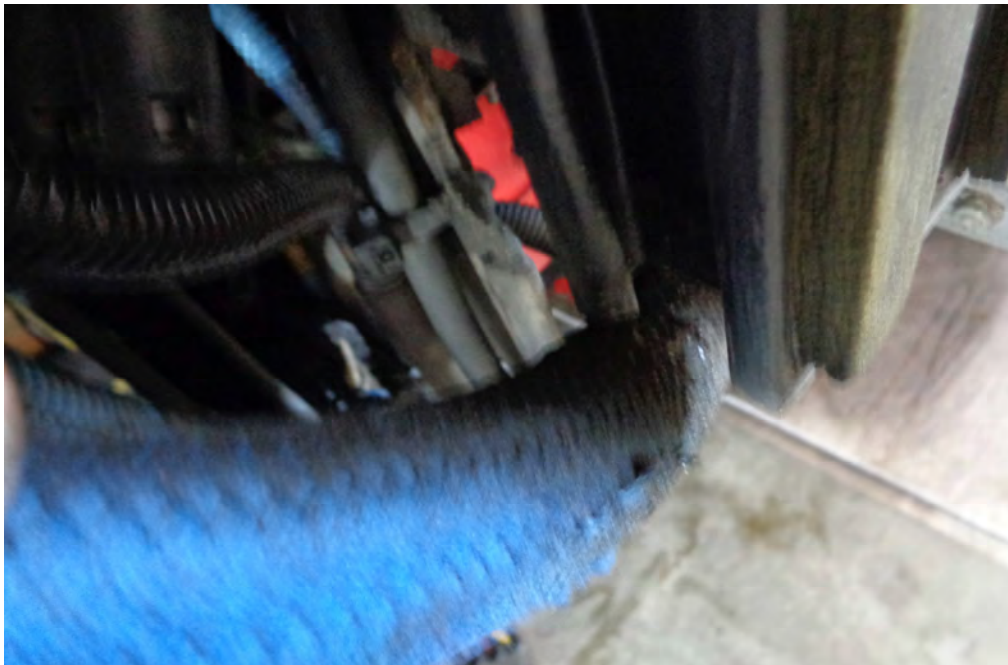
RVBA found the parts room operation to be very effective. There were very few vehicles waiting on parts during the week of the audit.

