

# TORONTO TRANSIT COMMISSION REPORT NO.

**MEETING DATE:** February 24, 2014

**SUBJECT:** AUDITOR GENERAL'S REPORT – REVIEW OF TORONTO  
TRANSIT COMMISSION BUS MAINTENANCE AND SHOPS  
DEPARTMENT – PHASE ONE: BUS MAINTENANCE AND  
WARRANTY ADMINISTRATION

## **ACTION ITEM**

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## **RECOMMENDATION**

It is recommended that the TTC Board:

- 1) Receive the attached report from the Auditor General's Office, City of Toronto, on the Review of Toronto Transit Commission Bus Maintenance and Shops Department – Phase One: Bus Maintenance and Warranty Administration, and
- 2) Approve the forwarding of the attached report for information to the Audit Committee of the City of Toronto.

## **BACKGROUND**

At its meeting on February 11, 2014, the TTC Audit Committee received the Auditor General's report and approved forwarding the report to a regular meeting of the Board and then to the Audit Committee of the City of Toronto.

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1-27  
Attachment:



**AUDITOR GENERAL'S  
REPORT  
ACTION REQUIRED**

**Review of Toronto Transit Commission Bus  
Maintenance and Shops Department, Phase One: Bus  
Maintenance and Warranty Administration**

<b>Date:</b>	January 28, 2014
<b>To:</b>	TTC Audit Committee
<b>From:</b>	Auditor General
<b>Wards:</b>	All
<b>Reference Number:</b>	

**SUMMARY**

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The Auditor General's 2013 Audit Work Plan included an audit of the Toronto Transit Commission (TTC) bus maintenance program. The TTC Bus Maintenance and Shops Department provides regular maintenance and repair services to a large fleet of vehicles and equipment. Due to the Department's extensive operations, the audit was divided into two separate phases. Phase One, which is the subject of this report, focused on conventional buses. Phase Two will focus on Wheel-Trans accessible buses and non-revenue vehicles.

The objective of the Phase One audit was to assess the operating effectiveness and efficiency of bus maintenance. The audit report includes 18 recommendations the objectives of which are to improve the effectiveness, efficiency and the economy of bus maintenance operations. All of the audit recommendations are in keeping and supportive of strategic objectives set out in TTC's Five-Year 2013-2017 corporate Plan.

The audit results and recommendations are contained in the attached report entitled "Review of Toronto Transit Commission Bus Maintenance and Shops Department, Phase One: Bus Maintenance and Warranty Administration." Management responses to the audit recommendations are also attached.

## RECOMMENDATIONS

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### The Auditor General recommends that:

1. The Board request the Chief Executive Officer to evaluate the merits of the 5,000 km bus preventive maintenance interval in preventing mechanical failures. Such an evaluation should include a review of other transit agencies' practices, TTC's own bus repair records, and piloting new maintenance intervals in a small fleet of buses.
2. The Board request the Chief Executive Officer to ensure compliance with TTC bus preventive maintenance inspection and provincial legislative requirements, in particular maintenance of major vehicle parts.
3. The Board request the Chief Executive Officer to ensure that bus kilometre records used for scheduling preventive maintenance inspections are accurate.
4. The Board request the Chief Executive Officer to improve efficiency of bus preventive maintenance inspections and increase bus availability for service by:
  - a. Avoiding duplication of a Safety Check when a comprehensive semi-annual inspection is scheduled; and
  - b. Consistent alignment of Safety Checks and Lubrication Inspections where possible.
5. The Board request the Chief Executive Officer to review the bus preventive maintenance inspections by assigning Service Persons as the primary staff members to perform the 10,000 kilometre Lubrication Inspections.
6. The Board request the Chief Executive Officer to take the necessary steps to ensure adequate bus annual brake inspections and relines including:
  - a. Developing and reviewing exception reports to identify early brake relines and brake failures for further investigation; and
  - b. Improving the current coding of annual brake inspections in the Bus Maintenance Vehicle Work Order (VWO) Information System to differentiate between relines conducted during annual brake inspections and premature relines.
7. The Board request the Chief Executive Officer to implement effective monitoring and quality assurance procedures to help improve the quality of bus repairs. Such procedures should include regular analyses of bus road call statistics to identify repair quality issues.
8. The Board request the Chief Executive Officer to establish standard repair times for common bus repairs, develop procedures to monitor efficiency of bus repair

activities, and incorporate the standard repair times into part of technician performance evaluation.

9. The Board request the Chief Executive Officer to take the necessary steps to enhance continuous training for Bus Maintenance and Shops Departmental staff. Such steps should include but not be limited to:
  - a. Developing a training policy detailing clear and specific training objectives, requirements and completion timeframes for coach technicians and other job classifications where appropriate; and
  - b. Monitoring the completion of training requirements and addressing non-compliance with training requirements.
10. The Board request the Chief Executive Officer to accurately assess failure rates of major internal bus rebuild parts as well as assessing the costs of rework associated with rebuild failures.
11. The Board request the Chief Executive Officer, in his ongoing assessment of outsourcing opportunities, to conduct a complete analysis of internal bus rebuild costs at the Duncan Shop accounting for all key and relevant direct and indirect costs.
12. The Board request the Chief Executive Officer to take immediate steps to improve the current defective parts retrieval process at bus garages including but not limited to:
  - a. Implementing adequate controls to account for and track the return of defective parts by technicians; and
  - b. Enhancing efficiency of the parts retrieval process currently carried out by warranty staff.
13. The Board request the Chief Executive Officer to take immediate steps to maximize the use of bus warranty provisions and increase warranty recovery revenue. Such steps should include but not be limited to:
  - a. Identifying and addressing reasons prohibiting successful filing of warranty claims;
  - b. Increasing warranty claim submission rate for bus defective parts and labour hours; and
  - c. Systematically tracking and monitoring claim submission rate and warranty cost recovery for the entire bus fleet.
14. The Board request the Chief Executive Officer to take necessary steps to minimize the number of warranty claims denied by bus manufactures based on “no fault found” in submitted defective parts or warranty administrative issues.

15. The Board request the Chief Executive Officer to take steps to ensure proper accounting procedures for bus warranty claims and payments. Such steps should include but not be limited to:
  - a. Establish proper accounting procedures for bus warranty payments including setting up accounts receivable for warranty claims, implementing procedures to adjust/write off disputed claims and periodic reconciliations;
  - b. Undertake collection of all valid outstanding claims; and
  - c. Review accounting procedures for warranty payments for other types of TTC vehicles including subway trains and streetcars to ensure adequate financial controls are in place.
16. The Board request the Chief Executive Officer to provide an adequately designed and supported bus warranty management information system facilitating effective and efficient management of warranty claims and recoveries.
17. The Board request the Chief Executive Officer, in preparing 2015 budget submission relating to shortening existing bus service life policy by three years, to provide clear short and long term financial impact information based on a comprehensive, accurate and objective life-cycle cost analysis.
18. The Board request the Chief Executive Officer to develop a plan for hybrid buses to help minimize increasing maintenance costs in future operating budgets. Such a plan should include a review of alternatives and other transit agencies' experiences in maintaining their hybrid bus fleets.
19. This report be forwarded to the City's Audit Committee for information.

## **Financial Impact**

The implementation of recommendations in this report will likely result in cost savings and improved operating efficiency. The extent of any resources required or potential cost savings resulting from implementing the recommendations in this report is not determinable at this time.

## **COMMENTS**

This was our first audit in connection with the fleet of the TTC. Phase One of the bus maintenance audit focused on conventional buses, and Phase Two will focus on Wheel-Trans accessible buses and non-revenue vehicles.

The TTC Bus Maintenance and Shops Department provides regular maintenance and repair services to a large fleet of vehicles and equipment including:

- 1,857 conventional buses
- 221 Wheel-Trans accessible buses

- 404 non-revenue vehicles.

With a complement of 1,546 approved positions in 2013, the Department operates eight garages and two repair shops. The 2012 Departmental operating costs were approximately \$245 million of which \$165 million were for ongoing operations and \$80 million for vehicle procurement and rebuilds.

Our Phase One audit report identifies 18 recommendations to help improve effectiveness and efficiency of preventive maintenance inspections, quality of repairs, staff training, the economy of bus rebuild functions, and warranty administration. All of the audit recommendations are in keeping and supportive of the strategic objectives set out in TTC's Five-Year 2013-2017 Corporate Plan.

Recommendations relating to warranty administration should be addressed by management immediately as the recommended changes can potentially result in significant increases in annual warranty revenue. At the time of writing, management staff have already taken actions to address a number of audit recommendations.

The audit report entitled "Review of Toronto Transit Commission Bus Maintenance and Shops Department, Phase One: Bus Maintenance and Warranty Administration" is attached as Appendix 1. Management's response to each of the recommendations contained in the report is attached as Appendix 2.

## **CONTACT**

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## **SIGNATURE**

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Jeff Griffiths, Auditor General

13-TTC-01

## **ATTACHMENTS**

Appendix 1: Auditor General's Report, Review of Toronto Transit Commission Bus Maintenance and Shops Department, Phase One: Bus Maintenance and Warranty Administration

Appendix 2: Management's Response to the Auditor General's Review of Toronto  
Transit Commission Bus Maintenance and Shops Department, Phase One:  
Bus Maintenance and Warranty Administration

**AUDITOR GENERAL'S REPORT**

**Review of Toronto Transit Commission  
Bus Maintenance and Shops Department**

**Phase One: Bus Maintenance and  
Warranty Administration**

**December 2, 2013**

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**Jeffrey Griffiths, CPA, CA, CFE**  
**Auditor General**



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## TABLE OF CONTENTS

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<b>EXECUTIVE SUMMARY</b> .....	1
<b>BACKGROUND</b> .....	5
<b>AUDIT OBJECTIVES, SCOPE AND METHODOLOGY</b> .....	8
<b>AUDIT RESULTS</b> .....	10
<b>A. PREVENTIVE MAINTENANCE INSPECTIONS</b> .....	10
A.1. Evaluate the Merits of the 5,000 km Maintenance Interval.....	12
A.2. Improve Adherence to Parts Maintenance Requirements.....	14
A.3. Ensure Accurate Kilometre Records in System.....	16
A.4. Improve Efficiency By Better Alignment of Inspections .....	17
A.5. Improve the Economy of Inspections .....	20
A.6. Monitor Quality of Annual Brake Inspections.....	21
<b>B. REPAIRS</b> .....	23
B.1. Improve Quality of Repairs .....	23
B.2. Improve Efficiency of Repairs.....	24
B.3. Ensure Adequate Continued Training for Coach Technicians .....	25
<b>C. BUS AND COMPONENT REBUILD</b> .....	27
C.1. Analyze Internal Rebuild Failure Rates.....	28
C.2. Accurately Assess Internal Rebuild Costs .....	28
<b>D. WARRANTY ADMINISTRATION</b> .....	31
D.1. Improve Defective Parts Retrieval Process.....	32
D.2. Increase Claim Submissions .....	34
D.3. Minimize Claim Denials By Manufacturers.....	36
D.4. Implement Accounts Receivable Procedures .....	37
D.5. Improve Warranty Information System .....	38

<b>E. FUTURE BUS ACQUISITION</b> .....	39
E.1. Policy on Bus Service Life .....	39
E.2. Develop a Hybrid Bus Plan to Minimize Future Maintenance Cost Increases.....	41
<b>CONCLUSION</b> .....	43
Exhibit 1: Key Preventive Maintenance Inspections, TTC Bus Maintenance and Shops Department, 2013 .....	44

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## EXECUTIVE SUMMARY

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The Auditor General's 2013 Audit Work Plan included an audit of Toronto Transit Commission's (TTC) bus maintenance program.

***Number and types of vehicles maintained by the Department***

The TTC Bus Maintenance and Shops Department provides regular maintenance and repair services to a large fleet of vehicles and equipment including:

- 1,857 conventional buses
- 221 Wheel-Trans accessible buses
- 404 non-revenue vehicles.

***Staffing and annual operating costs***

With a complement of 1,546 approved positions in 2013, the Department operates eight garages and two repair shops. The 2012 Departmental operating costs were approximately \$245 million of which \$165 million were for ongoing operations and \$80 million for vehicle procurement and rebuilds.

***Phase 1 audit focused on conventional buses***

Due to the Department's extensive operations, the audit was divided into two separate phases. Phase One, which is the subject of this report, focused on conventional buses. Phase Two will focus on Wheel-Trans accessible buses and non-revenue vehicles.

