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TO: James T. Gallagher, Chief Operations Officer

FROM: Yvonne Zheng, Senior Manager, Audit, Office of the Inspector General

SUBJECT: OIG Spot Check - Bus Operator Battery Reset Practices (19-AUD-07)

Introduction

The Office of the Inspector General (OIG) performed a review on bus operator battery reset practices. This review was conducted as part of our ongoing effort to assist Metro in improving the efficiency of operations and implementing an effective internal control system that ensures that safe and reliable buses are placed in service. The review found that to ensure Metro continues to provide the most efficient and effective means of transportation for its customers, Operations need to:

1. Continue to train and advise bus operators and controllers on the importance of not performing battery resets on inoperable buses while in revenue service pending further research and analysis.
2. Assess whether optimal resources (i.e., mechanics, replacement buses, tow trucks, etc.) and effective deployment plans are being used to minimize response time and meet service needs under the new practice to cease battery resets.
3. Consider further study to determine if it is possible to mitigate diagnostic software dangers associated with rebooting due to the time it may take for a mechanic to respond and since bus operator surveys showed that over 50% of the time bus rebooting did solve the problem. Specifically explore the possibility of using a backup battery for the device, allowing battery resets in those instances when it would be more efficient to do a reboot than waiting for a mechanic to respond, or if soft resets (logging on and off the Advanced Transportation Management System (ATMS)) can be used to fix certain problems without the need to do a hard battery reset.

Background

Buses can experience mechanical problems while in revenue service. The problem may be minor that allows the bus to continue in service after a quick fix, or major that requires the bus to be placed out of service. When a bus has an operating issue while in service (e.g., engine light on, air conditioner not on, header sign not on, wheelchair ramp not working, doors not operating properly, or brakes failing), the bus operator will notify Bus Operations Control (BOC). The issue might be mechanical, electrical or even software related.

In the past, when the BOC received a notification from a bus operator that he or she was having certain operating problems (not something like a flat tire), BOC would instruct the operator in some instances to perform a battery reset (See Attachment A – Bus Operator Battery Reset Process), which would shut the bus completely down and then restart it. BOC would make a note of the incident/problem in Metro's ATMS and also note whether the battery reset corrected the problem or the problem still exists. An Operations official advised that the ATMS database may not contain all of the battery resets performed because in some instances a bus operator on his/her own would perform a battery reset without notifying BOC in an attempt to correct a mechanical problem. If the battery reset did not fix the problem, BOC would decide if the bus should be taken out of service and a mechanic dispatched. Over time, Operations found that these practices caused the computers in the buses to loose valuable diagnostic information. Both the BOC and Bus Maintenance personnel were recently instructed to stop having bus operators perform battery shutdowns. In this regard, the following guidance was issued:

- A memo dated October 3, 2018, to BOC Controllers stated: "Maintenance has provided us with a new updated Road Call Reference Guide. A copy has been placed at each console and each Controller will receive a personal copy of the guide. Please make sure you read through the guide thoroughly. The information provided applies to all buses. It is imperative that everyone make note that the practice of having Operators perform a battery shutdown must stop immediately. The computers in the buses hold data that is pulled from the buses for diagnostic reasons. When a battery shutdown is performed, the computer loses valuable diagnostic information."

- The Bus Operations Maintenance Road Call Reference Guide, under "Service Disposition," was revised in August 2018 to state: "Do not have the battery switch turned off and on at any time during the process. This practice does not solve the problem and creates more negative issues than potential positive effects." This requirement pertained to the following bus operational problems:

    - Stalled Engine
    - Engine Does Not Start
    - Check Engine Indicator Light
    - Hot Engine
    - Stop Engine Light

Objectives, Scope, and Methodology of Review

The objectives of this review were to determine:

- The frequency of performing battery resets on buses while in revenue service, and

- The effectiveness of battery resets in correcting bus mechanical problems.

To achieve the review objectives, we performed the following procedures:

- Interviewed appropriate staff in Operations,
- Reviewed bus incident reports with a problem code of "ME" (mechanical problems) generated from the ATMS,
- Identified the number of incidents where a battery reset was performed and documented whether this process corrected the problem,
- Surveyed a sample of Metro bus operators on their experiences related to dealing with battery resets, and
- Listened by scanner to radio transmissions between bus operators and BOC Controllers.

This review is not an audit; therefore, government auditing standards are not applicable to this review.

Details of Review

1. Listen to Radio Transmissions between BOC and Operators

During the period of December 9, 2016 – April 14, 2017, we monitored a scanner for approximately 45 hours listening to radio transmissions between BOC and Metro bus operators to document any incidents where operators performed a battery reset/shutdown. Although our main focus was on bus rebooting, we documented all mechanical related incidents heard during the listening periods.

