Commonwealth of Massachusetts
Office of the State Auditor
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Official Audit Report – Issued September 27, 2012

Massachusetts Bay Transportation Authority's Automated Fare Collection System

For the period July 1, 2006 through June 30, 2011

TABLE OF CONTENTS

INTRODUCTION AND SUMMARY OF FINDINGS AND RECOMMENDATIONS

In accordance with Chapter 11, Section 12, of the Massachusetts General Laws, the Office of the State Auditor has conducted an audit of certain activities of the Massachusetts Bay Transportation Authority (MBTA) for the period July 1, 2006 through June 30, 2011. The objectives of our audit were to determine the MBTA's compliance with applicable laws, rules, and regulations and to review and analyze its management practices over the following areas and functions for the purpose of determining their adequacy: (1) the MBTA's internal control plan for its automated fare collection (AFC) system and (2) other non-AFC collection activity, including monthly passes, web-based sales, private agent sales, visitor passes, student passes, and corporate pass program sales.

Based on our audit we have concluded that, except as noted in the Audit Findings section of this report, during the period July 1, 2006 through June 30, 2011, the MBTA maintained adequate management controls and complied with applicable laws, rules, and regulations for the areas tested.

Highlight of Audit Findings

- Due to hardware and software deficiencies in its AFC system, the MBTA has inadequate controls that limit its verification of bus and trolley rider fare box cash receipts. Specifically, for the five-year period July 1, 2006 through June 30, 2011, actual fare box cash receipts deposited were $123.8 million, whereas the AFC system recorded over $225.5 million in fare box cash receipts. This variance of over $101.7 million clearly demonstrates significant reliability problems in the MBTA's collection and control of millions of dollars in cash revenue.

- Because the MBTA lacked effective physical controls over the hundreds of keys that provide access to fare box cash at the time of its initial receipt and transfer into the MBTA revenue system, the MBTA cannot ensure that all fare box cash is properly safeguarded against possible loss, theft, or misuse.

- The AFC system does not properly record all essential events necessary to properly track the removal, deposit, and reinsertion of cash boxes into assigned fare boxes. The inability of the AFC system to give MBTA management reliable tracking information regarding the movement of fare box cash exposes such revenue to potential fraudulent activity.

- In order to avoid large delays at the fare gates, the MBTA uses an outdated and unreconcilable "Speedy Box" cash collection system for special events whenever it anticipates a high volume of riders (e.g., Independence Day, the Boston Marathon). This method of collecting cash fares exposes the MBTA to the possibility that not all revenue

collected by the Speedy Boxes will be deposited at its Cash Processing Center[1] (CPC). In addition, under this system, the MBTA cannot ensure that all riders using these Speedy Boxes pay the proper fare amount. As a result, the MBTA was unable to reconcile over $2 million in revenue or calculate unpaid fare revenue for the period July 1, 2006 through June 30, 2011.

Recommendations of the State Auditor

- The MBTA should immediately implement corrective action in conjunction with its AFC vendor, Scheidt & Bachmann USA, Inc., to correct these software and hardware defects between NamSys, its cash management software, and the AFC system. This action should ensure that all fare box revenue can be reconciled between these reporting systems and that the amounts recorded in the fare box vaults are in agreement with the amounts received and deposited by the CPC. In addition, the MBTA should assign employees to monitor the information generated by AFC for cash box activity and investigate all noted discrepancies.

- Because of the risks associated with missing keys and chain of custody issues for keys that provide primary and secondary access to cash, we recommend that the MBTA:

    - Immediately replace all revenue keys and their associated locking systems.
    - Test all keys and associated locking mechanisms to determine the causes for the large number of broken keys.
    - Ensure that all keys are sequentially numbered.
    - Adhere to its April 2007 policies and procedures to properly control these revenue keys.

- The MBTA should conduct a cost-benefit analysis of collecting fares via the Speedy Box method and consider alternative methods, such as selling prepaid CharlieCards loaded with round-trip fares on the way into these events. This will ensure that most riders will already have their return ticket, thereby minimizing lines and waiting times at the AFC terminals at the end of these events.

[1] The MBTA's CPC is located at 32 Alford Street in Charlestown. The primary function of the CPC is to collect, count, and deposit all MBTA-generated cash revenues derived from fare vending machines, mobile vaults, and Speedy Boxes. The CPC is also responsible for reconciling cash received by and deposited into both the AFC and NamSys reporting systems.

OVERVIEW OF AUDITED AGENCY

The Massachusetts Bay Transportation Authority (MBTA), which was established in 1964 in accordance with Chapter 161A of the Massachusetts General Laws, provides bus, bus rapid transit (BRT), light rail, heavy rail, commuter rail, ferry, and demand-responsive public transportation services to 175 cities and towns in the Massachusetts Bay region, including the City of Boston. The MBTA operates a network of 219 fixed bus routes, five light rail lines (the four streetcar routes on the Green Line and the Ashmont-Mattapan trolley line), three heavy rail lines (the Blue, Orange, and Red Lines), one BRT line (the Silver Line), 13 commuter rail lines, and five commuter boat ferry routes. The population of the MBTA's service area is approximately 4.5 million, and its transportation revenue and ridership figures for fiscal years 2006 through 2011 were as follows:

Transportation Revenue

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
$331,096,000	$386,488,000	$440,962,000	$448,752,000	$439,322,000	$448,814,000

Ridership

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
380,260,730	357,578,991	370,718,600	367,247,601	356,050,343	380,694,311

The MBTA has a nine-member Board of Directors. The Secretary of Transportation for the Commonwealth is one of the directors and serves as the Chairman, and the Governor appoints the other eight directors. Chapter 161A also established the Advisory Board of the MBTA, which reviews and approves the MBTA's annual budget and consists of the Chief Executive Officer or designee of each of the 175 member municipalities. Each municipality has a weighted vote on the Advisory Board based on their assessments.

In order to become a more efficient public transportation system, the MBTA sought to replace its antiquated token/cash-based fare system with a more efficient and dynamic automated fare collection (AFC) system. As early as 1990, the MBTA began to investigate alternative fare collection technology by hiring J. W. Leas and Associates (Leas), which on December 4, 1990 issued a report entitled MBTA Evaluation of Fare Collection Alternatives. The consultant's study indicated that the MBTA's token/cash-based system was susceptible to certain internal and external control weaknesses, as follows:

- The handling of cash by a multitude of employees at numerous rapid transit stations and bus locations, rather than in a secure and controlled environment.
- The lack of automated and accurate revenue reporting and tracking of customer activity.
- Increased labor costs.
- Fare evasion.
- Minimal management information.