***Audit objective was to assess operating effectiveness and efficiency***

The objective of the Phase One audit was to assess the operating effectiveness and efficiency of bus maintenance. Results of the Phase One audit are presented in the report in the order of:

- Preventive maintenance inspections
- Repairs
- Bus and component rebuild
- Warranty administration
- Future bus acquisition

The key audit findings and recommendations are highlighted as follows:

***Recommended changes to warranty administration can potentially result in significant revenue increases***

***Warranty administration requires immediate attention***

Of the 18 recommendations contained in the report, recommendations pertaining to warranty administration require immediate management attention. Based on our review of a sample of approximately 100 buses eligible for warranty, we estimate 70 per cent of bus repairs eligible for warranty claims were not processed by the Department due to:

- Missing defective parts to return to manufacturers to support warranty claims
- Specific information pertaining to repairs eligible for warranty was incomplete, inadequate or not available.

***Improved warranty administration can potentially increase annual warranty revenue by \$4 to \$5 million***

Had the Department maximized its warranty provisions, we estimate a potential increase in warranty revenue in the range of \$4 million to \$5 million per year.

In addition, approximately \$200,000 worth of annual warranty claim value was denied by manufacturers. Two common claim denial reasons were:

- Submitted defective parts were determined to be in working order by manufacturers, and
- Administrative issues such as delayed submissions, wrong parts submitted or non-authorized repairs.

***Minimizing instances of claims denied by manufacturers could increase warranty recovery revenue***

Efforts should be made to minimize instances of claims denied by manufacturers.

***Recommended changes to improve effectiveness of operations***

***Effectiveness of the 5,000 km PMI interval needs to be evaluated***

The Department's preventive maintenance inspections (PMIs) are currently scheduled at every 5,000 km for a Safety Check and every 10,000 km for a Lubrication Inspection. Although the 5,000 km PMI interval has been in place for many years, the effectiveness of this particular maintenance interval in preventing mechanical failures has not been reviewed by staff. Most transit agencies use 10,000 km as their maintenance interval. The merits of the Department's existing 5,000 km maintenance interval needs to be evaluated based on vehicle repair data and best practices.

***Improving quality of repairs can help reduce service disruptions***

Our review of a sample of bus repair history identified repeated repairs for the same recurring defects in certain buses. Inadequate repairs contribute to incidents of in-service vehicle breakdowns, currently averaging nearly two incidents per bus per month. Management staff were aware of the issue and have taken measures to improve monitoring of repair quality.

***A training policy is important in ensuring technicians stay current with new technologies***

A significant number of the Department's coach technicians were certified many years ago, making it important for the Department to provide continuous training to ensure technicians stay current with new technologies. The Department has not developed a training policy specifying training requirements for different job classifications. Current training activities were delivered in a piecemeal manner lacking specific training requirements and monitoring of training completion.

***Recommended changes to improve efficiency of operations***

Our review of PMI procedures and inspection records identified opportunities to improve efficiency by consistent implementation of the following:

- Eliminating the 5,000 km Safety Checks that are scheduled close to a semi-annual comprehensive vehicle inspection required by the Ontario Ministry of Transportation
- Ensuring the 5,000 km Safety Check and 10,000 km Lube are conducted together at each 10,000 km interval

***Better alignment of PMIs will avoid duplication of work and reduce the number of times buses are pulled out of service for maintenance***

More efficient alignment of PMIs will avoid duplication of work and minimize the number of times buses are pulled out of service for maintenance. In addition, the Department can potentially realize savings equivalent to two full time equivalents (FTEs) per annum.

***Establishing standard repair times can help improve repair efficiency***

Further, the Department can improve repair efficiency by establishing standard labour hours for common repairs. Without standard repair hours, management staff have no means of ensuring efficient repair work by garage personnel.

### ***Recommendations regarding the economy of the operations***

***Improving the economy by assigning the work to the qualified and lower rated staff***

While a trained garage Service Person is qualified to perform the 10,000 km Lubrication Inspections, the Department currently assigns the work to higher rated staff positions. Using Service Persons as the primary staff for Lubrication Inspections have the potential to save the Department approximately \$200,000 per year.

***A detailed analysis of internal costs needs to be conducted for the bus rebuild functions***

To assess the economy of the Department's bus rebuild functions at its Duncan Shop, a detailed cost analysis comparing internal rebuild costs with market prices should be conducted. All key and relevant internal costs, including material handling costs and rebuild failure rates and associated rework costs, should be included in the internal costing.

### ***Recommendations regarding future bus acquisition***

***Shortening TTC's current 18-year bus service life policy may improve customer service without significant cost increase in the long term***

TTC's current policy is to maintain buses for a minimum of 18 years before retirement. This 18-year service life policy is considerably longer than the 12 to 15-year policies adopted by most North America transit agencies. Shortening TTC's bus service life policy could potentially improve vehicle reliability and customer services without significant overall cost increases over a long period. However, staff need to provide clear cost information based on a comprehensive cost analysis and realistic operational conditions.

***A plan is needed to help minimize future financial impact from increasing maintenance costs for the hybrid fleet***

Between 2005 and 2007 TTC procured over 690 hybrid buses with provincial and federal subsidies. Subsequent to acquisition, staff have been dealing with frequent and significant repair issues to these buses. As the warranty provisions on the hybrid buses expires in 2014, staff anticipate substantial increases in future hybrid maintenance costs. The hybrid experience underscores the importance of evaluating the reliability of new technologies in future vehicle acquisition. Going forward the Department needs to develop a plan to help minimize future financial impact from increasing hybrid maintenance costs.

## Conclusion

This audit report includes 18 recommendations to improve the effectiveness, efficiency and the economy of bus maintenance operations.

All of the audit recommendations are in keeping and supportive of the seven strategic objectives set out in the TTC's Five-Year Corporate Plan 2013-2017.

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## BACKGROUND

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The Toronto Transit Commission (TTC) is the third largest public transit system in North America serving over 4.5 million people through an integrated network of transit systems consisting of buses, streetcars and subways.

*CEO has set out clear directions on how to improve TTC*

In his recently issued Five-Year Corporate Plan 2013-2017, the TTC Chief Executive Officer identified seven strategic objectives and core strategies to "transform the TTC, our performance and our reputation". The seven strategic objectives include specific initiatives to transform employee performance and culture, improve vehicle reliability, and deliver optimal value for money.

*Ridership increased from 500 million in 2011 to 540 million in 2014*

Demand for public transit in Toronto continues to grow. Ridership has increased from approximately 500 million in 2011 to projected 540 million in 2014. TTC estimated that approximately 60 per cent of its customers use bus service for at least part of their trip. In 2012, TTC buses provided over 300 million customer trips.

*TTC has reduced its average bus fleet age*

Since 2003 TTC has made a significant investment in renewing the bus fleet. Over 1,500 new conventional buses were added between 2003 and 2012 reducing the average fleet age from 14.1 years in 2003 to 7.7 years in 2013. More than 200 new accessible buses were also added to the Wheel-Trans fleet between 2010 and 2012.

***153 new articulated buses will be added to the fleet***

In 2013 TTC introduced a fleet of 60-foot articulated buses on high-demand routes. Each articulated bus carries approximately 35 per cent more passengers than the existing 40-foot bus. The higher capacity articulated buses are more economical to operate as they are able to transport large passenger loads without increasing bus operator costs. According to TTC's 2014 budget report, the introduction of a fleet of 153 articulated buses will reduce annual operating costs by approximately \$5.4 million.

***All TTC buses are maintained by the Bus Maintenance and Shops Department***

The TTC Bus Maintenance and Shops Department provides regular maintenance and repair services to a large fleet of vehicles and equipment. As of June 2013, the fleet consisted of:

- 1,857 conventional buses
- 221 Wheel-Trans accessible buses
- 404 non-revenue vehicles
- 373 rubber tired shop equipment (e.g. compressors, pumps)
- 40 trailers

The Department operates the following facilities:

***Operating facilities include 7 garages, 1 Wheel-Trans garage, and 2 shops***

- Seven garages for maintenance and repair of conventional buses
- One Wheel-Trans garage for maintenance and repair of accessible buses
- Two heavy repair shops (Duncan and Harvey Shops) for major repairs, and mechanical and structural rebuilds of buses and streetcars

The Department uses a Vehicle Work Order (VWO) computer system to record bus kilometre information, schedule preventive maintenance inspections, and track vehicle repair and maintenance records.

***\$245 million annual operating costs with over 1,500 approved positions***

The Department's 2012 operating costs were approximately \$245 million of which approximately \$165 million was for ongoing operations and \$80 million for procurement of vehicles and bus and streetcar rebuilds. The 2013 approved budget for the department included 1,546 positions. Figure 1 shows the allocation of approved positions by facility.

**Figure 1: Allocation of Approved Staff Positions by Facility, TTC Bus Maintenance and Shops Department, 2013**

<b>TTC Facility</b>	<b>2013 Positions</b>
Seven garages for conventional buses	760
One Wheel-Trans garage for accessible buses	100
Duncan Shop	344
Harvey Shop	291
Others (head office, vehicle engineering, and fleet management)	51
<b>Total</b>	<b>1,546</b>

*Annual bus direct maintenance costs have been growing*

The Department is faced with escalating bus maintenance costs. TTC direct bus maintenance costs have risen from approximately \$76 million in 2007 to \$105 million in 2012. Bus direct maintenance costs as a percentage of total TTC bus operating costs (excluding fuel costs) have also increased from 22.0 per cent in 2007 to 23.2 per cent in 2012.

*Additional operating funds were needed for bus maintenance*

In the 2012, 2013 and 2014 operating budgets, the Department requested additional funds of \$3.3 million, \$2.6 million, and \$9.4 million respectively for bus maintenance. Reasons provided by staff for increases in operating costs included:

- New buses coming off warranty with more complicated systems, such as kneeling capability, security cameras, and advanced electronic systems
- Warranty for bus engine turbochargers has expired
- Higher than expected engine and transmission failures as the bus fleet continues to age
- Expiry of warranty coverage for hybrid buses
- Increased seat replacement work

*TTC will reduce \$2.2 million annual operating costs by outsourcing daily bus servicing*

TTC has taken measures to lower bus maintenance costs. In 2013 TTC began outsourcing daily bus servicing functions at garages. Daily bus servicing include fuelling, fluid top-up, and exterior and interior cleaning. When fully implemented by the end of 2013, outsourcing daily bus servicing and cleaning is estimated to result in approximately \$2.2 million annual savings.

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## AUDIT OBJECTIVES, SCOPE AND METHODOLOGY

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The Auditor General's 2013 Audit Work Plan included an audit of TTC bus maintenance.

*Review will be carried out in two phases*

TTC's Bus Maintenance and Shops Department operations are extensive including multiple functions and involve a significant number of vehicles and equipment. In order to ensure timely reporting of audit results, our audit has been divided into two phases.

*Phase 1, current audit report, focused on buses*

Phase One of our audit, which is the subject of this report, focused on maintenance inspection, repair and rebuild activities of conventional buses.

*Phase 2 will focus on other types of vehicle*

Phase Two will focus on maintenance and repair activities of Wheel-Trans accessible buses, non-revenue vehicles, and the streetcar rebuild program.

The scope of the bus maintenance audit did not include fleet acquisition and disposition. Nonetheless, certain issues arising from our review were found to be relevant to future fleet acquisition, and these issues were included in the current audit report.

A separate audit is planned pertaining to materials management including a review of controls over the inventory of auto parts.

*Focus of the audit was on assessing effectiveness and efficiency*

The objective of the Phase One audit was to assess the operating effectiveness and efficiency of bus maintenance. The audit included a review of the following areas:

- Compliance with preventive maintenance schedules and requirements
- Cost effectiveness and reliability of preventive maintenance inspections and repairs
- Cost effectiveness and efficiency of the bus rebuild program
- Use of manufacturer warranty

- Licensing and training of technicians
- Benchmarking with other transit agencies on key performance indicators

The audit covered the period from January 2012 to October 2013, except where multi-year analysis was conducted.