APPENDIX A

PHOTOS OF DEFECTS FOUND



Bus 1003: Loose Steering Arm



Bus 1005: Hole in Fire Suppression Hose



Bus 1005: Hose Leak at Hydraulic Reservoir



Bus 1205: Bolt Rubbing Hole in Brake Hose



Bus 1205: Six Bolts Missing in Driveshaft Flange



Bus 1205: Differential Gasket Leaking

APPENDIX B
SUMMARY TABLE OF DEFECTS FOUND

Durham Audit Defects December 13-17, 2021

Item #	Year Built	Date Inspected	Category	Defects	Major
Bus #1003					
1	2010	12/14/2021	Exterior	Deep scratch behind rear door	
2	2010	12/14/2021	Electrical	Electrical connection box open by air drier	
3	2010	12/14/2021	Chassis	RF hub grease fill leaking	
4	2010	12/14/2021	Interior	Floor covering cracked behind rear wheel housings	
5	2010	12/14/2021	Doors	Rear doors need adjustment	
6	2010	12/14/2021	WC Ramp	Rear edge of ramp sticks up above floor	
7	2010	12/14/2021	Steering	Steering arm loose in RF spindle	Yes
8	2010	12/14/2021	Brakes	Both air lines rubbing and frayed at RR brake chamber	Yes
9	2010	12/14/2021	Brakes	Excessive pushrod travel on LR brake chamber	Yes
10	2010	12/14/2021	Brakes	Nylon line rubbing on ping tank	
11	2010	12/14/2021	Engine	Hydraulic line leaking	
Bus #1005					
1	2010	12/17/2021	Exterior	Street side, side wiper needs adjustment	
2	2010	12/17/2021	Exterior	Curb side mirror bracket loose	
3	2010	12/17/2021	Exterior	Curb side wiper blade needs adjustment	
4	2010	12/17/2021	Driver's Controls	Driver's light lense missing	
5	2010	12/17/2021	Driver's Controls	Panel lamp switch won't turn	
6	2010	12/17/2021	Doors	Front door panels need adjustment in closed position	
7	2010	12/17/2021	WC Ramp	Rear edge of ramp sticks up above floor	
8	2010	12/17/2021	Interior	Driver's mirror loose	
9	2010	12/17/2021	Interior	Street side, center facing WC seat not latching	
10	2010	12/17/2021	Interior	1st curb side emergency window does not release	Yes
11	2010	12/17/2021	Interior	Adjust latch on last street side vent window	
12	2010	12/17/2021	Electrical	Wire harness hanging in RF wheel well	
13	2010	12/17/2021	Exterior	Lower step light at rear door loose	
14	2010	12/17/2021	Engine	Fire suppression hose rubbing through on firewall	Yes
15	2010	12/17/2021	Electrical	Resecure harness at J-box above ping tank	
16	2010	12/17/2021	Engine	Reclamp condensor drain hoses in engine compartment	
17	2010	12/17/2021	Exterior	Replace LR wheelhouse molding	
18	2010	12/17/2021	Brakes	Brake hose frayed badly on RR chamber	Yes
19	2010	12/17/2021	Engine	Hydraulic reservoir leaking badly	Yes
Bus #1007					
1	2010	12/15/2021	Driver's Controls	Driver's light lense missing	
2	2010	12/15/2021	Driver's Controls	Play in steering column lock	
3	2010	12/15/2021	Driver's Controls	Driver's seat cushion torn	
4	2010	12/15/2021	Doors	Bottom rear door bearings loose	
5	2010	12/15/2021	Exterior	Curb side wiper arm needs adjustment	
6	2010	12/15/2021	Driver's Controls	Dash lights inoperative	
7	2010	12/15/2021	Doors	Front door panels need adjustment in open adjustment	
8	2010	12/15/2021	Chassis	Both front hub grease fills leaking	
9	2010	12/15/2021	Exterior	Front curb side turn signal lense cracked	
10	2010	12/15/2021	Brakes	Line from ping tank to air dryer kinked	
11	2010	12/15/2021	Electrical	Top center brake light out	
12	2010	12/15/2021	Exterior	Street side rear wheel side panel loose	
13	2010	12/15/2021	Exterior	Left front bumper module cracked	
14	2010	12/15/2021	Interior	Yellow edge molding at rear seating platform loose	
15	2010	12/15/2021	Engine	A/C compressor belt cracked badly	Yes
16	2010	12/15/2021	Chassis	Pinion seal leaking	
17	2010	12/15/2021	Engine	Oil leaking on curb side, wash engine and check for leaks	

Item #	Year Built	Date Inspected	Category	Defects	Major
Bus #1015					
1	2010	12/15/2021	Exterior	Curb side wiper arm loose and needs adjustment	
2	2010	12/15/2021	Engine	Hydraulic reservoir leaking at band	
3	2010	12/15/2021	Doors	Front front door seal loose	
4	2010	12/15/2021	Doors	Front doors close too slow	
5	2010	12/15/2021	Doors	Replace heim joint on rear front door arm	
6	2010	12/15/2021	Interior	Red restraint on second WC seat position not retracting	
7	2010	12/15/2021	Interior	Floor covering cracked at rear wheel housing	
8	2010	12/15/2021	Chassis	Pinion seal leaking	
9	2010	12/15/2021	Engine	Dipstick tube on Allison unit loose	
10	2010	12/15/2021	Engine	Leak at bellhousing, wash engine and check for leaks	
Bus #1018					
1	2010	12/16/2021	Exterior	Replace driver's side wiper blade	
2	2010	12/16/2021	Exterior	Both front door moldings loose at bottom	
3	2010	12/16/2021	Chassis	RF hub grease fill leaking	
4	2010	12/16/2021	Exterior	Curb side rear corner panel loose	
5	2010	12/16/2021	Exterior	Curb side rear bumper module torn	
6	2010	12/16/2021	Engine	Engine oil dipstick bracket cracked	
7	2010	12/16/2021	Exterior	Adjust latch on street side wheelhouse panel	
8	2010	12/16/2021	Doors	Upper glass cracked in rear rear door	
9	2010	12/16/2021	Driver's Controls	Driver's light lense missing	
10	2010	12/16/2021	Driver's Controls	Driver's heat/defroster selector switch inoperative	
11	2010	12/16/2021	Doors	Front front door panel needs adjustment in open position	
12	2010	12/16/2021	Doors	Replace heim joint on rear front door arm	
13	2010	12/16/2021	Interior	Unable to unlatch street side rear WC seat	
14	2010	12/16/2021	Interior	Bottom stanchion cup behind rear door loose	
15	2010	12/16/2021	Chassis	Ramp splash shield loose	
16	2010	12/16/2021	Exterior	Street side rear wheel side panel loose	
17	2010	12/16/2021	Brakes	Street side brake chamber push rod rubbing	
18	2010	12/16/2021	Brakes	Bolt rubbing through hose to curb side brake chamber	Yes
19	2010	12/16/2021	Chassis	Pinion seal leaking	
Bus #1205					
1	2012	12/16/2021	Exterior	Replace curbside wiper blades	
2	2012	12/16/2021	Tires	Bolt in RRO tire	Yes
3	2012	12/16/2021	Electrical	Main harness bundle above ping tank needs re-routing	
4	2012	12/16/2021	Electrical	Top of plate holding main junction box loose at firewall	Yes
5	2012	12/16/2021	Exterior	Curb side engine compartment door broken at top	
6	2012	12/16/2021	Electrical	Broken P-clamp on top at alternator bracket	
7	2012	12/16/2021	Engine	Radiator brace rod loose	
8	2012	12/16/2021	Exterior	Street side tail light fixture on engine door broken	
9	2012	12/16/2021	Exterior	Rear front door light broken	
10	2012	12/16/2021	Doors	Front door panels need adjustment when closed	
11	2012	12/16/2021	Exterior	Top drivers side mirror does not adjust remotely	
12	2012	12/16/2021	Doors	Replace heim joints on both front door arms	
13	2012	12/16/2021	Electrical	Damaged wire in curbside wheel well	
14	2012	12/16/2021	Brakes	Hoses on both brake chambers fraying	Yes
15	2012	12/16/2021	Chassis	Differential housing gasket leaks	
16	2012	12/16/2021	Engine	Allison unit leaking from breather	
17	2012	12/16/2021	Engine	Power steering line leaking	
18	2012	12/16/2021	Engine	Main DPM line leaking at Allison unit	
19	2012	12/16/2021	Chassis	Six bolts missing in driveshaft flange	Yes