Furthermore, the Leas study indicated that a stored value ticketing system, which represented state-of-the-art fare technology in 1990, would resolve the issues inherent in the MBTA's manual, cash-based fare collection system.

The MBTA's attempts to modernize its fare collection system began in 1994. A brief history of these efforts, the procurement process used to install and manage the AFC system, and other associated issues are included in the Appendix to this report.

Finance Issues

In an attempt to address the finance issues of the MBTA, the Legislature passed Chapter 127 of the Acts of 1999, the so-called "Forward Funding" law. Effective July 1, 2000, this legislation dedicated 20% of sales tax revenue to the MBTA and, in exchange, charged the MBTA with issuing and paying its own debt. However, this law also transferred $3.3 billion in state debt (part of which was due to the Central Artery/Tunnel Project) onto the books of the MBTA.

As of fiscal year 2011, the MBTA had outstanding debt totaling over $5.5 billion, the principal and interest payments on which consumed almost 24% of the MBTA's projected operating revenues, and faced a deficit of over $161 million. The MBTA is currently attempting to address these deficits, which it projects will only increase with each passing fiscal year, through cost-cutting measures, fare increases, and service reductions.

Other Matters

In March 2011, the MBTA initiated an investigation of one of its vendors, Cubic Corporation, which handles the sale and fulfillment of MBTA monthly passes purchased online and over the telephone. Cubic has processed approximately $135 million annually in MBTA monthly pass sales since 2007.

As a result of its investigation, the MBTA determined that a Cubic employee had fraudulently created and sold more than 20,000 monthly passes worth several million dollars. The employee was subsequently arrested, and a criminal investigation is being conducted by the Massachusetts Attorney General's Office. Subsequently, as a result of this theft, the MBTA terminated its contract with Cubic and is currently handling its monthly pass program in-house using MBTA employees.

AUDIT SCOPE, OBJECTIVES, AND METHODOLOGY

In accordance with Chapter 11, Section 12, of the Massachusetts General Laws, the Office of the State Auditor has conducted an audit of certain activities of the Massachusetts Bay Transportation Authority (MBTA) for the period July 1, 2006 through June 30, 2011. The objectives of our audit were to determine the MBTA's compliance with applicable laws, rules, and regulations and to review and analyze its management practices over the following areas and functions for the purpose of determining their adequacy: (1) the MBTA's internal control plan for its automated fare collection system (AFC) system and (2) other non-AFC collection activity, including monthly passes, web-based sales, private agent sales, visitor passes, student passes, and corporate pass program sales.

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 and 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 objectives.

To achieve our objectives, we reviewed the following:

- Controls over cash and reconciliation of cash for AFC revenue for fare vending machines, fare boxes, and MBTA ticket office machines.
- Reporting of all AFC revenues as contained in the AFC Product Sales Summary Reports and reconciliations performed by the MBTA's Cash Processing Center (CPC), Revenue Audit, and Accounting departments.
- Controls over credit/debit card transactions and reconciliations performed by the MBTA's Accounting Department.
- Pass program sales reports and reconciliations maintained by the MBTA Accounting Department.
- Private agent sales reports and reconciliations for commuter rail and core transit system maintained by the MBTA Accounting Department.
- Commuter rail sales office and on-board sales maintained by the Massachusetts Bay Commuter Railroad Company and monitored by the MBTA Accounting Department.
- Special events revenue reported by the CPC for preloaded CharlieCard and Speedy Box receipts.

- The results of a statistical sample we conducted for 72 of 1,843 cash boxes removed from fare boxes to evaluate the accuracy of the AFC system in recording the movement of this cash, and ultimate receipt and deposit of these funds by the CPC. Our sample was designed to achieve a 95% confidence level in the results of our testing.

Based on our audit we have concluded that, except as noted in the Audit Findings section of this report, during the period July 1, 2006 through June 30, 2011, the MBTA maintained adequate management controls and complied with applicable laws, rules, and regulations for the areas tested.

AUDIT FINDINGS

1. OVER $101.7 MILLION IN UNEXPLAINED VARIANCE DUE TO AUTOMATED FARE COLLECTION SYSTEM DEFICIENCIES

Our audit found that, due to hardware and software deficiencies, the Massachusetts Bay Transportation Authority's (MBTA) automated fare collection (AFC) system has not been able to communicate with the MBTA Cash Processing Center's (CPC) NamSys computer operating system since the inception of the AFC system in 2005. Accordingly, fare box cash receipts for buses and trolleys have been manually counted and cannot be reconciled to any AFC/NamSys revenue reports. Specifically, although the MBTA's actual fare box cash deposits totaled over $123.8 million for the period July 1, 2006 through June 30, 2011, the AFC system recorded over $225.5 million in fare box cash receipts for this same period. This total variance of over $101.7 million clearly demonstrates significant reliability problems with the AFC system. A summary of these variances by fiscal year follows:

Fiscal Year	Cash Per AFC System	Actual Cash Deposited	Unexplained Variance
2007	$43,706,730	$24,164,529	($19,542,201)
2008	98,038,514	24,519,214	(73,519,300)
2009	22,005,985	24,599,361	2,593,376
2010	20,079,255	25,053,610	4,974,355
2011	41,738,023	25,499,646	(16,238,377)
Total	$225,568,507	$123,836,360	($101,732,147)

Moreover, although the MBTA's AFC system recorded over $225.5 million in cash collected from fiscal years 2007 through 2011 as shown above, the MBTA's NamSys system, which is supposed to automatically interface and reconcile with the AFC system, recorded over $308.8 million in fare box cash during this five-year period, a variance of over $184.9 million with the actual cash deposited during this period, as shown in the following chart:

Fiscal Year	Cash Per NamSys System	Actual Cash Deposited	Unexplained Variance
2007	$ 62,771,070	$24,164,529	($38,606,541)
2008	99,751,282	24,519,214	(75,232,068)
2009	58,374,459	24,599,361	(33,775,098)
2010	31,772,428	25,053,610	(6,718,818)
2011	56,138,250	25,499,646	(30,638,604)
Total	$308,807,489	123,836,360	($184,971,129)