Our audit work included the following:

- Reviews of the TTC's Five-Year Corporate Plan 2013-2017
- Reviews of relevant legislative and policy requirements
- Reviews of literature and studies pertaining to transit bus maintenance
- Reviews of external consultant reports relating to bus maintenance
- Reviews of the Department's financial and operational data, and internal reports and analyses
- Interviews with TTC staff, staff of other transit agencies and privately operated repair shops
- On-site visits of Duncan shop, Harvey shop, and TTC bus garages
- Reviews of hard-copy files at TTC garages and on-site testing
- Analyses of vehicle preventive maintenance, repair and rebuild system records, warranty claim data, and licensing and training records
- Consultation with the Director of the City's Fleet Services, and consultation with the Director of the City's Urban Forestry, Parks, Forestry and Recreation Division

*A wide range of work was conducted for the audit*

*Benchmarking with other transit agencies' bus maintenance practices*

As part of our audit, we contacted a number of North America transit agencies to obtain specific operational and financial information. We requested each transit agency to complete a written benchmarking questionnaire, and followed up with telephone or personal interviews where needed to clarify the information provided. The following seven transit agencies provided information:

***Seven transit agencies provided information***

- Metropolitan Transit Authority (MTA) New York City Transit
- Massachusetts Bay Transportation Authority (MBTA) - Boston
- Ottawa OC Transit
- Calgary Transit
- York Region Transit
- Brampton Transit
- Durham Region Transit

***Compliance with generally accepted government auditing standards***

We conducted this performance audit in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

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## **AUDIT RESULTS**

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### **A. PREVENTIVE MAINTENANCE INSPECTIONS**

***PMIs are key to ensure vehicle reliability***

Preventive maintenance inspections (PMIs) are fundamental to effective vehicle maintenance. Undertaking PMIs at strategic intervals can help prevent mechanical failures and extend vehicle useful life.

***Various PMIs required for TTC buses***

The Bus Maintenance and Shops Department has established comprehensive PMIs consisting of the following key requirements:

- Timely repairs of defects noted by bus drivers during daily operation
- Regular PMIs at 5,000 km and 10,000 km intervals
- Mandatory semi-annual vehicle inspection as required by the Ministry of Transportation of Ontario (MTO)

- Annual brake inspection and reline
- Seasonal services
- Services of major vehicle parts at specific intervals.

Exhibit 1 attached to this report provides further details of the above key PMIs.

***Most PMIs are performed at TTC garages***

Almost all of the PMIs are performed by maintenance personnel at TTC's seven garages. The only exception is the annual brake inspections conducted by licensed technicians at Duncan Shop.

Each TTC garage has an inspection team ranging from 8 to 11 staff. These teams conduct 5,000 km and 10,000 km PMIs and semi-annual MTO inspections. The rest of the PMIs, such as seasonal services and regular servicing of differentials and transmissions, are conducted by general garage personnel responsible for repairs and other daily garage activities.

***The Department has established PMI Standard Procedures and regularly reviews a sample of inspection results***

To ensure PMIs are conducted adequately, the Department has established Standard Operating Procedures detailing inspection steps and criteria for the 5,000 km and 10,000 km PMIs, the semi-annual MTO inspection, and the annual brake inspection.

In addition, commencing January 2013 the Department has assigned two Engineering Technicians who regularly review a sample of buses to determine the quality of recent PMIs conducted by garage personnel. The review results are provided to the respective garage management staff for follow-up.

Staff from the Ministry of Transportation also conduct periodic inspections of a sample of TTC buses to ensure adherence to provincial safety standards. According to TTC staff, all TTC buses inspected in 2012 and 2013 received full approval from the Ministry. Based on our review of certain documentation, this information appears to be valid.

### **A.1. Evaluate the Merits of the 5,000 km Maintenance Interval**

*The 5,000 km PMI interval is not required by law or manufacturers*

Of the regular PMIs conducted by the Department, the 10,000 km lube is required by bus manufacturers, and the semi-annual inspection is legislatively required by the Ministry. The 5,000 km Safety Check is not required by law and is a Departmental policy.

*Basis for the Department's 5,000 km PMI interval is not clear*

Management staff could not provide specific reasons for the basis of the 5,000 km PMI interval other than it has been the Departmental policy for many years. According to a former TTC employee, the 5,000 km interval originated from the need for mechanics to manually adjust a brake component every 5,000 km. However, with the current automatic brake technology the manual adjustment is no longer needed.

*The majority of transit agencies use 10,000 km as maintenance interval*

According to a 2010 U.S. Transportation Research Board survey of North America transit agencies, 71 per cent of survey respondents conduct their PMIs at approximately 10,000 km (i.e. 6,000 miles) interval.

In addition, most of the agencies which responded to our survey use 10,000 km as the maintenance interval. The exceptions are New York City Transit and York Region Transit.

New York City Transit uses the 5,000 km as the maintenance interval for buses travelling at very low speed in high traffic areas. York Region Transit is currently conducting PMIs at the 5,000 km interval but will be extending it to 10,000 km commencing 2014. York Region management staff explained that the change to 10,000 km interval was based on their analysis of bus breakdown data.

Figure 2 outlines the PMI intervals used by the TTC and those transit agencies which responded to our request for information.

**Figure 2: Preventive Maintenance Intervals, Audit Survey of Transit Agencies, 2013**

<b>Transit Agency</b>	<b>Number of Buses</b>	<b>PMI Distance Interval</b>
<b>Toronto Transit Commission</b>	<b>1,857</b>	<b>Every 5,000 km for a safety check and every 10,000 km for lube</b>
MTA New York City Transit, USA	5,712	Every 5,000 km for buses travelling less than 13 km per hour in high traffic areas Every 6,500 km for buses serving outer borough areas Every 10,000 km for buses on express routes
Massachusetts Bay Transportation Authority (MBTA) – Boston, USA	1,058	Every 10,000 km for the first 40,000 km driven Every 40,000 km after the initial 40,000 km driven
Ottawa OC Transit	936	Every 60 days or every 9,600 km whichever comes first
Calgary Transit	818	Every 10,000 km
York Region Transit	485	Currently every 5,000 km for visual inspection and every 10,000 km for lube Changing to every 10,000 km PMI effective January 2014
Brampton Transit	341	Every 15,000 km
Durham Region Transit	235	Every 10,000 km

We recognize that there may be a need for the Department’s 5,000 km maintenance interval given Toronto’s urban environment (with more “stops and goes”) and winter weather conditions. Nevertheless, the Department should undertake a review of the effectiveness of its 5,000 km maintenance interval in preventing mechanical failures.

***Recommend reviewing the merits of the 5,000 km maintenance interval***

Where feasible, the Department should consider piloting a different PMI interval with a small fleet of buses to determine its impact on vehicle reliability.

The Department could potentially realize significant cost savings and increased bus availability for service if certain bus models can be adequately maintained at a longer kilometre interval.

**Recommendation:**

- 1. The Board request the Chief Executive Officer to evaluate the merits of the 5,000 km bus preventive maintenance interval in preventing mechanical failures. Such an evaluation should include a review of other transit agencies' practices, TTC's own bus repair records, and piloting new maintenance intervals in a small fleet of buses.**

**A.2. Improve Adherence to Parts Maintenance Requirements**

*Audit testing to verify accuracy of maintenance records in VWO system*

Each TTC garage keeps individual hard-copy files for all its buses. The files contain recent maintenance inspection and work order records. As part of our audit, we reviewed a sample of vehicle files at various garages and verified that the Vehicle Work Order (VWO) system records were consistent with those in the files.

For distance-based PMIs (e.g. 5,000 km and 10,000 km inspections), most transit agencies have an acceptable “window” to measure compliance. TTC’s policy is plus or minus 800 km of the prescribed kilometre intervals.

To assess compliance level with the required PMIs, we reviewed VWO system maintenance records and reports for the period January to June 2013. Seasonal service compliance level was based on fall 2012 results.

*High compliance with 5,000 km and 10,000 km maintenance but low compliance with parts maintenance*

Our review of maintenance inspection records noted high compliance with the 5,000 km and 10,000 km inspection requirements, but low compliance level with differential and transmission servicing. Details of our review results are summarized in Figure 3.

**Figure 3: Summary of Preventive Maintenance Inspections (PMIs) Compliance Levels, TTC Bus Maintenance, January to June 2013**

PMI	Required Inspection Interval	Compliance Level	Audit Findings
Safety Check	Every 5,000 km +/- 800 km*		Nearly all buses in service received the 5,000 km PMIs
Lubrication and Inspection (Lube)	Every 10,000 km +/- 800 km*		Nearly all buses in service received the 10,000 km PMIs
Ministry of Transportation of Ontario (MTO) Inspection	Every 6 months		A semi-annual MTO inspection was conducted on the majority of buses before the expiry date as required by the Ministry  Eight buses had their inspections completed after the expiry with delays from several days to 4 weeks
2012 Fall Seasonal Service	Every year September 1 to November 30		The majority of buses received the 2012 fall seasonal service between September 1 and November 30, with the exception of 20 buses from one garage
Differential Lube	Every 240,000 km +/- 800 km*		Low compliance for buses in four garages; many buses were more than 1,600 km overdue
Transmission Lube	Every 50,000 km +/- 800 km*		Low to moderate compliance for buses in six garages; many buses were more than 1,600 km overdue

\* Acceptable window for measuring compliance with distance-based PMIs

Among the buses for which a differential or transmission lubrication service was not performed within the scheduled kilometre intervals, a number of them are the oldest bus model purchased in 1996. Management indicated that these buses were given a lower maintenance priority in 2013 as they are due for retirement in 2014.

*Timely maintenance of vehicle parts is important for state of good repair*

In our discussions with staff we have been assured that delays in servicing differentials and transmissions will not compromise customer or vehicle safety. Nonetheless, the timely maintenance of vehicle parts is important for vehicle reliability and state of good repair.

*One way to help improve compliance with parts maintenance*

Unlike the regular 5,000 km and 10,000 km PMIs and MTO inspections which are conducted by a dedicated inspection team at each garage, maintenance of differentials and transmissions are assigned to general garage technicians whose primary responsibilities are vehicle repairs. Assigning differential and transmission maintenance to dedicated inspection teams may therefore help improve compliance.

**Recommendation:**

- 2. The Board request the Chief Executive Officer to ensure compliance with TTC bus preventive maintenance inspection and provincial legislative requirements, in particular maintenance of major vehicle parts.**

**A.3. Ensure Accurate Kilometre Records in System**

*All PMIs are scheduled by the Department's VWO system*

All PMIs are scheduled by the Department's VWO system based on either distance travelled or the date since the last inspection. Daily bus kilometre records are tracked by the TTC Transportation Department's communication system via radio transmission. The data is then uploaded to the VWO system on a daily basis.

To determine whether the VWO system kilometre records were reasonably accurate, we reviewed the actual kilometreage of 25 buses at three different garages.

*Significant differences between odometer readings and VWO system records in buses sampled*

We identified significant differences between bus odometer reading and VWO system records in nearly every bus sampled. In most cases, the system records were higher than odometer readings, but in a small number of buses the reverse was noted. The variances between system record and odometer reading were over 700,000 km in several buses.

*Inaccurate kilometre tracking can potentially undermine effectiveness of PMIs*

Since the Department relies on its VWO system to schedule all PMIs, it is important to ensure bus kilometre records in the system are updated and accurate. Inaccurate system kilometre data can potentially result in PMIs being called too early or too late, consequently impacting the effectiveness of PMIs in preventing mechanical failures.

In response to the audit findings, management staff indicated that they were aware of the inaccurate kilometre issue which was probably caused by the outdated communication system. Management staff have been exploring various corrective measures including system upgrades and other interim measures.

**Recommendation:**

- 3. The Board request the Chief Executive Officer to ensure that bus kilometre records used for scheduling preventive maintenance inspections are accurate.**

**A.4. Improve Efficiency By Better Alignment of Inspections**

Figure 4 outlines the purposes and standard labour hours for the 5,000 km and 10,000 km PMIs, and the semi-annual inspection.

**Figure 4: Purposes and Standard Labour Hours for Preventive Maintenance Inspections, TTC Bus Maintenance**

<b>PMIs</b>	<b>Inspection Interval</b>	<b>Purpose</b>	<b>Standard Labour Hour</b>
<b>Safety Check</b>	Every 5,000 km	Licensed technicians inspect critical safety features including steering and suspension, axles, tires, air system, and brake to ensure safe vehicle operation.	55 minutes
<b>Lubrication and Inspection (Lube)</b>	Every 10,000 km	Lubrication of various vehicle parts, engine oil and filter changes, and a visual inspection of items such as exterior and interior lights, mirrors, circulating pump, tires, brake pedals, and bike rack.	2.4 hours
<b>Ministry of Transportation of Ontario (MTO) Inspection</b>	Every 6 months	Licensed technicians inspect buses according to Ontario Regulation 611 “Safety Inspections”, the Highway Traffic Act. Components inspected include: <ul style="list-style-type: none"> <li>- Air system</li> <li>- Brake drum measurement</li> <li>- Cooling system</li> <li>- Electrical wiring</li> <li>- Battery</li> <li>- Alternator</li> <li>- Engine</li> </ul>	8 hours

***A MTO inspection covers what need to be done in a Safety Check***

Our review of PMI procedures noted that the semi-annual MTO inspection, which takes 8 hours to perform, covers all procedures in a 5,000 km Safety Check. Consequently when a MTO inspection has been conducted, it is not necessary to conduct a separate Safety Check.