Item #	Year Built	Date Inspected	Category	Defects	Major
Bus #1706					
1	2017	12/16/2021	Exterior	Front front door trim molding loose	
2	2017	12/16/2021	Exterior	Deep gouge on street side corner panel	
3	2017	12/16/2021	Engine	SCR catalytic converter rubber mounts cracked	
4	2017	12/16/2021	Electrical	Top of batteries needing cleaning	
5	2017	12/16/2021	Driver's Controls	Throttle pedal mounting plate loose	
6	2017	12/16/2021	Exterior	Star crack in driver's side windshield	
7	2017	12/16/2021	Exterior	Replace driver's side wiper blade	
8	2017	12/16/2021	Exterior	Adjust curb side wiper arm	
9	2017	12/16/2021	Doors	Front door panels need adjustment when closed	
10	2017	12/16/2021	Doors	Replace heim joints on both front door arms	
11	2017	12/16/2021	WC Ramp	Rear edge of ramp sticks up above floor	
12	2017	12/16/2021	Interior	Two seat cushions are loose on second 3-passenger WC seat	
13	2017	12/16/2021	Interior	Replace glass in emergency rear door release box	
14	2017	12/16/2021	Engine	Oil leak at bellhousing	
15	2017	12/16/2021	Engine	Compressor lube line leaking badly	Yes
16	2017	12/16/2021	Brakes	Air dryer spitting oil	
Bus #1707					
1	2017	12/15/2021	WC Ramp	Rear edge of ramp sticks up above floor	
2	2017	12/15/2021	Doors	Replace heim joint on rear front door arm	
3	2017	12/15/2021	Interior	Dash trim loose at front doors	
4	2017	12/15/2021	Interior	Stanchion cup behind rear door loose	
5	2017	12/15/2021	Exterior	Driver's side washer nozzle not working	
6	2017	12/15/2021	Engine	Oil filler cap leaking	
7	2017	12/15/2021	Engine	Bleeder hose on surge tank broken	
8	2017	12/15/2021	Chassis	Rear axle radius rod bushings worn	
9	2017	12/15/2021	Brakes	Curb side brake chamber push rod rubbing and clevis lock nut loose	
10	2017	12/15/2021	Brakes	Curb side brake chamber hoses rubbing through	Yes
11	2017	12/15/2021	Engine	Oil line from engine to spinner filter leaking	
12	2017	12/15/2021	Engine	Air compressor mounting gasket leaking	
13	2017	12/15/2021	Engine	Transmission to accumulator line meeting	
Bus #1712					
1	2017	12/14/2021	Engine	Oil leak at compressor mounting gasket	
2	2017	12/14/2021	Exterior	Radiator door damaged	
3	2017	12/14/2021	Electrical	Reclamp shunt at starter solenoid	
4	2017	12/14/2021	Interior	Driver's window won't close	
5	2017	12/14/2021	Doors	Front front door panel needs adjustment when closed	
6	2017	12/14/2021	Interior	Broken latch on overhead driver's compartment door/	
Bus #1902					
1	2019	12/14/2021	Engine	Lock nut on A/C compressor adjuster loose	
2	2019	12/14/2021	Chassis	LR shock leaking	
3	2019	12/14/2021	Exterior	Adjust rear latch on battery compartment door	
4	2019	12/14/2021	Electrical	Clean the top of the batteries	
5	2019	12/14/2021	Exterior	Dipstick in windshield washer reservoir broken	
6	2019	12/14/2021	Exterior	Curb side turn signal lense cracked	
7	2019	12/14/2021	WC Ramp	Rear edge of ramp sticks up above floor	
8	2019	12/14/2021	Interior	Door for main electronic box behind driver won't latch. Taped shut	
9	2019	12/14/2021	Steering	Steering shaft not greased	
10	2019	12/14/2021	Chassis	Skid plate under battery compartment loose	