The original AFC contract for $75,042,016 with Scheidt and Bachmann USA, Inc. (S&B), which was signed on February 4, 2003, was designed to provide the MBTA with an AFC system composed of three major components: (1) fare collection equipment, including bus fare boxes, fare vending machines (FVMs), and turnstile gates; (2) hub station management; and (3) hardware and software necessary to link the system together and integrate with existing MBTA computer systems such as NamSys. The MBTA's CPC uses the NamSys software system as a part of its revenue inventory control procedures to track money containers and count their contents. As of June 30, 2011, the contract for the AFC system, through over $19 million in approved change orders, had increased from the original award of over $75 million to over $94 million. One of these change orders, which was approved by the MBTA on August 24, 2005, reduced the required 100% Revenue Service Testing (RST) to be performed by S&B on the AFC equipment prior to being accepted by the MBTA. Consequently, we determined that the MBTA and S&B did not appear to perform adequate RST and system-wide testing to ensure that the AFC system met all the specifications of the contract. For example, MBTA records indicate that actual RST was performed on only 370 of 1,407 bus fare boxes, 83 of 318 full-service FVMs, and 48 of 156 cashless FVMs. We also noted that adequate RST was not performed on retail service terminals and receivers (units that receive fare box cash and deposit these funds into a secure money tank) prior to their acceptance by the MBTA. As a result, the various hardware and software problems within the AFC that are noted throughout this report went undetected and were therefore not corrected prior to the implementation of the AFC system by the MBTA.

It should also be noted that a prior audit (No. 2005-0583-3A) of the MBTA conducted by the Office of the State Auditor (OSA) revealed that the MBTA had imprudently reduced the RST for its new AFC system when it agreed to reduce the AFC contractor's hardware warranty repair and maintenance obligations for AFC equipment. As noted in our prior audit report, after the AFC contract was awarded, the scope of required RST was reduced in both the number of units to be tested and in the duration of testing from a 60-day period to a 30-day period. Moreover, the warranty period for the hardware was reduced from one year after successful RST to begin upon delivery and expire after successful RST of 75% of installed fare boxes. By reducing the scope of the RST and the hardware warranty, the MBTA could not ensure that the AFC system would perform as required under the contract specifications. Sound business practices advocate that when equipment is procured that incorporates new technologies that must integrate with

various fare media and operating systems on a system-wide basis, sufficient testing and warranties must be in place to ensure that the system works as intended and that the interests and assets of the MBTA are fully protected.

MBTA officials indicated that a combination of hardware malfunctions and software interface issues have prevented the accurate recording and transmittal of AFC information. However, these officials indicated that discussions on correcting this interface problem with S&B, which has taken the position that the problem may lie with the NamSys software and not the AFC software, have not yielded a solution.

Recommendation

The MBTA should immediately implement corrective action in conjunction with S&B to correct the software and hardware deficiencies causing the interface issues between NamSys and the AFC. This action should ensure that all fare box revenue can be reconciled between these reporting systems and that the amounts recorded in the fare box vaults are in agreement with the amounts received and deposited by the CPC.

Auditee's Response

All cash collected on MBTA bus and light rail vehicles is securely transferred from on-board fare boxes to the MBTA's revenue department. At all points in the process, cash is monitored to ensure proper security and no revenue loss.

All MBTA fares are collected through an automated fare collection (AFC) system designed and built by Scheidt and Bachmann and deployed in 2007. For cash fares collected on buses and light rail vehicles, fare boxes are vaulted and cash is transferred to the MBTA money room. First, cash is transferred from the fare box to a mobile vault. Then, vaulted fares are transported to the MBTA money room via armored truck. At all points in this process, vaulting occurs in a secure environment managed by key card access control devices and under constant video monitoring.

The MBTA revenue department uses an industry standard software system to ensure proper counts of MBTA cash revenue. This software system, the NAMSYS system, has an interface to the MBTA's Scheidt and Bachmann fare collection system. This interface is designed to ensure that cash deposits into the Farebox system are reconciled with physical cash counts. Since its implementation with the MBTA automated fare collection system, there have been integration issues between the two systems.

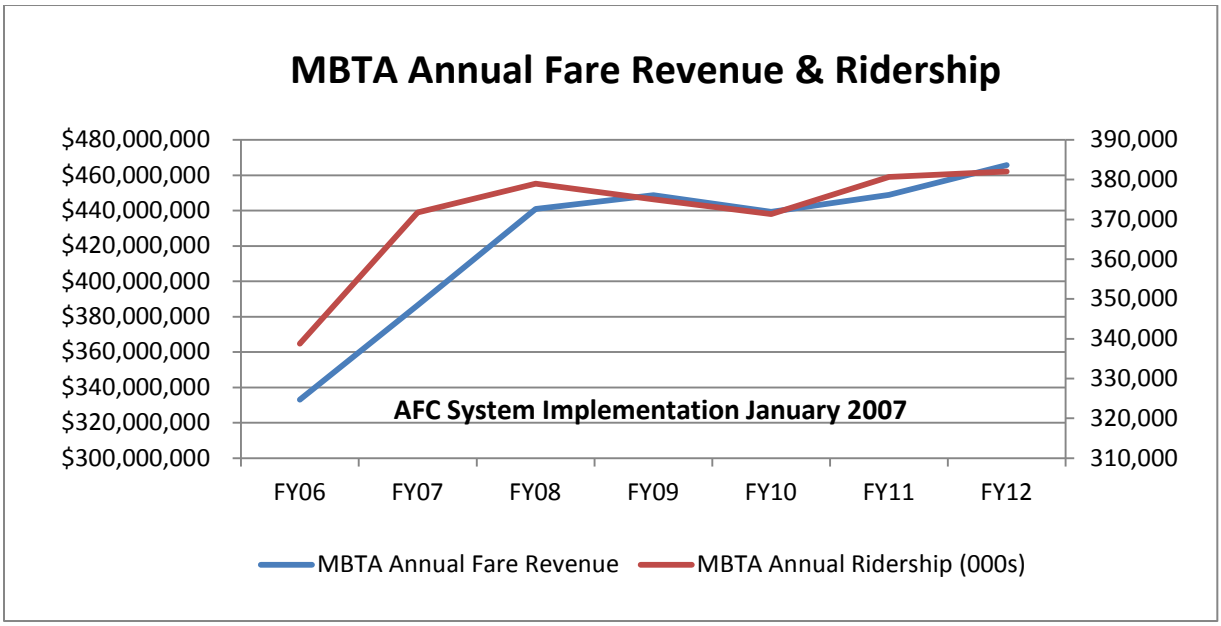
The MBTA and Scheidt and Bachmann have shared responsibility for implementing corrective action to the NAMSYS interface with the AFC System. Software design to fix interface errors is undergoing comprehensive review before agreement by both parties. The MBTA will work to expedite the process of making software improvements alongside

numerous manual business process improvements. It should be noted that this represents a reporting/software issue, not a risk for revenue loss.