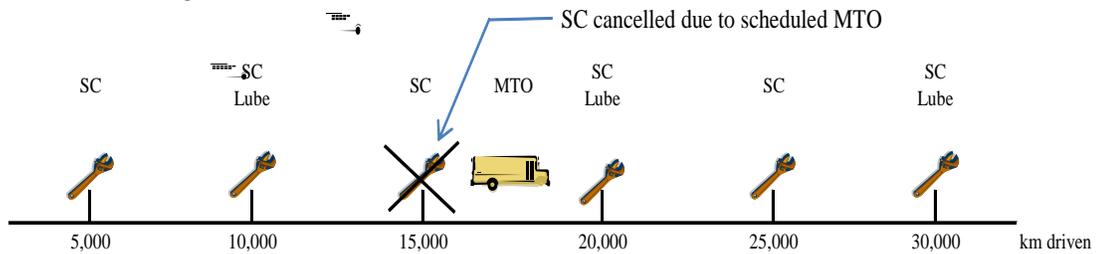
***Policy to align the intermediate Safety Check with Lube where possible***

In addition, to minimize the number of times buses being taken out of service for regular maintenance, the Department's policy is to conduct every intermediate 5,000 km Safety Check with the 10,000 km Lube where possible.

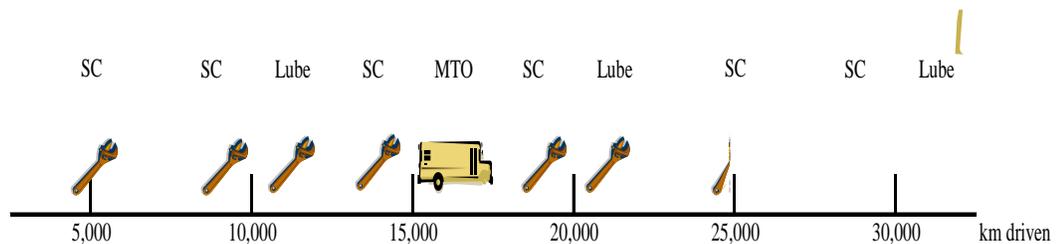
Figure 5(a) depicts an efficient scheduling of PMIs where a Safety Check scheduled close to a MTO inspection is cancelled, and the intermediate 5,000 km Safety Checks are conducted together with the 10,000 km Lube.

Figure 5(b) shows an example of observations noted in a number of buses' maintenance routines where a Safety Check was conducted just before a scheduled MTO, and the intermediate 5,000 km Safety Checks were conducted separately from the 10,000 km Lubes. As a result buses are more frequently pulled out of service for maintenance.

**Figure 5(a): Efficient Alignment of PMIs**



**Figure 5(b): Inefficient Alignment of PMIs**



SC - Safety Check every 5,000 km

Lube - Lubrication inspection every 10,000 km

MTO - Semi-annual inspection required by the Ministry of Transportation of Ontario

 Bus pulled out of service for PMI

Figure 6 highlights instances where a Safety Check was conducted very close to a MTO inspection.

**Figure 6: Examples of Safety Checks Conducted Close to MTO Inspections**

Bus	MTO Date	Safety Check Date	Days Between MTO and Safety Check	Km Between MTO and Safety Check
A	January 12-17	January 18	1 day	40 km
B	June 3-9	May 30	3 days	854 km
C	April 11-22	April 10	1 day	167 km
D	July 23-26	July 22	1 day	163 km

Figure 7 shows instances where a Safety Check and a Lube were separately conducted with only one or two days apart.

**Figure 7: Examples of Separately Conducted Safety Checks and Lubes**

Bus	Safety Check Date	Lube Inspection Date	Days Apart	Km Driven Between PMIs
E	January 5	January 3	2 days	167 Km
F	January 18	January 19	1 day	230 Km
G	April 16	April 17	1 day	357 Km
H	July 20	July 19	1 day	266 Km

***Saving of 1.5 FTE by eliminating the redundant 5,000 km Safety Checks***

Eliminating the redundant Safety Checks can potentially save 2,600 person hours annually, equivalent to 1.5 full-time equivalent (FTE), without impacting vehicle reliability. More importantly, this will reduce the number of times buses are pulled out of service for PMIs.

***Savings of 0.5 FTE by combining Safety Checks with Lubes***

In addition, whenever a PMI is conducted, approximately 22 minutes “set-up time” are needed for vehicle shuttling, retrieving parts and tools, and inputting data. Combining Safety Checks with Lubes minimizes the otherwise duplicated “set-up times” and could potentially save over 1,000 person hours per year, equivalent to 0.5 FTE.

***Manual process should be replaced by programming the VWO system to align PMIs***

While the Department expects garage staff to cancel a Safety Check when a MTO is scheduled and to combine Safety Checks with Lubes where possible, it has not been able to program these in its VWO system.

Current procedures require garage forepersons to manually identify and cancel a Safety Check if a MTO is scheduled, and to re-align Safety Checks and Lubes when they are scheduled on different days. Given the large number of PMIs scheduled each day, consistent implementation is difficult by means of a manual process.

**Recommendation:**

- 4. The Board request the Chief Executive Officer to improve efficiency of bus preventive maintenance inspections and increase bus availability for service by:**
  - a. Avoiding duplication of a Safety Check when a comprehensive semi-annual inspection is scheduled; and**
  - b. Consistent alignment of Safety Checks and Lubrication Inspections where possible.**

**A.5. Improve the Economy of Inspections**

*Different categories of unionized staff for maintenance work*

There are three main categories of unionized staff positions in garage operations as outlined in Figure 8 below.

**Figure 8: Main Categories of Unionized Positions in TTC Bus Garage Operations**

<b>Position</b>	<b>License Requirement</b>	<b>PMI Responsibilities</b>	<b>Highest Hourly Rate (effective April 2013)</b>
Coach Technician	Yes	All PMIs	\$37.47
Mechanical Service Person	No	Lubrication Inspections	\$31.23
Service Person	No	Lubrication Inspections	\$27.80

*No legal requirement for qualification of staff performing Lubes*

By law only licensed Coach Technicians can perform the 5,000 km Safety Check and the MTO inspection. There is however no legislative requirement for qualification of persons conducting vehicle Lubrication Inspections.

*Currently assign Lubes to the higher rated positions even though the lower rated positions are qualified*

Each garage inspection team comprises of typically 6 to 8 Coach Technicians and 1 to 2 Mechanical Service Persons. There is no Service Person position in a PMI team. Although the job description of a Service Person includes vehicle lubrication, these jobs are currently assigned to the higher rated Mechanical Service Persons in a PMI team.

Our review of a sample of vehicle inspection records found that in many instances a Coach Technician performed the Lubrication Inspections instead of a Mechanical Service Person.

*Potential savings by assigning Lubes to trained Service Persons*

To ensure the economy of PMIs, the Department should include Service Persons in each garage inspection team such that they are the primary staff performing Lubrication Inspections. This could potentially result in approximately \$200,000 annual savings.

**Recommendation:**

- 5. The Board request the Chief Executive Officer to review the bus preventive maintenance inspections by assigning Service Persons as the primary staff members to perform the 10,000 kilometre Lubrication Inspections.**

**A.6. Monitor Quality of Annual Brake Inspections**

*Annual brake inspections are conducted at Duncan Shop*

By law all TTC buses are required to undergo a comprehensive brake inspection every 12 months. Due to the complexity of the work and the need for special tools, the annual brake inspections are conducted at the Duncan Shop by a specialized team. The 2013 approved unionized positions for the brake inspection team were 41. The standard labour time for each brake inspection is 10 hours.

*Each brake is relined if less than 4 mm during an annual inspection*

During an annual brake inspection, regardless of the existing brake conditions, all brake components are disassembled for inspection, and all bearings are cleaned, repacked and adjusted. While the safety standard for brake lining is a minimum of 1 mm, the Department's policy is to reline any brake lining less than 4 mm during an annual inspection.

Consequently, after an annual brake inspection, a bus should not need another reline for at least another 10,000 km as all brakes should have been either relined or checked to have a minimum of 4 mm lining.

*Noted instances of repeated brake relines within short distances driven*

Despite the extensiveness of an annual brake inspection, our review of six-month data noted in a number of instances multiple relines took place within short kilometre intervals and time periods. Examples of these instances are provided in Figure 9.

**Figure 9: Examples of Repeated Brake Relines Within Short Periods, TTC Bus Brake Reline History, March to September, 2013**

Bus	In-Service Year	Reline Date	Wheel Reline	Km	Reline Interval (Km)	Labour Hours
I	2006	June 2-3	all 4 wheels	497,338		10
		June 13-15	2 front wheels	499,434	2,096	10
J	2006	June 26-28	2 rear wheels	543,540		10
		July 12-13	2 front wheels	545,273	1,733	10
K	2010	May 9-13	2 front wheels	212,637		5
		June 3-4	all 4 wheels	214,809	2,771	8

*Management did not review exception reports identifying buses with repeated relines*

While there may be valid reasons for frequent brake relines, these instances should be identified and reviewed by management. We noted that current management reviews focused on production reports and average brake reline intervals for various bus models, but not exception reports identifying buses with repeated relines.

*System records on brake relines should be improved*

To facilitate management reviews, system coding and data for annual brake inspections and relines need to be improved. All brake inspections and relines are currently coded without specific information that could be used to identify premature relines.

**Recommendation:**

- 6. The Board request the Chief Executive Officer to take the necessary steps to ensure adequate bus annual brake inspections and relines including:**
  - a. Developing and reviewing exception reports to identify early brake relines and brake failures for further investigation; and**
  - b. Improving the current coding of annual brake inspections in the Bus Maintenance Vehicle Work Order (VWO) Information System to differentiate between relines conducted during annual brake inspections and premature relines.**

## **B. REPAIRS**

### **B.1. Improve Quality of Repairs**

*Inadequate repairs contribute to “road calls” and affect customer service*

Inadequate repairs contribute to “road calls” which are incidents of service delays while vehicles are in service. The Department’s internal analysis of 2010 to 2011 “road call” statistics found high frequency of “road calls” averaging nearly two mechanical related “road calls” per bus per month. Our analysis of 2013 “road call” statistics for buses at one garage coincided with the Department’s internal analysis results.

*Repeated defects and repairs could be indicative of inadequate problem diagnosis and repair work*

In reviewing a sample of bus repair history, we noted a considerable number of buses with repeated repairs for the same recurring defects. Certain repeated defects and repairs might be a result of inadequate problem diagnosis and repair work.

Examples of vehicle history reports showing repeated defects and repairs are summarized below:

*Examples of repeated defects and repairs on the same buses*

- Between July and September 2013, a bus stalled six times while in service. After each malfunction, technicians inspecting the bus reported “no defect”, re-fuelled the fuel tank, road tested the bus, and put it back to service. Each repair was recorded as taking two hours of labour. During a semi-annual MTO inspection in September the bus’s fuel tank was found to be “dented with rotten surface” and the parts were replaced after 3.5 hours of labour.
- Between January and October 2013, on 12 separate occasions different bus operators reported transmission problems with one bus. In most cases, technicians who examined the bus found no major oil leak, topped up the transmission oil, and put the bus back to service. Soon afterward the bus was reported to have the same problem. The cause of the transmission problems was not identified or adequately addressed.

- During a semi-annual MTO inspection in mid January 2013, various parts of a bus’s heating system were replaced taking 5.5 labour hours. On the first day of service after the MTO inspection the bus was found to have heating problems and required an additional two hours of repair. Five days afterward the bus was reported to have heating problems while in service. This resulted in additional 6.5 hours of repair. Again a heating problem was reported in the following day but the technician did not find any defect. Three days afterward the same bus was found to have heating problem caused by its hose which took 10 hours of labour to repair.

*Management has taken actions to reduce the number of "road calls"*

During the course of our audit, management staff advised that they were aware of the issues of repeated repairs and the high frequency of “road calls”. According to management staff, they have implemented enhanced quality assurance and monitoring measures since July 2013 and the number of “road calls” has been declining.