We documented 53 mechanical related incidents. For 7 (13%) of these incidents, the bus operator was told to do a battery reset/shut down. Because of the random and frequent movement of a scanner, we were not able to determine how many of the resets corrected the problem.

2. Review of Bus Incident Reports

We reviewed bus incident reports in ATMS with a problem code of "ME" (mechanical problems) for the week of August 5 to August 11, 2017. During this period, 1,091 bus incident reports were filed under the problem code of "ME." Our analysis found that:

- A battery reset was performed for 28 (3%) of the 1,091 incidents.
- For 15 (54%) of the 28 battery resets, the problem was resolved. For the remaining 13 incidents, the operator was provided a replacement bus or instructed to bring the bus into the division for repairs.

For the week that we reviewed, we found that battery resets performed by operators corrected the problem over 50% of the time. When these battery resets were performed by operators and the mechanical problems were corrected, transit customer delay was minimized and Metro resources

were saved (e.g., mechanics were not sent out in the field and/or a replacement bus did not have to be brought out to replace the bus in distress). Because battery resets are no longer being performed by operators due to the importance of preserving diagnostic data, Operations should assess how this new practice will affect customer delay time and available resources.

3. Battery Reset Questionnaire

In August 2018, we sent out questionnaires to a sample of Metro bus operators to capture their experiences with bus shutdowns/battery resets on Metro buses. Bus operators were asked to answer the questions based on their experiences from the previous week that they worked. We received responses from 687 bus operators. Some respondents did not answer every question. Below is an overview of the questions asked and the results:

Question 1: How many times in a typical day while operating a bus did you have to perform a bus shutdown/battery reset? (679 respondents)

Fifty-eight percent of respondents stated that they did not have to perform a battery reset, 27% stated that they had to perform a battery reset 1 time, 10% stated 2 times, and 5% stated that they had to perform a battery reset 3 or more times in a typical day.

Question 2: How many times in the past week, while operating a bus in service did you have to perform a bus shutdown/battery reset? (679 respondents)

Fifty-two percent of respondents stated that they did not have to perform a battery reset. The remaining 48% of respondents performed at least one battery reset during the past week.

Question 3: If you were instructed to shut down the bus, how much time (in minutes) did it typically take? (534 respondents were instructed to do a shutdown)

Fifty-one percent of respondents stated the process took 5 minutes or more, 31% stated it took 3-4 minutes, and 8% said 1-2 minutes.

Question 4: In situations where you performed a battery reset/shutdown, did performing this function correct the problem? (676 respondents)

Ninety percent of the respondents stated that performing this function corrected the problem at least some of the time, if not all the time. The remaining 10% stated that performing a battery reset never corrected the problem.

Question 5: In your opinion as a bus operator, would it be more efficient if a battery reset button was located inside the bus, such as on the dashboard or in a similar area? (679 respondents)

Ninety percent of the respondents said “Yes” and 10% of the respondents said “No.”

Question 6: The type of bus in which the battery reset occurred? (631 respondents)

Operators responded that battery resets were performed on all bus models. The majority (50%) of the battery resets were performed on the NABI 45 feet buses.

Question 7: The primary function for which you use the battery reset function is? (634 respondents)

Respondents stated the battery reset process was used for engine and mechanical issues 56% of the time.

Comment Section on Questionnaire: Several bus operators in our sample commented that Metro roadside mechanics and BOC staff have advised them that doing bus shutdowns / battery resets on some bus models can be harmful to the bus.

Both review of bus incident reports in the ATMS and bus operator responses to our questionnaire found that in many instances battery resets corrected mechanical problems. Ninety percent of the 676 respondents stated that performing a battery reset corrected the problem at least some of the time if not all of the time.

4. Bus Engineering Input on Battery Resets

We interviewed Kwesi Annan, Senior Engineer, Vehicle Technology & Acquisition Department, who indicated that it would be difficult to install a battery shut off switch inside the bus to reduce the dangers to operators, buses, and customers when operators go outside the bus to perform a battery reset. Mr. Annan advised that he does not believe a battery reset would likely correct any problem. (Note: This opinion is contrary to the survey responses of operators.) He further stated that operators should not perform mechanical repairs. He provided us information on the October 2018 directive to BOC Controllers to stop the practice of having operators reset batteries, but instead contact dispatch for instructions and to have a mechanic dispatched to their location.