The MBTA has undertaken a reorganization of its Automated Fare Collection program in recent months. As the automated fare collection project implementation is completed, this reorganization ensures all fare collection roles and responsibilities are properly aligned in the organization. As part of this reorganization AFC revenue operations were assigned to the MBTA Treasury department to work more closely with the money room operations. Also, a review of the security protocols at the Money Room is currently underway by an outside firm. As part of this review, the firm will examine the findings from this report, and provide the MBTA with recommendations to further strengthen security over the collection and transport of revenue.

The MBTA must emphasize that the software reporting deficiencies cited in the finding do not constitute a revenue loss. Revenue collection is performed securely using a key card access controlled system that is under constant video surveillance. While reconciliation is made more difficult by the errors of the system, all revenue is being securely collected, counted and deposited.

As is noted in the graph below, revenue and ridership track closely together and indicates a significant increase in fare collections due to the AFC implementation. This close tracking of revenue and ridership confirms that revenue is being securely collected.



Auditor's Reply

The OSA is pleased that the MBTA has begun to implement our recommendation relative to this matter and has joined with S&B to correct the failure of the NamSys to properly interface with the AFC system. In its response, the MBTA states, "At all points in the process, cash is monitored to ensure proper security and no revenue loss." We acknowledge the fact that the

MBTA has implemented significant physical security measures over the cash being collected within this system. However, clearly the internal control that would be afforded by effective software interfaces between its NamSys and AFC systems, which would provide for an accurate reconciliation of the fares collected to the amounts deposited by the MBTA, is an equally critical component of the internal control environment over these activities. Consequently, despite the MBTA's assertion, without such controls, there is inadequate assurance that all funds that are being collected within this system are being properly safeguarded from theft.

A review of security protocols at the CPC may prove worthwhile. However, our observations did not identify any problems with any physical controls in the CPC. Rather, our primary concern in this area related to controls involving the reconciliation of cash collected. As noted above, for the period under audit, fare box cash receipts recorded by the AFC system varied by more than $100 million as compared to the actual cash received by the CPC as a result of deficiencies within the AFC system.

In its response, the MBTA provided a chart showing the historic trends in MBTA ridership and revenue collections and contends that this chart confirms that revenues are being securely collected. Although we acknowledge that this chart, if accurate, does show a correlation between ridership and revenues collected, given the magnitude of the revenues being collected (hundreds of millions annually), such correlation is no substitute for proper and verified effective internal controls over the entire MBTA AFC activity and reliable records that can be used to reconcile funds collected in the fare boxes to the amounts deposited by the MBTA. Our audit identified deficiencies in both of these areas.

Finally, we view this matter as a significant internal control weakness in the MBTA's fare collection system. The contract with S&B, under which the MBTA has paid over $94 million as of June 30, 2011, was intended to strengthen internal control weaknesses and thus far has failed to do so.

2. INADEQUATE CONTROLS OVER ACCESS KEYS TO FARE BOX CASH AT ITS INITIAL RECEIPT PLACES SUCH REVENUE AT RISK

As part of our audit of internal controls implemented by the MBTA for its AFC system, we reviewed and tested the MBTA's controls over primary revenue keys, which allow direct access to cash, and secondary revenue keys, which provide indirect access to either an FVM cash box

or a bus or trolley fare box mobile cash vault. We determined that the MBTA did not have formal policies and procedures in place prior to ordering and receiving the initial AFC revenue keys in 2005 and 2006. Prudent business practices advocate that the MBTA should have established policies and procedures to control key inventories before issuing revenue keys to its employees. Because the MBTA lacked effective controls over the primary and secondary keys that provide access to fare box cash at the time of its initial receipt and transfer into the MBTA revenue system, the MBTA cannot ensure that all such revenue is adequately safeguarded against possible loss, theft, or misuse.

During our audit, the MBTA presented us with an inventory of four different categories of keys that provide either primary (direct access) or secondary (indirect access) to fare box cash, as follows:

Key Type	Access to Cash	Device Opened
C	Primary Access	Fare vending machine cash box
G	Primary Access	Mobile vault cash containers
A	Secondary Access	Mobile vault door
B	Secondary Access	Fare vending machine cash box lock
TVM	Secondary Access	Fare vending machine door

Cash Processing Center
Inventory of Keys as of May 11, 2011

Key Type	Total Keys	Issued	Broken/ Destroyed	Not Issued in Vault	Unnumbered in CPC Vault	Assigned	Missing Keys per MBTA
C	813	4	39	132	628	10	-
G	25	10	4	8	-	-	3
A	75	14	49	8	-	-	4
B	811	35	43	22	685	26	-
TVM	553	89	53	406	-	-	5
Totals	2,277	152	188	576	1,313	36	12

Properly safeguarding access to, accounting for, and documenting the chain of custody for these keys is critical to ensure the integrity of the MBTA's fare cash receipts. Accordingly, in order to determine whether the MBTA had complied with the proper safeguarding of these revenue keys, we asked the MBTA to provide us with the following information to determine the accuracy of the inventory of keys presented to us:

- Shipping and receiving reports to document the order and receipt of these keys.
- Chain of custody logs to establish the transfer of these keys from the ordering department to the CPC.
- Key assignment logs and locations for all keys.
- Formal policies and procedures utilized by the MBTA to ensure the proper controls for these keys.