**Recommendation:**

- 7. The Board request the Chief Executive Officer to implement effective monitoring and quality assurance procedures to help improve the quality of bus repairs. Such procedures should include regular analyses of bus road call statistics to identify repair quality issues.**

**B.2. Improve Efficiency of Repairs**

*A significant percentage of garage resources are needed for day-to-day repairs*

A significant portion of the Department’s resources, approximately 65 per cent of garage personnel, are assigned for bus repair activities. Efficiency of repairs therefore directly affects the Department’s resource requirements and annual budgets. Efficient repairs can also reduce bus down time and in turn increases bus availability for services.

*Establishing standard times for common repairs help ensure work efficiency*

To ensure repair activities are performed efficiently, best practices call for establishing expected times for common repairs and measure staff overall performance against the expected time frames.

***Industry standard repair times are available from manufacturers***

Industry standard repair times are available from manufacturer manuals for specific bus models. These industry standards can be used as a guide for establishing internal standard repair times.

This is not to say each repair has to be completed within the prescribed time frame, but a technician's work that consistently and significantly exceed the expected time frames should be identified and further reviewed by management.

***TTC has not established standard repair times***

The Department has not established standard repair times for common bus repairs. We are aware that neither subway nor streetcar maintenance have standard repair times. Without any standard repair times, it would be difficult for management to measure efficiency of repairs or to improve staff performance.

**Recommendation:**

- 8. The Board request the Chief Executive Officer to establish standard repair times for common bus repairs, develop procedures to monitor efficiency of bus repair activities, and incorporate the standard repair times into part of technician performance evaluation.**

**B.3. Ensure Adequate Continued Training for Coach Technicians**

***Legislative requirement for coach technician licensing***

Under the Ontario College of Trades and Apprenticeship Act and its Regulations, technicians working on buses must be certified "Truck and Coach Technicians" who have undergone specific trade training.

***No requirement for continued training after certification***

While certified coach technicians are required to renew their licenses annually, there is no regulatory or licensing requirement for continuous training after initial certification. To ensure its technicians are up-to-date with current technologies and skills, the Department needs to identify training needs and provide on-going in-house training.

***Continued training is particularly important for the Department's technicians***

Continued training would be particularly important for the Department as many of its coach technicians were certified a number of years ago. Based on a review of a sample of individual certification records, approximately 80 per cent of the Department's coach technicians were certified more than ten years ago, and nearly 40 per cent more than 25 years ago.

TTC's corporate Training Department is responsible for organizing, recording, and delivering training to TTC employees. However, departmental management staff are responsible for developing training requirements pertaining to specific job classifications within the department.

***A departmental training policy has not been established***

Our review found that the Department has not established a training policy specifying "who should receive what training". Current training activities were delivered in a piecemeal fashion lacking specific objectives, targets, and monitoring of training completion.

***No policy requirement on mandatory training for new technicians***

For instance, there is no departmental policy on mandatory training for new coach technicians. Although the job description of a coach technician indicates four mandatory training courses such as Air Conditioning Servicing and Vehicle Electronic Controls, this was not stated in any departmental policy.

***Lack of a clear requirement on training completion time frame***

Furthermore, the time frame for completion of the mandatory courses was not defined in the job description or a departmental policy. TTC corporate Training Department staff advised that new technicians are "expected" to complete the mandatory courses within their nine-month probationary period but this is not a departmental requirement.

***Lack of monitoring on completion of training***

Our review of training records found that in one garage 16 per cent of coach technicians who have been in the position for more than 5 years have not taken the mandatory "Vehicle Electronic Controls" course. In another garage, 9 per cent of coach technicians who have been in the position for more than 5 years haven't taken the "Air Conditioning Servicing" course.

**Recommendation:**

- 9. The Board request the Chief Executive Officer to take the necessary steps to enhance continuous training for Bus Maintenance and Shops Departmental staff. Such steps should include but not be limited to:**
  - a. Developing a training policy detailing clear and specific training objectives, requirements and completion timeframes for coach technicians and other job classifications where appropriate; and**
  - b. Monitoring the completion of training requirements and addressing non-compliance with training requirements.**

## **C. BUS AND COMPONENT REBUILD**

*A bus rebuild function is important for transit agencies*

Transit agencies in general have either an in-house or outsourced bus rebuild function to replace malfunctioned parts and refurbish aging buses. A rebuild function is particularly necessary for older bus models as original manufacture parts might no longer be available for purchase.

*TTC operates an in-house bus rebuild function*

TTC's bus rebuild program is operated fully in-house at its Duncan Shop. The Bus Maintenance and Shops Department oversees the operation of Duncan Shop and Harvey Shop. Duncan Shop specializes in heavy duty repair and bus rebuild while Harvey Shop is primarily for bus and streetcar structural rebuild. The focus of this audit is on Duncan's bus rebuild activities.

*Duncan Shop's key rebuild activities*

Duncan Shop's bus rebuild operation includes:

- Rebuilding or modifying small mechanical or electrical parts
- Overhauling engines, transmissions, and other major components
- Conducting complete bus mechanical and structural rebuild after nine years of service (i.e. mid-life overhaul)

*Size and budget of Duncan's bus rebuild*

In 2013 approximately \$26 million operating budget and 100 unionized and management positions were allocated to Duncan's bus rebuild functions. It produced in 2013 approximately 10,000 small bus parts, overhauled approximately 1,000 major bus parts, and rebuilt 180 buses.

**C.1. Analyze Internal Rebuild Failure Rates**

*Lack of systematic analysis of rebuild failure rates*

While Duncan Shop staff rebuild a large quantity of major bus parts such as engines and transmissions, a systematic analysis of rebuild failure rates has not been undertaken by management. Although the Department's VWO information system records bus repair history, this information was not used by Duncan management staff to determine the rebuild failure rates.

In response to audit requests, management analyzed the major failure rate of a specific engine model, and reported that eight per cent of rebuild engines experienced a major failure within two years after rebuild. However, according to Duncan management staff, the majority of the failed rebuild engines were due to poor maintenance practice by garage staff rather than issues in rebuild quality.

*Analyzing failure rates is important for assessing rebuild quality and identifying systemic rebuild issues*

Systematic analyses of rebuild failure rates are important management controls, without which management staff cannot assess the quality of the internal rebuild, nor can management identify systemic rebuild issues on a timely basis. In addition, costs associated with rework of failed rebuild parts need to be accounted for in ascertaining the full costs of internal rebuild.

**Recommendation:**

- 10. The Board request the Chief Executive Officer to accurately assess failure rates of major internal bus rebuild parts as well as assessing the costs of rework associated with rebuild failures.**

**C.2. Accurately Assess Internal Rebuild Costs**

*Other transit agencies opt for outsourcing their bus rebuild functions*

Instead of re-building parts and buses internally, TTC has the option of purchasing new parts and outsourcing the rebuild work to private companies specializing in bus rebuild and repairs. A number of transit agencies currently outsource their rebuild functions.

***Many internal rebuild costs, according to management, were comparable with market prices***

Assessing the cost-effectiveness of a fully in-house rebuild function such as Duncan Shop is similar to making a “make or buy” business decision. In order to make a sound business decision, Duncan Shop management staff have undertaken a cost analysis to compare internal rebuild costs (i.e. “make”) with market prices (i.e. “buy”). Based on management’s cost comparisons, Duncan’s internal rebuild costs in many cases were comparable with market prices.

***A number of key relevant costs were not included in the internal cost estimates***

After reviewing management’s cost comparisons and additional data from the TTC Finance Department, we noted that a number of relevant internal costs should have been added to the internal cost estimates. Management’s cost analysis included only direct material, direct labour, and fringe benefits. Figure 10 provides further details on costs included in the internal analysis and costs that were not included. These additional costs should have been accounted for in the internal analysis.

**Figure 10: Cost Categories Included and Excluded in Management’s Parts Rebuild Internal Cost Estimates**

Included in internal costing	Not included in internal costing
Direct labour (e.g. technicians’ actual “wrench” time on rebuild activities)	On-site indirect expenses (e.g. on-site supervision, uniform, apprenticeship, janitorial expenses for rebuild facilities)
Direct material (e.g. costs of parts and components directly used for rebuild)	Occupancy costs (e.g. rebuild facility costs, depreciation, and utilities)
Fringe benefits (e.g. vacation, sick time, pension and health benefits)	Material handling costs (e.g. costs of moving, warehousing, and administering materials used in rebuild)
	Off-site management and administrative costs (e.g. off-site supervision, payroll, administration)
	Cost of rework of failed rebuild products (i.e. additional costs incurred from repair or rework of failed rebuild parts, as discussed in the previous Section)

***A more complete cost estimate would require further analyses by staff***

Detailed analyses by TTC staff would be needed to determine the relevant costs that had not been included in the internal cost estimates. At the time of our audit, these costs have not been quantified. As a result, we were not able to provide a more complete and precise estimate of internal costs.

Nonetheless, the excluded cost categories are likely significant, and when added to the internal costing will increase the internal cost estimates considerably. This may tip the scale of the “make or buy” decision towards favoring purchasing new or outsourcing for many internally rebuild parts at Duncan.

Recently TTC has successfully implemented outsourcing daily bus cleaning and fuelling services, which will result in approximately \$2.2 million annual savings according to staff.

***TTC is assessing opportunities for outsourcing to ensure optimal value for money***

Furthermore, in his latest Five-Year Corporate Plan 2013-2017, the TTC Chief Executive Officer identified seven strategic objectives and core strategies to transform the TTC. A key initiative to deliver the "Financial Sustainability" objective, as outlined in the Corporate Plan, is:

*"Ongoing "make vs. buy" review of non-core areas that could be delivered more efficiently and effectively by a third party."*

In TTC's ongoing assessment of outsourcing opportunities, a number of operational factors must be considered in determining the overall benefits of outsourcing certain rebuild functions at its Duncan Shop. Certain of these operational considerations are:

***Operational factors are important to consider***

- Significant order lead time can post a challenge to day-to-day operation if the Department relies on external suppliers. For instance, ordering certain remanufactured engines may take up to six months before delivery.
- Although new or remanufactured parts come with warranty, the process of warranty claims can be time consuming and claims can be denied for various reasons.
- Duncan Shop management staff expressed concerns about the quality of work by private shops. However, other transit agency staff currently using private rebuild shops did not express any major concern.
- The current Union negotiated agreements post a significant challenge and limitations for TTC management to outsource rebuild work to private shops.

*A partially outsourced model should be explored*

In assessing the pros and cons of outsourcing, it may be beneficial for TTC management staff to explore the partially outsourced model currently being used by Urban Forestry of the City’s Parks, Forestry, and Recreation Division.

Urban Forestry has been implementing a partially outsourced model since 2011. It currently has a multi-year contract with a number of vendors to provide 50 per cent of forestry services (e.g. general maintenance and tree planting, pruning and removal). Both contracted staff and City unionized employees report to the same supervisory staff employed by the City.

*A partially outsourced model increases workforce flexibility and improve productivity*

The partially outsourced model allows management to use contracted staff as an extension of City workforce to address overflow work demands. Urban Forestry staff are currently working on the cost savings resulting from the partially outsourced model. Staff reported significant improvements in productivity from both contracted staff and City employees.

The success of the partially outsourced model, according to staff, lies in close working relationships with the City’s Human Resource Division and union representatives, as well as a strong contract management process.

**Recommendation:**

- 11. The Board request the Chief Executive Officer, in his ongoing assessment of outsourcing opportunities, to conduct a complete analysis of internal bus rebuild costs at the Duncan Shop accounting for all key and relevant direct and indirect costs.**

**D. WARRANTY ADMINISTRATION**

*Warranty provisions for new buses*

Manufacturer warranties for new buses generally include:

- 2 years “bumper to bumper” coverage for an entire bus
- 5-year parts and labour for major parts such as engines and transmissions
- 12-year parts and labour for structural components such as body panels and flooring

Warranty limitations and adjustments are specified in purchase agreements.

***Roles of the Department's warranty staff***

The Department has a team of five staff members dedicated to warranty administration. Located at the Department's headquarters, the Warranty Section staff are responsible for:

- Processing and submitting claims for defective parts and repair labour costs
- Coordinating repairs at manufacturer authorized facilities
- Initiating and coordinating manufacturer retrofits to rectify vehicle design flaws (i.e. latent defects)
- Negotiating settlements with manufacturers

***Warranty recoveries could be over \$10 million per year***

The Warranty staff play a pivotal role in the recovery of warranty revenues which could be over \$10 million annually just from claims and retrofits.