APPENDIX C

GOTRIANGLE AND GODURHAM RESPONSE LETTER

To: Sean Egan, Director of Transportation, City of Durham
From: Brian Fahey, Transit Administrator, GoTriangle
Date: March 10, 2022
Subject: GoDurham Maintenance Audit

Dear Mr. Egan,

This letter is to confirm GoTriangle and GoDurham’s receipt and review of the GoDurham Transit Vehicle Maintenance Audit, conducted December 13 – 17, 2021.

Addressing Defects

GoDurham maintenance addressed all defects that were found during the audit, except on one vehicle that is “hard down” while awaiting parts (see table 1 below). In addition, two of the defects listed as “Major” (loose steering arm and bolts missing in drive shaft flange) were deemed as significant safety risks, and resulted in disciplinary actions and retraining for the technicians who conducted the previous preventative maintenance.

Table 1. Addressing Defects

Bus #	Date Inspected	Total Defects	Major Defects	All Defects Fixed as of
1015	12/15/2021	10	0	12/17/2021
1018	12/16/2021	19	1	12/17/2021
1205	12/16/2021	19	4	12/21/2021
1003	12/14/2021	11	3	N/C
1005	12/17/2021	19	3	12/28/2021
1007	12/15/2021	17	1	12/20/2021
1015	12/15/2021	10	0	12/17/2021
1706	12/16/2021	16	1	12/17/2021
1707	12/15/2021	13	1	12/20/2021
1712	12/14/2021	6	0	1/5/2022
1902	12/14/2021	10	0	12/15/2021



Preventative Maintenance Training

GoDurham is currently working on new training programs for supervisors and technicians. This includes a new PM training program. GoDurham maintenance staff are planning a visit to Charlotte Area Transit System (CATS) in March to view and discuss their PM training and Q/A programs. GoDurham maintenance staff intend to implement the new PM training program this spring.

In addition, GoDurham maintenance is already in the process of implementing other training programs. For example, GoDurham is hosting OEM training in March for technicians on the Lift-U wheelchair ramps/lifts. GoDurham has also extended the invitation to other technicians at our partner agencies who wish to attend.

Data Collection System

GoDurham's budget in FY22 includes the purchase or upgrade of the existing maintenance system to state-of-the-art web-based system. GoDurham will be moving forward with the upgrade in quarter 4 of FY22. Moreover, GoDurham is currently evaluating proposals for a new CAD/AVL system, which includes an optional Automated Vehicle Monitoring (AVM) component. Once a CAD/AVL system is selected, GoDurham will evaluate options for integrating information between the new CAD/AVL system and the new web-based maintenance system (i.e. "pre and post-trip defects sent directly from CAD/AVL to maintenance system for work order generation", "AVM fault data sent directly from CAD/AVL to maintenance system", etc.).

Maintenance Cost Data

GoDurham currently collects maintenance cost data in the monthly performance monitoring process. However, staff acknowledge that there needs to be clarification on what costs are included, as well as determining a baseline to measure monthly costs. GoDurham will work with GoTriangle and the City of Durham to incorporate this information into the monthly performance monitoring process beginning in FY23.



Electronics Technician and Quality Control Positions

GoDurham is submitting a request to include a full-time Electronics Technician in the FY 23 budget. In addition, GoDurham is also submitting a request for an additional supervisor who will be responsible for implementing and monitoring a new Quality Control program in FY 23.

The GoDurham team is committed to implementing new processes to improve upon its strong record for quality vehicle maintenance, and GoTriangle is committed maintaining oversight of the program with an emphasis on the aforementioned recommendations.

Sincerely,

Brian P. Fahey

Brian Fahey
Transit Administrator
GoTriangle

cc Rochelle Parent
Laurie Barrett
Doug Middleton
Bob Losiniecki