Through this request, we were able to determine that the AFC Department, acting as the purchaser and receiver of all keys under the AFC contract, could provide us with shipping and receiving documentation for only 843 (37%) of the total 2,277 CPC keys. Furthermore, it could not document the total number of keys initially ordered and added at later dates by the AFC vendor. Also, chain-of-custody logs were not maintained. Finally, with the exception of 10 keys received after August 15, 2007, there were no formal policies and procedures in place for the control of these important revenue keys. As a result of these control issues, the MBTA's key inventory was exposed to possible loss, theft, or misuse. In fact, MBTA key inventory records indicate that keys that provide primary and secondary access to cash are missing and that, accordingly, access to cash by unauthorized individuals could occur.

The following areas of concern were noted in our review of the MBTA's revenue key inventory:

- Seven keys that provided primary and secondary access to mobile vault cash are missing.
- Three keys that provide access to FVM cash were used during contractor installation of AFC equipment and were not under the CPC's control.
- Five keys that provide secondary access to FVM cash are missing.
- A total of 1,313 keys were unnumbered and lacking individual identifying numbers, thereby making it impossible to maintain an effective inventory that properly controls the risk that misuse of these keys would be promptly detected. Documentation was not available for purchase orders, receiving reports, packing slips, and the chain of custody of keys.

- Large quantities of keys were broken, which indicates that locking mechanisms may be defective or subject to abuse.
- An excessive number of primary access keys were on hand.
- An excessive number of secondary access keys were on hand.

Of particular concern is that the CPC and the AFC Department cannot account for 100% of the revenue keys documented as having been received by the MBTA (three G keys and four A keys are recorded as missing) that provide access to the cash contents of the MBTA's mobile vaults. Moreover, due to a lack of documentation for purchase orders and receiving documents, it was not possible to determine the actual number of ordered, received, and missing keys. In addition, chain of custody issues for the C keys, coupled with the five missing TVM keys, present a risk to FVM cash contents. Finally, the fact that 1,313 keys are unnumbered presents a control risk.

As previously stated, the MBTA did not have formal policies and procedures in place prior to ordering and receiving the initial AFC revenue keys in 2005 and 2006 and, as a result, formal chain of custody logs and control procedures were not in place. Prudent business practices advocate that, before releasing revenue keys, the MBTA should establish policies and procedures to control key inventories and safeguard revenue. Subsequently, the MBTA implemented proper formal policies and procedures to adequately control any new purchases made after the implementation date of April 17, 2007. The areas addressed in the Revenue Keys Policies and Procedures are as follows:

- The CPC shall control revenue keys at all times.
- All keys must be received by two staff members, and shipping documents must be maintained.
- Periodic inventories must be conducted at least once every 12 months.
- Keys must be secured.
- Keys must be numbered.
- Broken keys must be disposed of according to procedure.
- Key rings are to be controlled by certain individuals.
- Those allowed to order keys must be authorized and preapproved.

Our review of a single purchase of keys made by the MBTA after the implementation of the Revenue Keys Policies and Procedures indicated that the ordering, receipt, and proper safeguarding of these keys were done in compliance with these new MBTA requirements.

Recommendation

To minimize the risks associated with missing keys and chain of custody issues for keys that provide primary and secondary access to cash, we recommend that the MBTA:

- Immediately replace all A, B, C, G, and TVM keys and their associated locking systems for the 318 full-service FVMs and 75 mobile vaults into which fare cash is deposited.
- Test all keys and associated locking mechanisms to determine the causes for the large number of broken keys.
- Ensure that all keys are sequentially numbered.
- Continue to adhere to its April 2007 policies and procedures to properly control these revenue keys.

Auditee's Response

The installation of the AFC equipment was a major transition from a simple electro-mechanical based token system to a computer based, software driven, fare collection system. The coordination of resources (the installation contractor, the AFC equipment vendor, and various MBTA department staff) needed to meet the installation deadline, required access to equipment during various times of the day to facilitate the installation. During this time period, the Authority agrees that the critical need to maintain control and security of equipment keys was not provided at all times.

However, subsequent to the equipment installation, large, heavy, Medeco padlocks (hockey puck locks) were installed on all FVM cash containers which provide protection by preventing physical access to the interior of the unit by unauthorized personnel. The installation of these hockey puck (HP) locks was the final step after testing and commissioning of each device had taken place. There are strict controls to protect the keys to these HP locks as all are numbered and their assignments are kept on a key list maintained by the AFC maintenance foremen at the Franklin St. Office.

In addition to an HP key, a valid user ID and password are needed to open an FVM without triggering an intrusion alarm which is also sent to the Central Computer System. Failure to comply with these requirements (valid user ID and password) will also send an alarm notification to the Transit Police via an interface with the existing MBTA alarm system. All cash containers inserted into a fare vending machine have serialized barcodes and corresponding transponders which are recorded into the AFC system upon insertion and removal of containers. The AFC fare vending machines were also installed simultaneously with a new video networking system controlled by the MBTA.

Based on the recommendations of the auditors to minimize any risk associated with missing keys and chain of custody issues, the authority will:

Replace the G cylinder keys and locking systems and document this process. As stated above, the HP lock protects TVM cylinder access and provides protection against unauthorized access to the vending machine.

AFC Maintenance will begin testing all keys and locking mechanisms to determine the cause for the large number of broken keys. Any defective equipment will be documented and replaced.

AFC Maintenance will ensure that all key are sequentially numbered and will coordinate this effort with Revenue Collection management and key room staff.

AFC Maintenance will continue to adhere to policies outlined in "MR-1 Control of Revenue Keys – September 2007."

Auditor's Reply

We believe that the actions that the MBTA indicates it is taking in its response, including investigating the cause for an inordinate number of broken keys, ensuring that all keys are sequentially numbered, adhering to its April 2007 policies and procedures to properly control all revenue keys, and agreeing to replace the G key locking systems for the mobile vaults, are necessary and appropriate. However, in order to minimize the risk that cash may be accessed by unauthorized individuals, we continue to urge that the MBTA also replace, at a minimum, all locking mechanisms for the A key, which permits access to the mobile vaults, and the C key, since three of these keys were documented as not being in control of the CPC at all times and provide direct access to the cash container once the FVM has been opened.