**D.1. Improve Defective Parts Retrieval Process**

In submitting warranty claims, the Department is required to return defective parts to manufacturers for the claims to be honored.

***Current defective parts retrieval process at garages***

Technicians at TTC garages are instructed to tag defective parts and place them in an open bin inside the garage. Warranty staff visit each garage bi-weekly to retrieve the defective parts, and reconcile parts in the bin with vehicle repair records from the VWO system. An example of a garage warranty bin is shown in Figure 11.

**Figure 11: An Example of an Open Warranty Bin in a Garage**



***Defective parts were frequently missing in the bin and could not be located***

Our discussions with staff and site visits found that frequently parts were missing from warranty bins. Parts could be misplaced or simply discarded by mistake. In many cases, by the time Warranty staff identified missing parts during their bi-weekly visits, it is usually too late to locate them. In addition, the current parts retrieval process is labour intensive and time consuming for Warranty staff who are required to physically sort and identify defective parts placed in the bins, and load and transport parts to headquarters.

Instead of requiring technicians to place defective parts in an open bin, best practices in warranty administration require technicians to submit defective parts at a stock room in exchange for new parts. Defective parts “returned” should be reconciled with new parts “issued” on a regular basis such that discrepancies can be addressed in a timely manner.

***Financial impact of missing defective parts could be significant***

Without defective parts, Warranty staff are not able to file claims for repairs under warranty. The Department could not determine the amount of warranty revenue loss due to missing defective parts. However, as many bus parts such as engine components are costly to replace, the revenue loss is likely significant.

**Recommendation:**

- 12. The Board request the Chief Executive Officer to take immediate steps to improve the current defective parts retrieval process at bus garages including but not limited to:**
  - a. Implementing adequate controls to account for and track the return of defective parts by technicians; and**
  - b. Enhancing efficiency of the parts retrieval process currently carried out by warranty staff.**

**D.2. Increase Claim Submissions**

*The Department has not determined its warranty claim rate*

Part of our audit was to estimate the extent to which the Department exercised warranty provisions. However, while the Department's Warranty staff routinely tracked the number of claims they submitted, they did not have information on the number of repairs eligible for claims. Consequently, the warranty claim rate has not been determined by staff.

*We reviewed claim records of 97 recently purchased buses to assess warranty claim rate*

Due to the limited capacity of the warranty claim system, a review of the entire fleet's repair and claim records would require extensive manual comparisons and was not feasible. Instead we focused on the claim records of 97 recently purchased buses. These buses were selected because they were put in service in 2011 or 2012 and consequently most of their repairs were under warranty.

At our request, Warranty staff reviewed repair records of the 97 buses, and determined that a total of 2,673 repairs were eligible for warranty.

*Approximately 30% of eligible repairs were claimed*

Of the 2,673 repairs eligible for warranty claims, we identified that only 802 claims were submitted. Consequently, approximately 30 per cent of the eligible repairs were processed for warranty claims, and the remaining 70 per cent were not claimed.

*For newer buses, high success rate in warranty recovery as long as a claim is filed*

*Possible reasons for the Department's low claim submission rate*

*Maximizing warranty claims could potentially increase annual warranty revenue by \$4 to \$5 million*

For the 802 claims submitted, 752 were reimbursed, 17 were pending manufacturer decisions and would likely be approved, and 33 had been denied by manufacturers. It appears that when claims were submitted for newer buses, they were likely to be approved by manufacturers.

Based on our discussions with staff and reviews of selected vehicle work order reports and claim records, a number of reasons might have contributed to the low claim submission rate:

- Missing defective parts to support the claims
- Insufficient information to complete claim documents, e.g. missing details in repair work, labour hours, or specific parts replaced
- Warranty staff did not process claims due to low claim value.

Since 2011, the Department received on average \$1.9 million per year from warranty claims relating to defective parts and labour hours. Based on our sample analysis, the \$1.9 million annual warranty revenue was likely from claiming approximately 30 per cent of the eligible repairs for warranty. Had the Department maximized its warranty claims for all eligible repairs, a significant amount of additional warranty revenue could potentially have been recovered. Based on our analysis, the additional warranty revenue could be in the range of \$4 million to \$5 million per year.

**Recommendation:**

- 13. The Board request the Chief Executive Officer to take immediate steps to maximize the use of bus warranty provisions and increase warranty recovery revenue. Such steps should include but not be limited to:**
- a. Identifying and addressing reasons prohibiting successful filing of warranty claims;**
  - b. Increasing warranty claim submission rate for bus defective parts and labour hours; and**
  - c. Systematically tracking and monitoring claim submission rate and warranty cost recovery for the entire bus fleet.**

### D.3. Minimize Claim Denials By Manufacturers

*Approximately \$200,000 worth of annual claim value was denied by manufacturers*

Approximately \$200,000 worth of annual claim value was denied by manufacturers. Manufacturers can deny warranty claims for various reasons, which could be minimized by improved garage and administrative practices. Outlined below are two common reasons for claim denial encountered by the Department.

*Two common reasons for claim denial*

#### **Denied for “no fault found”**

Approximately \$160,000 worth of annual claim value was denied for this reason. Manufacturers determine that defective parts submitted for claims were in working order and deny claims. The Department did not request manufacturers to return the “no fault found” parts even though they were determined to be in working order by manufacturers. Staff explained that garage technicians in general would not reuse returned parts due to their uncertain quality.

*Improving part condition diagnosis will help reduce "no fault found" denials*

“No fault found” denials are indicative of misdiagnosis of part conditions at operating garages. While we recognize that certain instances of misdiagnosis are inevitable due to complex vehicle technologies, efforts should be made to minimize instances of misdiagnosis and resulting claim denials.

*Various administrative issues can result in claim denial*

#### **Denied for various warranty administration reasons**

Approximately \$37,000 worth of annual claim value was denied for various administrative reasons such as delayed submissions (agreed time frame is generally 45 days), wrong parts submitted, claims submitted to vehicle manufacturers instead of parts manufacturers or vice versa, or non-authorized repairs.

#### **Recommendation:**

- 14. The Board request the Chief Executive Officer to take necessary steps to minimize the number of warranty claims denied by bus manufactures based on “no fault found” in submitted defective parts or warranty administrative issues.**

#### **D.4. Implement Accounts Receivable Procedures**

***TTC Finance Department did not set up bus warranty claims as accounts receivable***

Currently, warranty claims are not recorded in the TTC corporate financial system as accounts receivable. Manufacturers are directed to forward cheques and credit memos to the TTC Finance Department. Upon receiving warranty cheques, Finance staff deposit cheques, record the deposits as offsets to Accounts Payable and forward credit memos to Warranty staff.

***Warranty staff track and reconcile warranty payments with claim records***

Warranty staff use a stand-alone system to record initial claims submitted, and upon receiving credit memos from the Finance Department, match payment receipts against individual claims and update status in the warranty database.

***Warranty staff were tasked to carry out financial monitoring functions of a large number of outstanding claims with significant dollar value***

This process lacks financial oversight on tracking and monitoring outstanding claims. It relies on the diligence of Warranty staff to perform financial monitoring functions of a large number of outstanding claims with significant dollar value. At the time of our audit, we identified a total of \$1.4 million in outstanding claim value, of which approximately \$1 million claim value was in dispute and \$400,000 was pending manufacturer decisions. In addition, as warranty claims were not set up as accounts receivable, there was no process to adjust/write off disputed claims.

Implementing adequate accounting procedures for payments received should be part of Corporate Finance's responsibilities. TTC management should also review current accounting processes for warranty payments for other types of TTC vehicles to ensure adequate procedures are followed.

**Recommendation:**

- 15. The Board request the Chief Executive Officer to take steps to ensure proper accounting procedures for bus warranty claims and payments. Such steps should include but not be limited to:**
- a. Establish proper accounting procedures for bus warranty payments including setting up accounts receivable for warranty claims, implementing procedures to adjust/write off disputed claims and periodic reconciliations;**
  - b. Undertake collection of all valid outstanding claims; and**
  - c. Review accounting procedures for warranty payments for other types of TTC vehicles including subway trains and streetcars to ensure adequate financial controls are in place.**

**D.5. Improve Warranty Information System**

*Current warranty information system is not adequately designed or supported*

The Department's warranty system is an Access management information database originally developed ten years ago. It is a stand-alone system with no linkage to the Department's VWO system or TTC Corporate Financial system. Furthermore, the warranty system is not supported by the TTC Information Technology (IT) Services Department for software updates or troubleshooting. Warranty staff are left to deal with frequent system issues beyond their working capacity.

*The system has limited analytical capacities*

In addition, the warranty system has limited analytical capacity making it difficult for staff to perform basic analyses such as aging analysis for outstanding claims, or analysis of common claim denial reasons to provide feedback to operating garages. The system was so dated that claim and recovery summary reports could not be exported to Excel for further analysis. Consequently, almost all of our audit analyses involved manual review.

*An effective warranty information system should have interfacing capacities with other systems*

In order to improve work efficiency, the warranty system should have the capacity to interface with the Department's VWO system and TTC Corporate Financial System. This will enable warranty staff to efficiently identify repairs eligible for warranty claims, as well as automating the task of recording warranty receivables by Finance staff.

**Recommendation:**

**16. The Board request the Chief Executive Officer to provide an adequately designed and supported bus warranty management information system facilitating effective and efficient management of warranty claims and recoveries.**

## **E. FUTURE BUS ACQUISITION**

### **E.1. Policy on Bus Service Life**

*TTC's policy is to operate buses for 18 years*

TTC's current policy is to keep buses in service for a minimum of 18 years before retirement. This 18-year service life policy is considerably longer than the 12 to 15-year policies adopted by most North America transit agencies.

*TTC tried to determine the optimal bus retirement age*

In 2010, TTC commissioned an external consultant firm to conduct a "Bus Optimal Life Study". The study was to "assess the benefits and costs of maintaining TTC buses in service for varying periods of time with the objective of potentially identifying a preferred or "optimal" bus retirement age."

*The consultant recommended shortening the 18-year service life policy*

Contrary to the consultant team's previous experience, their total life-cycle cost analysis of TTC buses was not able to identify an optimal point for bus retirement age. Nonetheless, the consultant recommended TTC shortening its existing 18-year service policy to 15 to 16-year to be consistent with common bus replacement practices and help maintain service quality and safety.

*Staff proposed to shorten service life policy by 3 years*

Based on the consultant recommendation and an internal cost analysis, staff developed a business case to shorten current policy from 18-year to 15-year for diesel buses, and from 15-year to 12-year for hybrid buses. The business case was part of the Department's Bus Fleet/Facility Plan, 2014-2018 Capital Program.

***Proposed change was on hold until further cost analysis by staff***

At the date of this report, TTC's 2014-2023 Capital Budget (approved by the Board at its November 18, 2013 meeting) highlighted the need to change to a 15-year service life policy but additional funding was not available. Staff indicated in the report that they "*intend to undertake a comprehensive life-cycle analysis for buses in 2014 and to present a plan to the Board for consideration as part of the 2015 budget cycle.*"

***A shorter service life policy could be beneficial in the long term***

After reviewing the consultant report and staff's cost analysis, we are of the view that shortening the bus service life policy could potentially improve vehicle reliability and customer service without significant increases in overall costs over a long period.

***Further cost analyses need to be conducted by staff***

However, several areas in the consultant report and staff's business case require further analysis and clarification in order to provide accurate and complete information for sound decision-making. These areas are:

***Clear financial impact data need to be provided by staff***

- a. While the staff business case contained detailed data, it did not give a clear picture of short and long term financial impacts.

Shortening bus service life will inevitably increase capital investment needed to procure more buses to sustain service levels. However, cost reductions from lower vehicle maintenance costs may offset the increased capital investment over time. Critical financial information such as the amount of initial capital cost increases and savings from reduced maintenance costs should be clearly identified in a business case.

***All overhaul costs need to be included in the cost analysis***

- b. The life-cycle cost assessment needs to be comprehensive including all mechanical and body overhaul costs.

One of the challenges encountered by the consultant team was that the oldest buses in the TTC fleet at the time (in 2010) were 14 years old even though they were retained to assess optimal bus life in the context of TTC's 18-year service life policy. Because the consultant's cost analysis was based on 14 years of service, it would not have included the cost of bus overhaul at the 15 year service point.

*The cost savings estimates need to be based on realistic conditions*

- c. Staff's business case identified Net Present Value (NPV) benefit of approximately \$153 million savings for shortening hybrid bus service life from 15-year to 12-year over a 15-year life cycle.