5. Impact of Battery Resets

Some of the bus operators who were surveyed at random advised that the reset process took 5 minutes or more to complete. The battery reset process may expose the operator to dangers outside the bus and customers on the bus may become impatient if delays are long. Operators felt having a bus reboot switch inside the bus would be highly desirable, instead of the method they use now.

Soft reboots, where the operator is merely logging on and off the ATMS, may be a first resort and may be also an option that operators used to achieve a positive result, as opposed to a hard reboot of the system.

We did not survey the operators on how long it takes for a mechanic to respond to fix a bus problem, because this data is not something they keep track of with any specificity. The ATMS only tracks part of this activity, and M3 tracks the other part, so it is difficult to determine the actual time to respond versus the time to repair, which would be reflected in the M3 system

information. We further wonder if there is an option where an operator might do a controlled shutdown first using a soft reboot, before shutting down the battery in a manner that endangers diagnostic software and possibly other aspects of the bus systems.

Conclusion

Overall, it appears that battery shutdowns performed by operators did in many instances help fix the problem. Whether the problems fixed were electrical and software problems, as opposed to actual hardware problems that would not generally be correctable through any sort of reboot, is not clear. Metro has determined that battery resets can cause the computers in the buses to loose valuable diagnostic information. Guidance has recently been issued to cease the practice of operators performing battery resets. We believe soft resets are possibly an effective option rather than or before hard resets. When hard resets might be warranted, it would reduce the time to perform a battery reset and be safer for operators and passengers if a battery reset switch was located inside the bus. We also believe determining and researching the mechanical or electrical issues causing operators to reset batteries would be optimal, but with so many potential sources of problems, that may not be successful. We are not informed of the average time it takes for mechanics to be deployed and arrive at a location to fix a bus. We wonder if mechanics might also often reset the battery to correct problems. We believe it may be worth performing additional research to determine what problems are solved by soft versus hard resets, and if there are any circumstances under which a device with software diagnostics might be protected from a battery reset, such as if it had its own backup battery, or if a controlled shutdown and reset might be done safely and be the most efficient action in limited circumstances when it has been determined that a reboot does in fact correct that particular problem.

Recommendations

To ensure that Metro continues to provide its customers with an efficient and effective transit experience, we recommend that Operations Management:

1. Continue to communicate to bus operators and controllers on a regular basis that the practice of bus operators performing battery shutdowns has ceased.

2. Continue to assess and provide the resources required to minimize transit customer delay time given that the battery reset process did fix some operational problems.

3. Continue to study what circumstances cause bus field repairs and what specifications might be included in future procurements for systems and devices used in buses to reduce breakdowns and improve bus performance.

4. Consider the engineering adjustments necessary for improved safety of operators or others associated with battery resets that might occur by operators regardless of the new guidelines to cease operator battery resets.

5. Consider if battery hatches (See Attachment B – Picture of Battery Hatch in lower right side back of the bus) should be locked the way hatches inside the buses are to prevent unauthorized access.

6. Consider if further research on what circumstances or problems are corrected by a soft software reset versus a full battery reset, if it is possible to mitigate risks for software diagnostic damages in the event of a battery reset, and if considering the time it takes for a mechanic to arrive, it might be more efficient to allow the performance of the appropriate reset in those cases.

Request for Management Comments to Recommendations

The Operations Department is requested to provide OIG within 20 days a written response on the actions taken or planned concerning the recommendation in this report.

cc: Phillip Washington, Chief Executive Officer
Alex DiNuzzo, Senior Executive Officer, Maintenance
Al Martinez, Senior Director, Information Technology
Robert Holland, Senior Executive Officer, Transportation
Diane Frazier, Service Operations Superintendent
Stephen Rank, Service Operations Superintendent
Nancy Saravia, Senior Manager, Transportation Planning
Diana Estrada, Chief Auditor
Monica, Del Toro, Audit Support Manager
Karen Gorman, Inspector General
Metro Board of Directors
Board Deputies

BUS OPERATOR BATTERY RESET PROCESS

A Metro employee provided the following battery reset process:

1. Notify Bus Operations Control (BOC) that there is an operation problem with the bus.
2. BOC may advise bus operator to do a battery reset.
3. Pull bus over and shut off engine.
4. Advise passengers of problem.
5. Open both doors and exit bus.
6. Walk to rear of bus and open hatch to battery compartment.
7. Turn battery off then wait a few minutes and turn back on (Note: for newer model buses, leave off longer because battery has more electronics).
8. Shut hatch and return to bus.
9. Notify BOC if battery shutdown fixed the problem.
10. If shutdown does not correct the problem, BOC will provide further instructions to bus operator.

PICTURE OF A BATTERY HATCH

Location of Bus Batter Hatch