3. AUTOMATED FARE COLLECTION SYSTEM'S INABILITY TO COMPLETELY TRACK FARE BOX CASH PLACES SUCH REVENUE AT RISK FOR POTENTIAL FRAUDULENT ACTIVITY

We determined that the AFC information system is not properly recording all events necessary to track the removal, deposit, and reinsertion of cash boxes into assigned fare boxes. As a result, the inability of the AFC system to provide MBTA management with reliable tracking information regarding the removal and deposit of fare box cash, coupled with the aforementioned weaknesses for control of revenue keys and the MBTA's inability to properly reconcile fare box cash receipts, exposes fare box cash to potential loss, theft, or misuse.

As previously mentioned in the Overview of Audited Agency section of this report, two of the MBTA's major goals in implementing an AFC system were to minimize the handling of cash by MBTA employees and to provide more accurate and timely revenue reporting. Prior to the installation of the AFC system, the CPC used the NamSys system as a part of its revenue

inventory control procedure to track money containers and count their contents and compare these to registered revenue (money physically counted by CPC staff). The new AFC system was designed to provide an interface with NamSys to provide revenue, counting, and other information on the AFC cash containers. In addition, it was intended that NamSys would report on a real-time basis to the AFC system any changes in the status of the cash containers.

Accordingly, Section 2.0 of the Contract Scope of Services for the AFC states the following:

> *The Contractor shall integrate the AFC network with the existing MBTA network (NamSys) and assure that interfaces to the existing software systems operate properly, provide the necessary security protections and in no way interfere with the operations of the existing software systems. This information shall be transferred in a real time basis from the AFC Central Computer System to the NamSys. In addition, NamSys will report to the AFC Central Computer System when there is a change in the status of the cash container, including the following: removed from farebox/Fare Vending Machine (FVM), inserted in farebox/FVM, vaulted (farebox cashboxes).*

However, our testing of AFC's tracking of cash boxes removed from fare boxes and promptly deposited into mobile vaults for transfer to the CPC revealed that the NamSys and AFC systems are not accurately transferring cash box data between these systems and that, accordingly, the interface specifications contained in the AFC Contract Scope of Services are not functioning as required. Moreover, the inability to accurately track the movements of fare box cash from their removal to deposit in sealed CPC mobile vaults creates the risk for potentially fraudulent activity.

The MBTA's AFC Policies and Procedures require that all cash boxes removed from a fare box be immediately emptied into a mobile vault before they are allowed to be reinserted back into a fare box. We selected a statistical sample of 72 of the 1,843 cash boxes that AFC records indicated were both probed and removed from bus and Green Line fare boxes for four days during the month of March 2011 to determine whether the AFC system recorded all the required cash box vaulting steps. Our statistical sample was designed to achieve a 95% confidence level in the results of our testing. The six vaulting steps are as follows:

- Probe cash box (probing downloads and uploads cash box information to AFC).
- Remove cash box from fare box.
- Insert cash box into receiver (at this point cash is dropped into a mobile vault).
- Remove cash box from receiver.

- Insert cash box back into fare box.
- Check for "Probe OK" (indicates that cash box has been recognized and reset).

However, using the AFC cash box tracking information provided to us by the MBTA, we were unable to trace the removal of a number of cash boxes from both bus and Green Line vehicles through all the MBTA's required vaulting procedure steps.

Our test indicated that only two of the 72 cash boxes designated as being removed from a fare box went through the required six-step vaulting process. Moreover, only 41 (57%) of the 72 cash boxes were recorded by the AFC system as being emptied into a mobile vault. Mobile vaults are picked up by revenue agents and transported to the CPC, whereupon the vaults are opened and the contents are counted. These 41 cash boxes were probed (the first step of the six-step vaulting process) before being emptied into the mobile vaults, and the financial information uploaded to the AFC system indicated that these 41 cash boxes contained $15,571. More importantly, 31 (43%) of the 72 cash boxes were not recorded by AFC as being emptied into a mobile vault. These 31 cash boxes were probed prior to their removal from their fare boxes, and the AFC financial information transmitted indicated that these cash boxes contained $9,107. Therefore, our test indicated that 36.9% ($9,107/$24,678) of the total amount of cash in the 72 cashboxes tested could not be traced to the mobile vaults and the CPC.

We traced the indicated cash contents of the 41 cash boxes that were recorded by the AFC system as deposited into a mobile vault to the total deposits recorded by the AFC system for each mobile vault. We then compared the total deposits recorded by the AFC system to the total deposits recorded by NamSys and to the actual cash recorded and deposited by the CPC. Our test found the following:

- AFC mobile vault total: $350,040
- NamSys total: $2,019,294
- Actual deposit to bank: $376,650

As shown above, the AFC system recorded $26,610 less than the bank deposit ($376,650 - $350,040). Moreover, the amount recorded by NamSys, which derives its information from the AFC/NamSys interface, was $1,642,644 ($2,019,294 - $376,650) over the actual bank deposit. Our test results clearly show that the AFC/NamSys interface is not working in accordance with

the specifications of the contract. Because its AFC system cannot completely track the six-step vaulting procedure, the MBTA cannot ensure that all cash receipts are being properly accounted for and adequately safeguarded.

Although the specific deficiencies within the AFC system that prevented the accurate recording of all cash box vaulting steps could not be determined, they may include a combination of hardware, software, and transmission issues. For example, our review of the AFC equipment inventory noted numerous hardware problems, which may be one of the major contributing factors to the revenue tracking issues. Specifically, we noted the following hardware repair status for AFC equipment as of May 2011:

Hardware	Total	Unrepairable	Being Repaired	Out of Service
Cash Boxes	1,902	286	210	496 (26%)
Fare Boxes	1,460	6	104	110 (7.5%)
Mobile Vault	75	1	15	16 (21%)

Recommendation

To ensure that all fare box cash is adequately safeguarded and accounted for, we recommend that the MBTA take the following actions:

- Immediately contact S&B to establish the reasons for the cash box tracking problem.
- Work with S&B to determine the cause for the AFC/NamSys interface problem so that cash collected per the AFC system can be reconciled to cash received by the CPC for deposit.
- Assign employees to monitor the information generated by the AFC system for cash box activity and investigate any noted discrepancies.

Auditee's Response

The MBTA believes that the software to track the removal, deposit, and reinsertion of cash boxes into assigned fare boxes is functioning properly when all procedures are followed by the MBTA Vault Agents. The Scheidt & Bachmann AFC system does provide various methods of tracking the vaulting process. However, the MBTA plans to reinstruct the MBTA Vault Agents responsible for removing, depositing, and reinserting cash boxes into assigned fare boxes on the proper procedures for the complete vaulting process. In addition, the MBTA will assign appropriate personnel from Treasury Revenue Department to monitor the information generated by the AFC system and investigate any discrepancies in the vaulting process.