The estimated savings were based on the premise that both the 8th and 12th year mechanical and body overhauls (that are currently planned for hybrids) could be eliminated under a 12-year policy. In our view, this assumption may be overly optimistic. Since a diesel bus needs to have a mechanical and body overhaul after 8 years of service, it is questionable whether a hybrid can continue providing reliable services for 12 years without undergoing any overhaul.

**Recommendation:**

- 17. The Board request the Chief Executive Officer, in preparing 2015 budget submission relating to shortening existing bus service life policy by three years, to provide clear short and long term financial impact information based on a comprehensive, accurate and objective life-cycle cost analysis.**

**E.2. Develop a Hybrid Bus Plan to Minimize Future Maintenance Cost Increases**

*Size and costs of TTC's hybrid bus fleet*

As of July 2013, TTC's bus fleet (total 1,857 buses) consisted of 1,166 (63 per cent) diesel buses, and 691 (37 per cent) hybrid buses. The fleet of hybrid buses was procured between 2005 and 2007. In procuring the hybrid buses, TTC took advantage of provincial and federal funding for purchasing alternate fuel vehicles. The combined provincial and federal subsidies covered approximately 67 per cent of the total purchase costs. TTC paid on average approximately \$240,000 per hybrid after subsidies.

*Staff has been encountering frequent and significant repair issues with the hybrid fleet*

Since the hybrid buses have been in service, the Department has been dealing with significant repair issues ranging from frequent battery breakdowns to malfunctioning computer systems and engines. Other transit agencies that acquired the same hybrid models have experienced similar problems. The hybrid engine replacement costs were so high that in 2012 New York City MTA Transit, currently operating over 1,600 hybrid buses, evaluated the feasibility of converting the engines to diesel powered.

*Staff anticipated substantial increases in future hybrid maintenance costs*

The engine replacement costs for TTC's hybrids have until recently been covered under the first 5-year warranty. As the warranty expires in 2014, staff anticipate a considerable increase in repair costs in the coming years. According to staff projections, the average annual maintenance cost per hybrid will rise from \$45,000 after 5 years of service to over \$90,000 after 10 years of service. The increases in future maintenance costs for a fleet of 691 hybrids will be in the tens of millions.

*Future fleet acquisition should carefully evaluate reliability of new technologies*

Staff attributed the hybrid's high breakdown rate to new technologies at the time when the model was introduced to the market. The hybrid experience underscores the importance of acquiring reliable vehicles to minimize risks of long-term financial burden.

*A plan needs to be developed to help minimize future financial impact*

Going forward, staff need to develop a plan for hybrid buses that can help minimize future financial impact. One of the options could be phasing out the hybrids earlier than the planned 15-year service life. This was illustrated in the previous section. Staff should explore other alternatives and leverage on other agency experiences in maintaining their hybrid fleets.

**Recommendation:**

- 18. The Board request the Chief Executive Officer to develop a plan for hybrid buses to help minimize increasing maintenance costs in future operating budgets. Such a plan should include a review of alternatives and other transit agencies' experiences in maintaining their hybrid bus fleets.**

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## CONCLUSION

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*Our first TTC fleet audit provided 18 recommendations to help improve effectiveness, efficiency, and the economy of bus maintenance operation*

This was our first audit of TTC fleet. Phase One of the bus maintenance audit focused on conventional buses, and Phase Two will focus on Wheel-Trans accessible buses and non-revenue vehicles. Our Phase One audit provided 18 recommendations relating to preventive maintenance inspections, repairs, rebuilds, warranty administration, and future bus acquisition.

Implementation of audit recommendations will help improve effectiveness and efficiency of preventive maintenance inspections, quality of repairs, staff training, and the economy of bus rebuild functions. All of the audit recommendations are in keeping and supportive of the strategic objectives set out in TTC's Five-Year Corporate Plan 2013-2017.

Recommendations relating to warranty administration should be addressed by management immediately as the recommended changes can potentially result in significant increases in annual warranty revenue. At the time of writing, management staff have already taken actions to address a number of audit recommendations.

## EXHIBIT 1

### Key Preventive Maintenance Inspections, TTC Bus Maintenance and Shops Department, 2013

PMI	Inspection Interval	Key Functions	Performed By
<b>Daily inspection</b>	Every 24 hours or more frequent	Bus drivers operating the vehicles record in a form any defects found at the beginning of the shift, while en route, and at the end of the shift as prescribed in Ontario Regulation 199/07. Defects are addressed by Bus Maintenance staff on the same date.	Bus drivers report defects  Garage personnel address defects
<b>Service Check</b>	Every 5,000 km +/- 800 km*	Licensed technicians inspect critical safety features including steering and suspension, axles, tires, air system, and brake to ensure safe vehicle operation while in service.	Dedicated inspection team at each TTC garage
<b>Lubrication and Inspection (Lube)</b>	Every 10,000 km +/- 800 km*	Lubrication of various vehicle parts, engine oil and filter changes, and a visual inspection of items such as exterior and interior lights, mirrors, circulating pump, tires, brake pedals, and bike rack.	
<b>Ministry of Transportation of Ontario (MTO) Inspection</b>	Every 6 months - an inspection must be completed prior to the 6-month expiry	Licensed technicians inspect buses according to Ontario Regulation 611 "Safety Inspections" made under the Highway Traffic Act. Components inspected include: - Air system - Brake drum measurement - Cooling system - Electrical wiring - Battery - Alternator - Engine	
<b>Brake Inspection and Reline</b>	Every 12 months	All brake components are disassembled for inspection, and all bearings are cleaned, repacked and adjusted by licensed technicians at Duncan Shop.	Duncan Shop technicians
<b>Spring and Fall Seasonal Service</b>	Spring Service – every year March 1 to May 31  Fall Service – every year September 1 to November 30	Prepare buses for hot/cold weather operation including inspection and servicing of the air condition system, heating system, bike rack, stop announcement and camera systems, and air filter cleaning and replacement for specific bus models.	TTC Garage personnel
<b>Differential Lube</b>	Every 240,000 km +/-800 km*	Lubrication of differential	
<b>Transmission Lube</b>	Every 50,000 km +/-800 km*	Lubrication of Transmission	
<b>Diesel Particulate Filter replacement</b>	Every 12 months	Replacement of diesel particulate filter for 1,088 buses	

\* For distance-based PMIs (e.g. 5,000 km and 10,000 km inspections for TTC), most transit agencies have an acceptable "window" to measure compliance. TTC's policy is plus or minus 800 km of the prescribed kilometre intervals.

**Management's Response to the Auditor General's  
Review of Toronto Transit Commission Bus Maintenance and Shops Department, Phase One:  
Bus Maintenance and Warranty Administration**

Rec No.	Recommendations	Agree (X)	Disagree (X)	Management Comments: (Comments are required only for recommendations where there is disagreement.)	Action Plan/Time Frame
1.	<p>The Board request the Chief Executive Officer to evaluate the merits of the 5,000 km bus preventive maintenance interval in preventing mechanical failures. Such an evaluation should include a review of other transit agencies' practices, TTC's own bus repair records, and piloting new maintenance intervals in a small fleet of buses.</p>	X			<p>The merits of the 5,000 km maintenance interval will be reviewed by the Bus Maintenance Technical Support Services (TSS). Preventative Maintenance routines and intervals used by other agencies will also be investigated and reviewed to determine best practises.</p> <ul style="list-style-type: none"> <li>• <i>Target for Completion of Review:</i> <span style="float: right;"><i>Nov 2014</i></span></li> </ul> <p>If warranted through the review process, a test fleet of buses will be identified and the preventative maintenance intervals will be adjusted to further evaluate the merits of the 5,000 km interval.</p> <ul style="list-style-type: none"> <li>• <i>Target for Commencement of Pilot:</i> <span style="float: right;"><i>Jan2015</i></span></li> <li>• <i>Target for Completion of Pilot &amp; Close Out of Recommendation:</i> <span style="float: right;"><i>Dec 2015</i></span></li> </ul>

Rec No.	Recommendations	Agree (X)	Disagree (X)	Management Comments: (Comments are required only for recommendations where there is disagreement.)	Action Plan/Time Frame
2.	The Board request the Chief Executive Officer to ensure compliance with TTC bus preventive maintenance inspection and provincial legislative requirements, in particular maintenance of major vehicle parts.	X			<p>Bus Maintenance will continue to ensure compliance with all legislative requirements.</p> <p>The +/- 800 KM interval tolerance for the inspection of differentials and transmissions will be evaluated by TSS and adjusted as appropriate. Data suggest this tolerance is too narrow.</p> <ul style="list-style-type: none"> <li>• <b>Target for Completion of Review:</b> <span style="float: right;"><b>May 2014</b></span></li> </ul>
3.	The Board request the Chief Executive Officer to ensure that bus kilometre records used for scheduling preventive maintenance inspections are accurate.	X			<p>Bus Maintenance is aware of the discrepancies in mileage records. Bus Maintenance will continue to conduct periodic audits of the existing systems that are used to capture mileage to monitor the discrepancies.</p> <p>Options are also being evaluated to more accurately capture mileage information. These options include the replacement of the current CIS system (which is obsolete); and, the investigation into possible add on instruments for each vehicle.</p> <p><u>Replacement of the CIS System</u></p> <p>The replacement of the CIS System is required by various departments for various reasons. The CIS system includes functions such as communication, alarm systems, data collection systems (including mileage collection), etc... The replacement of this system will require involvement from numerous departments and will be a multi-year project. Funds for the replacement of the CIS System have been included in the 2014 Budget request which is pending approval. Replacement of the CIS System will include a business analysis, investigation of technologies available, development and testing, procurement and implementation of equipment.</p>

Rec No.	Recommendations	Agree (X)	Disagree (X)	Management Comments: (Comments are required only for recommendations where there is disagreement.)	Action Plan/Time Frame
3. cont'd					<p>The following timeline &amp; milestones are estimated for this project once approved:</p> <ul style="list-style-type: none"> <li>• <i>Departments involved to be identified</i> <span style="float: right;"><i>Q1 of 2014</i></span></li> <li>• <i>Depts. to identify personnel for project team:</i> <span style="float: right;"><i>Q1 of 2014</i></span></li> <li>• <i>Conduct Business Analysis:</i> <span style="float: right;"><i>Q2 – Q4 of 2014</i></span></li> <li>• <i>Investigate &amp; develop new system:</i> <span style="float: right;"><i>Q1 - Q3 of 2015</i></span></li> <li>• <i>Conduct test pilot:</i> <span style="float: right;"><i>Q4 of 2015</i></span></li> <li>• <i>Implement solution on vehicle fleets:</i> <span style="float: right;"><i>2016-2018</i></span></li> </ul> <p><u>Add-On Instrumentation</u></p> <p>An interim solution will also be looked at by investigating possible stand-alone instrumentation that can be installed locally on the bus by Bus Maintenance.</p> <ul style="list-style-type: none"> <li>• <i>Target for completion of investigation &amp; cost analysis into stand-alone instrumentation:</i></li> </ul> <p style="text-align: right;"><i>Jun 2014</i></p>

Rec No.	Recommendations	Agree (X)	Disagree (X)	Management Comments: (Comments are required only for recommendations where there is disagreement.)	Action Plan/Time Frame
4.	<p>The Board request the Chief Executive Officer to improve efficiency of bus preventive maintenance inspections and increase bus availability for service by:</p> <p>a. Avoiding duplication of a Safety Check when a comprehensive semi-annual inspection is scheduled; and</p> <p>b. Consistent alignment of Safety Checks and Lubrication Inspections where possible.</p>	<p>X</p> <p>X</p>			<p>All Preventative Maintenance Inspection intervals will be reviewed and evaluated by the Bus Maintenance Department as suggested in Recommendation 1. Efforts to avoid duplication and to better align work is ongoing.</p> <ul style="list-style-type: none"> <li>• <i>Target for completion of review:</i> <span style="float: right;"><i>Nov 2014</i></span></li> </ul> <p>Upgrades to the IFS Vehicle Work Order (VWO) system are also expected to reduce the duplication of Safety Checks by automating inspection call outs. It is also expected to improve alignment of work. Upgrades to the IFS VWO system are currently in progress and will be ongoing.</p> <p>Upgrades are being addressed in phases. Each phase uses a similar work flow process. That is, a working committee will be established, a business analysis will be conducted, software solutions &amp; technologies will be investigated and developed and a test pilot will be conducted. Implementation of the solution will then be rolled out in stages. Phase 1 of upgrades is currently in progress.</p> <p>The automation of inspection callouts will be a part of Phase 2 work. Estimated timeline and milestones for phase 2 are as follows:</p> <ul style="list-style-type: none"> <li>• <i>Target for completion of business analysis:</i> <span style="float: right;"><i>Q3 of 2014</i></span></li> <li>• <i>Target for developing a solution &amp; evaluating solution via test pilot:</i> <span style="float: right;"><i>Q4 of 2014</i></span></li> <li>• <i>Target for implementation of solution:</i> <span style="float: right;"><i>Q1 of 2015</i></span></li> </ul>

Rec No.	Recommendations	Agree (X)	Disagree (X)	Management Comments: <i>(Comments are required only for recommendations where there is disagreement.)</i>	Action Plan/Time Frame
5.	The Board request the Chief Executive Officer to review the bus preventive maintenance inspections by assigning Service Persons as the primary staff members to perform the 10,000 kilometre Lubrication Inspections.	X			<p>Bus Maintenance will review the feasibility of utilizing Service Persons as the primary staff to perform the Lubrication Inspections. Discussions with the Union and with Employee Relations will be required for agreement if it is decided to pursue this initiative</p> <ul style="list-style-type: none"> <li>• <i>Target for completion of review:</i> <span style="float: right;"><i>Dec 2014</i></span></li> </ul>
6.	<p>The Board request the Chief Executive Officer to take the necessary steps to ensure adequate bus annual brake inspections and relines including:</p> <p>a. Developing and reviewing exception reports to identify early brake relines and brake failures for further investigation; and</p> <p>b. Improving the current coding of annual brake inspections in the Bus Maintenance Vehicle Work Order (VWO) Information System to differentiate between relines conducted during annual brake inspections and premature relines.</p>	X			<p>Bus Maintenance will examine changes to the reporting on the brake reline process to differentiate between relines which have been triggered by vehicle or brake system faults and those due to normal wear or for taking advantage of a legislated inspection.</p> <ul style="list-style-type: none"> <li>• <i>Target for completion of assessment:</i> <span style="float: right;"><i>Q2 of 2014</i></span></li> <li>• <i>Target for development and implementation:</i> <span style="float: right;"><i>Q4 of 2014</i></span></li> </ul>

Rec No.	Recommendations	Agree (X)	Disagree (X)	Management Comments: <i>(Comments are required only for recommendations where there is disagreement.)</i>	Action Plan/Time Frame
7.	<p>The Board request the Chief Executive Officer to implement effective monitoring and quality assurance procedures to help improve the quality of bus repairs. Such procedures should include regular analyses of bus road call statistics to identify repair quality issues.</p>	X			<p>Bus Maintenance is in the process of developing a Vehicle Reliability and Quality Assurance Group. Various QA activities have already been implemented including the daily review of bus road calls and mean miles between defects. Development of this group and the development of QA activities will be ongoing.</p> <ul style="list-style-type: none"> <li>• <i>Target for developing QA Group:</i> <span style="float: right;"><i>Dec 2014</i></span></li> <li>• <i>Target for developing QA Program:</i> <span style="float: right;"><i>Ongoing-Process</i></span></li> </ul>
8.	<p>The Board request the Chief Executive Officer to establish standard repair times for common bus repairs, develop procedures to monitor efficiency of bus repair activities, and incorporate the standard repair times into part of technician performance evaluation.</p>	X			<p>As identified in Recommendation #4, upgrades to the IFS VWO system are in progress. Upgrades to the IFS VWO system will allow better tracking of repair times. These upgrades are part of Phase 1. A test pilot at Eglinton Garage is scheduled for April 2014. Evaluation of the pilot will follow. If successful, rollout to other locations will be addressed in stages.</p> <ul style="list-style-type: none"> <li>• <i>Target for testing Phase 1 upgrades:</i> <span style="float: right;"><i>Q2 of 2014</i></span></li> <li>• <i>Rollout at other locations (if successful):</i> <span style="float: right;"><i>Q3-Q4 of 2014</i></span></li> </ul> <p>Using data collected from IFS VWO, Bus Maintenance will evaluate current TTC repair times against OEM standard repair times to identify areas for improvement. Discussions with local unions regarding productivity gains will be ongoing with the goal of establishing reasonable standard repair times</p>

Rec No.	Recommendations	Agree (X)	Disagree (X)	Management Comments: (Comments are required only for recommendations where there is disagreement.)	Action Plan/Time Frame
9.	<p>The Board request the Chief Executive Officer to take the necessary steps to enhance continuous training for Bus Maintenance and Shops Departmental staff. Such steps should include but not be limited to:</p> <p>a. Developing a training policy detailing clear and specific training objectives, requirements and completion timeframes for coach technicians and other job classifications where appropriate; and</p> <p>b. Monitoring the completion of training requirements and addressing non-compliance with training requirements.</p>	<p>X</p> <p>X</p>			<p>Bus Maintenance and the Training &amp; Development Departments will work together to develop a training policy to outline specific training needs for Coach Technicians, and outline a process to monitor compliance.</p> <ul style="list-style-type: none"> <li>• <i>Identify existing and additional staffing resources that may be required such as Training Development Coordinators, Subject Matter Experts, etc.:</i> <span style="float: right;"><i>Feb 2014</i></span></li> <li>• <i>Identify labour &amp; non-labour budget impacts:</i> <span style="float: right;"><i>Apr 2014</i></span></li> <li>• <i>Analyze and identify training needs and develop training plan:</i> <span style="float: right;"><i>Jun 2014</i></span></li> <li>• <i>Commence development of new and revised training programs, as appropriate:</i> <span style="float: right;"><i>Jan 2015</i></span></li> <li>• <i>Improve program &amp; monitor compliance:</i> <span style="float: right;"><i>Ongoing</i></span></li> </ul>

Rec No.	Recommendations	Agree (X)	Disagree (X)	Management Comments: <i>(Comments are required only for recommendations where there is disagreement.)</i>	Action Plan/Time Frame
10.	<p>The Board request the Chief Executive Officer to accurately assess failure rates of major internal bus rebuild parts as well as assessing the costs of rework associated with rebuild failures.</p>	X			<p>As identified in recommendation #7, Bus Maintenance is in the process of developing a Vehicle Reliability and Quality Assurance Group. This will include identifying quality issues of Shop rebuild items. This will be an ongoing exercise</p> <p>A change to the IFS VWO system will also be investigated to assist staff to capture the costs uniquely associated with internal rebuilt parts that have pre-maturely failed. The delineation between normal and pre-mature failure will be based on industry standards.</p> <ul style="list-style-type: none"> <li>• <i>Target for the investigation:</i> <span style="float: right;"><i>Q2 of 2014</i></span></li> <li>• <i>Target for software changes &amp; rollout:</i> <span style="float: right;"><i>Q4 of 2014</i></span></li> </ul>
11.	<p>The Board request the Chief Executive Officer, in his ongoing assessment of outsourcing opportunities, to conduct a complete analysis of internal bus rebuild costs at the Duncan Shop accounting for all key and relevant direct and indirect costs.</p>	X			<p>Bus Maintenance will review and analyse Bus Rebuild costs to include all relevant direct and indirect costs.</p> <ul style="list-style-type: none"> <li>• <i>Target for completion of review and analysis:</i> <span style="float: right;"><i>Dec 2015</i></span></li> </ul>

Rec No.	Recommendations	Agree (X)	Disagree (X)	Management Comments: <i>(Comments are required only for recommendations where there is disagreement.)</i>	Action Plan/Time Frame
12.	<p><b>The Board request the Chief Executive Officer to take immediate steps to improve the current defective parts retrieval process at bus garages including but not limited to:</b></p> <p><b>a. Implementing adequate controls to account for and track the return of defective parts by technicians; and</b></p> <p><b>b. Enhancing efficiency of the parts retrieval process currently carried out by warranty staff.</b></p>	<p>X</p> <p>X</p>			<p>Recommendations 12 to 16 all pertain to the Warranty Recovery Process. This involves various departments, processes and systems that are intertwined. To address Recommendations 12 to 16, a Phase 3 of the IFS VWO Upgrades will be added. This will include a complete review of all warranty recovery activities &amp; development of improved tracking tools. Target timeline and milestones are as follows:</p> <ul style="list-style-type: none"> <li>• <i>Target to identify departmental personnel to form a working committee:</i> <span style="float: right;"><i>Mar 2014</i></span></li> <li>• <i>Target to complete a business analysis</i> <span style="float: right;"><i>Dec 2014</i></span></li> <li>• <i>Target for developing a solution:</i> <span style="float: right;"><i>Sep 2015</i></span></li> <li>• <i>Target for evaluating solution via test pilot:</i> <span style="float: right;"><i>Oct - Dec 2015</i></span></li> <li>• <i>Target for implementing solution:</i> <span style="float: right;"><i>Jan 2016</i></span></li> </ul> <p>Note – During the business analysis, improvements to current processes that do not require immediate implementation of a technical solution will be rolled out as interim solutions to improve warranty recovery</p>

Rec No.	Recommendations	Agree (X)	Disagree (X)	Management Comments: <i>(Comments are required only for recommendations where there is disagreement.)</i>	Action Plan/Time Frame
13.	<p>The Board request the Chief Executive Officer to take immediate steps to maximize the use of bus warranty provisions and increase warranty recovery revenue. Such steps should include but not be limited to:</p> <p>a. Identifying and addressing reasons prohibiting successful filing of warranty claims;</p> <p>b. Increasing warranty claim submission rate for bus defective parts and labour hours; and</p> <p>c. Systematically tracking and monitoring claim submission rate and warranty cost recovery for the entire bus fleet.</p>	<p>X</p> <p>X</p> <p>X</p>			Reference Action Plan for Recommendation #12
14.	<p>The Board request the Chief Executive Officer to take necessary steps to minimize the number of warranty claims denied by bus manufactures based on “no fault found” in submitted defective parts or warranty administrative issues.</p>	<p>X</p>			Reference Action Plan for Recommendation #12

Rec No.	Recommendations	Agree (X)	Disagree (X)	Management Comments: <i>(Comments are required only for recommendations where there is disagreement.)</i>	Action Plan/Time Frame
15.	<p>The Board request the Chief Executive Officer to take steps to ensure proper accounting procedures for bus warranty claims and payments. Such steps should include but not be limited to:</p> <p>a. Establish proper accounting procedures for bus warranty payments including setting up accounts receivable for warranty claims, implementing procedures to adjust/write off disputed claims and periodic reconciliations;</p> <p>b. Undertake collection of all valid outstanding claims; and</p> <p>c. Review accounting procedures for warranty payments for other types of TTC vehicles including subway trains and streetcars to ensure adequate financial controls are in place.</p>	<p>X</p> <p>X</p> <p>X</p>			Reference Action Plan for Recommendation #12
16.	<p>The Board request the Chief Executive Officer to provide an adequately designed and supported bus warranty management information system facilitating effective and efficient management of warranty claims and recoveries.</p>	<p>X</p>			Reference Action Plan for Recommendation #12

Rec No.	Recommendations	Agree (X)	Disagree (X)	Management Comments: <i>(Comments are required only for recommendations where there is disagreement.)</i>	Action Plan/Time Frame
17.	The Board request the Chief Executive Officer, in preparing 2015 budget submission relating to shortening existing bus service life policy by three years, to provide clear short and long term financial impact information based on a comprehensive, accurate and objective life-cycle cost analysis.	X			<p>Bus Maintenance will review the Business Case submitted in the 2014 Budget Requests. Revisions will be made to improve the clarity of information being communicated regarding short and long term financial impact from moving from an 18 to a 15 year bus life cycle.</p> <ul style="list-style-type: none"> <li>• <i>Target to review and revise business case: Jun 2014</i></li> </ul>
18.	The Board request the Chief Executive Officer to develop a plan for hybrid buses to help minimize increasing maintenance costs in future operating budgets. Such a plan should include a review of alternatives and other transit agencies' experiences in maintaining their hybrid bus fleets.	X			<p>Bus Maintenance will review maintenance &amp; reliability concerns regarding the Hybrid bus fleet. This review will include ongoing discussions with other transit agencies that maintain Hybrid buses. Ongoing investigations of ways to minimize or mitigate increasing maintenance costs will continue. This will include evaluating options such as early retirement, retrofit and do-nothing strategies.</p> <ul style="list-style-type: none"> <li>• <i>Target to review and analyze fleet reliability and increasing maintenance costs: Ongoing</i></li> <li>• <i>Target for investigating &amp; evaluating options: Jun 2014</i></li> </ul>