The MBTA believes that potential for fraud from the movement of fare box cash activities are mitigated through the controlled environment in which the vault process takes place. For cash fares collected on buses and light rail vehicles, fare boxes are vaulted and cash is transferred to the MBTA money room. First, cash is transferred from the fare box to a mobile vault; then, vaulted fares are transported to the MBTA money room via armored truck. At all points in this process, vaulting occurs in a secure environment managed by key card access control devices and under constant video monitoring. Furthermore, the MBTA will take the appropriate corrective action to address the interface reporting error between NAMSYS and the Scheidt & Bachmann AFC system (see MBTA's Response to Audit Finding #1).

Auditor's Reply

Contrary to what the MBTA states in its response, our testing clearly indicated that the AFC information system is not properly recording all events necessary to track the removal, deposit, and reinsertion of cash boxes into assigned fare boxes. This deficiency, coupled with the other deficiencies we identified in the AFC process, including the aforementioned weaknesses for control of revenue keys and the MBTA's inability to properly reconcile fare box cash receipts, clearly exposes the MBTA's fare box cash to potential loss, theft, or misuse. As noted above, our review of AFC-generated data indicated that only two of 72 cash boxes tested were recorded by AFC as having met the requirements of the system's six-step vaulting process. Most importantly, the fact that our test of these 72 cash boxes indicated that AFC system could document only 41, or 57% of these cash boxes as having been emptied into a mobile vault for transport to the CPC indicates serious deficiencies in the AFC system that prevent it from functioning as designed, which in the OSA's opinion are not mitigated by other controls. Accordingly, we continue to urge the MBTA to work with S&B to establish the reasons for these cash box tracking problems.

Based on its response, the MBTA is implementing our recommendation to assign personnel to monitor information generated by the AFC system and to investigate discrepancies in the vaulting process. However, we again urge the MBTA to establish a formal AFC internal audit function that is solely charged with investigating and resolving, in real time, all identified discrepancies in fare media, devices, and cash receipts.

4. OVER $2 MILLION IN UNRECONCILED FARE REVENUE RECEIPTS AND POTENTIAL LOSSES IN FARE REVENUE DUE TO USE OF SPEEDY BOXES

We determined that the MBTA uses an outdated and unreconcilable cash collection system for special events whenever a high volume of riders is anticipated in order to avoid large delays at

the fare gates. This method of collecting cash fares exposes the MBTA to the possibility that not all revenue collected by so-called "Speedy Boxes" will be deposited, intact, by the CPC. In addition, the MBTA cannot ensure that all riders using Speedy Boxes are paying the proper fare.

In reviewing the sources of MBTA fare revenues, we noted that despite implementing a new AFC system in May 2005, the MBTA still uses an informal and questionable method for collecting fares on some of the MBTA's busiest days. Specifically, the MBTA's use of Speedy Boxes, which are locked metal containers into which cash may be inserted, for collecting cash fares at certain stations during high-attendance events (e.g., the Boston Marathon, July 4th, Red Sox games) in order to move customers through the fare gates quickly and avoid delays makes reconciliation of these receipts impossible and exposes the MBTA to potential lost fare revenue.

We determined that during the period July 1, 2006 through June 30, 2011, the MBTA collected $2,138,986 in cash fare revenue from the Speedy Boxes, as follows:

Fiscal Year	Totals
2007	$1,760,549
2008	163,758
2009	62,770
2010	54,327
2011	97,582
Total	$2,138,986

This Speedy Box collection method exposes the MBTA to several risks. The first and most significant is that the MBTA has no way to reconcile the revenue collected in the Speedy Box because the cash deposited by the passengers into the boxes is not matched to any tickets issued. When the MBTA's Revenue Collection Department is dispatched to empty the Speedy Boxes, the collectors unlock and transfer the contents into a deposit bag and then transport the money via truck to the CPC. Upon arrival at the CPC, the revenue is hand-counted and entered into NamSys. By not controlling the amount of money received via the issuance of prepaid tickets, the MBTA is not able to determine how much money should be in these Speedy Boxes and lacks a basic internal control to prevent the possibility of misappropriation of these funds. Moreover, the use of these Speedy Boxes also exposes the MBTA to potential lost fare revenue from riders who do not deposit the proper fare.

The AFC system has the ability to create pre-paid CharlieCards in bulk that can be sold at these busy stations. These passes can be created either at the CPC or at the MBTA's main office at 10 Park Plaza, Boston, in a secure manner, with each pass having a unique number. By using pre-numbered passes already loaded with a pre-determined dollar amount, the MBTA can reconcile the fare revenues deposited to the actual tickets sold, thereby providing a level of accountability and control that the Speedy Box system lacks.

Recommendation

The MBTA should conduct a cost-benefit analysis of collecting fares via the Speedy Box method and consider alternative methods, such as selling prepaid CharlieCards loaded with round-trip fares on the way into these events. This will ensure that most riders already have their return ticket, thereby minimizing long lines and waiting times at the AFC terminals at the end of these events. Moreover, by using this type of system, the MBTA can reconcile and safeguard these fare revenues and minimize the possibility of unpaid fares.

Auditee's Response

The Authority provides various methods of in-station fare media sales for special events and through targeted sales for events such as the Boston Marathon, including the suggested method of selling prepaid fares. The MBTA has worked with partners at sporting events to install and market sales locations inside of the arenas to assist in proper fare collection and boarding. Unfortunately even with these sales channels, ensuring that customers can access in-station sales during largely attended events can become a safety and egress issue depending on the size of the station directly affected.

While the Authority understands that the method of using "speedy boxes" does not provide the best audit trail, it provides the safest manner for collecting fare from passengers already progressed to gates after major events. When in use, the "speedy boxes" are monitored by designated Operations staff, and are under constant video surveillance. All boxes are numbered, logged and strict controls are in place by the Revenue Collection Department over the securing, transporting and removal of the contents.

The Authority will however, take the auditor's recommendation to consider other methods of fare distribution for these events including the potential for special event purchases using downloadable mobile tickets.

Auditor's Reply

We recognize that any method used to collect fares must prioritize the safety of the MBTA's customers. However, we believe that it is prudent, given the amount of funds at risk, for the

MBTA to consider the OSA's recommendation to utilize other methods of fare collection, including downloadable mobile tickets, in place of the Speedy Boxes.

APPENDIX

Procurement Process for the Installation and Management of the MBTA's Automated Fare Collection System

The MBTA's first attempt to modernize its fare collection system was a solicitation to bidders entitled MBTA Rapid Transit Fare Collection System Replacement, which was issued in 1994 via a Request for Proposals (RFP). This RFP, which was issued under the federal guidelines for competitive bidding procedures, invited bidders to submit proposals in accordance with contract specification for the delivery and installation of AFC equipment throughout the MBTA.

Three firms—Scheidt & Bachmann USA, Inc., (S&B), Thorn Transit Systems International, Ltd., (Thorn) and Cubic Transportation Systems, Inc., (Cubic)—submitted proposals for the delivery and installation of the proposed 1994 AFC system. In November 1995, the MBTA awarded a $39.9 million contract to S&B based on price and highest-rated technical quality. However, the awarding of that contract was legally contested by both Thorn and Cubic on the basis that the Massachusetts General Laws require that the construction work necessary to install the AFC system equipment be awarded through a sealed, competitive-bid process. After a 1996 court ruling in favor of the plaintiffs, the MBTA was directed to issue an RFP for the design and delivery of the AFC equipment and to utilize a sealed, competitive-bid process for the installation of that equipment.

The MBTA did not make another attempt to modernize its fare system until 2001. During the interim, new technologies were being developed by the transportation fare equipment industry. The MBTA decided that, at a minimum, any future replacement fare system would have to include the following features:

- Smart card technology: Pocket-sized cards with embedded integrated circuits that utilize radio frequency identification to allow reading by AFC fare equipment.
- CharlieCards: Plastic stored value tickets utilizing smart card technology.
- CharlieTickets: Paper stored value tickets with magnetic strip.
- Monthly passes.

Finally, it was decided that the AFC system would have to allow for flexibility in purchasing fares by cash, credit, or debit cards and would have to process the transportation revenue of the MBTA in a secure and technologically driven way.

With the aforementioned goals of improving the functionality and accountability of its fare collection system, on October 19, 2001 the MBTA issued RFP No. 35-01 to solicit proposals for the furnishing, design, manufacture, delivery, activation, and oversight of an AFC system. The AFC Phase 1 was designed to replace the current cash/token-based system used on subways, trolleys, and buses with fare vending machines (FVM) at these locations. MBTA riders would be able to purchase fare media at FVMs with cash, credit, and debit cards. Bus and trolley fare boxes would accept cash, monthly passes, and stored value smart cards, such as CharlieTickets and CharlieCards.

RFP No. 35-01 was issued under the federal guidelines for competitive bidding procedures and included weighted selection criteria that factored price at 45% and technical quality at 55%. Four firms submitted proposals, which were received on February 15, 2002. The MBTA's evaluation committee deemed two of the four bidders as unresponsive to the bid requirements. The two remaining bidders, Cubic and S&B, were allowed to continue through the competitive negotiation process. On July 11, 2002, the MBTA Board of Directors voted to award the AFC procurement contract to S&B for $75,042,016.

As a result of a significant bid reduction by S&B as well as other bidding concerns, Cubic filed various legal and administrative appeals protesting the contract award to S&B based on the following claims:

- S&B planned to manufacture AFC components in Germany and Belgium, in violation of the Federal Transit Administration's "Buy America" standard that these components be manufactured in the United States.
- Because S&B had never produced a working fare box, it would be unable to meet the technical specifications of the contract.
- S&B's final bid price was unrealistically low and therefore should have been rejected by the MBTA.
- The MBTA unfairly favored S&B when it changed the schedule for fare box installation.
- S&B could not meet the original 100% performance bond requirement that the MBTA unfairly reduced to only 50% of the contract price, thereby favoring S&B.

On February 4, 2003, after the Appeals Court denied Cubic's petition,[2] the MBTA signed the $75,042,016 AFC contract, whose completion date was extended from December 31, 2004 to September 2006. From December 15, 2003 to August 6, 2009, the MBTA approved 15 change orders to the contract with S&B valued at approximately $19.6 million, which increased the final contract costs to $94.64 million.

On October 4, 2005, in accordance with a 1996 court ruling requiring that the installation of the AFC equipment be awarded on a sealed competitive bid basis, the MBTA awarded a $22.9 million contract to City Lights Electrical Co., Inc. Upon the contract's completion in February 2008, approved change orders had increased the final contract cost to $ 33.5 million.

In order to effectively and efficiently manage a procurement contract of this magnitude, the MBTA entered into a $5.7 million contract (including amendments) with Parsons Transportation Group (PTG) on February 1, 2001 to support the different phases of the AFC project. The following activities are examples of PTG's contracted duties:

- Performing production acceptance testing of fare boxes.
- Monitoring AFC equipment.
- Conducting periodic revenue audits to ensure the accuracy of AFC system.
- Reviewing engineering change orders.

On May 22, 2007 (two years after the AFC system was originally installed), as part of the final amendment to the Service Agreement between the MBTA and PTG, the MBTA agreed to pay PTG $52,330 to develop policies and procedures for reconciling AFC system revenues to the MBTA's internal accounting systems in the following agreed-upon areas:

- Reporting and reconciling AFC revenues and posting them to the general ledger.
- Reporting and reconciling corporate pass program revenue.
- Reporting and reconciling AFC system revenues in the MBTA's Cash Processing Center (CPC), including investigating variances.
- Conducting periodic audits by MBTA staff.

[2] On February 27, 2003, Cubic's final petition for relief was denied by the Massachusetts Supreme Judicial Court.

- Removing and resetting vaults.
- Validating, reconciling, and investigating cash count variances between AFC-reported amounts and those of the CPC's NamSys reporting system.
- Investigating vault deletions or instances in which vaults are mistakenly combined.
- Counting and depositing CPC cash.
- Investigating daily variances of credit/debit transactions and verifying the accuracy of fees deducted by third-party services.
- Monitoring, identifying, and investigating fraud.
- Safeguarding CPC revenue keys.
- Inventorying all spare coin and bill vaults.