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A Complete Analysis of The Bus Revenue Collection System Reconciliation Process

Contract No.: IL-06-0077

March 1994

Prepared by

CHICAGO TRANSIT AUTHORITY

Finance Department

Revenue Equipment Technology & Maintenance

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The purpose of these tests was to follow the collection and reconciliation of bus revenue from beginning to the end, analyze these processes, and determine possible sources of discrepancies between data and actual counts of revenue. It was also an effort to determine how well the equipment itself was working. It is important to note that these tests were not an attempt to determine, expose, or in any way suggest revenue loss due to mishandling.

16. Abstract

The purpose of this report is to describe and analyze the equipment, procedures and security measures used in collecting and reconciling bus farebox revenue. The process is followed completely from the deposit of fares into the farebox, through vaulting and emptying the cashbox, to counting and depositing the revenue into the bank.

During the course of this process, events occur that render the farebox data difficult to reconcile with the contents of the farebox cashbox. The source of these difficulties could be electronic malfunctions in the farebox, communication glitches between the farebox and the data system, procedural elements, or some other difficulty in the system.

In the analysis, we examined the process by observation and testing. We divided the tests into three (3) parts: In the first part, we deposited some predetermined fares into the farebox, then checked this with the recorded and transmitted data to search for discrepancies. The second part consisted of counting the contents of individual cashboxes and comparing what we counted with what the data reported. The third and final part involved carefully counting the contents of a number of vaults and comparing our counts with the data recorded.

During these series of tests, we made important observations of procedures and practices, and included them as part of our total study. Our findings, comments and recommendations are presented in this report.

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PREFACE

In a transit system as large as the Chicago Transit Authority, there will probably always be difficulty in perfect reconciliation of any revenue collection process. With the high volume of cash, the number of steps involved and the quirks associated with serving the public, finding an absolute foolproof method of revenue reconciliation is not a simple task.

With high volumes of cash in a system where revenue is collected at numerous locations, including *moving* locations, the problems become obvious. There will always be the opportunity for shrinkage. Due to the high number of fares received, manual collection and registration of fares are inefficient and inaccurate. In addition, electronic equipment is likely to malfunction in such hostile environments as a rail station or a moving bus.

Since the revenue is collected from many different locations and the system is so large, collection of revenue requires several steps to bring it together and reconcile it with what is expected or calculated. Unless these steps are performed perfectly, there will be mistakes, human or otherwise, somewhere along the line.

Serving the public has never been an easy chore. The idiosyncrasies of the public require judgement calls and exceptions to rules on a regular basis. How does the bus driver handle the passenger who has paid $1.15 of a $1.20 fare, then realizes that the passenger has no more money? The answer is a judgement call. However, no matter what the decision, there will be no reconciliation of the fare for that passenger.

There are also concerns that employees may be involved in intentionally defeating the reconciliation efforts. These concerns range from employees purposely recording data incorrectly to theft.

However, such presumptions or accusations are irresponsible at best without knowing the integrity of the revenue collection system data and the reliability of revenue collection equipment. Research has shown such decisions have been made on *estimated* data. Part of our task here is to test and verify or discredit the revenue collection system before attempting to attribute discrepancies to any other source.

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Special Thanks to *James Connelly*, Manager of the Central Counting facility and the entire *Central Counting Staff* for your patience and assistance. Special Thanks also goes out to the entire testing "crew": *John M. Kowalski, Charles J. Karneffel, Christopher G. Julun* and *Edward J. Fabsits*. In addition, thank you for *Bruce Moffat* from Capital Investment for his insightful comments while patiently monitoring the progress of this project.

This report is the product of the hard work and cooperation of those mentioned above, without whose help we could never have completed this analysis.

March 1994

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ABSTRACT

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During the course of this process, events occur that render the farebox data difficult to reconcile with the contents of the farebox cashbox. The source of these difficulties could be electronic malfunctions in the farebox, communication glitches between the farebox and the data system, procedural elements, or some other difficulty in the system.

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The purpose of these tests was to follow the collection and reconciliation processes of bus revenue from beginning to end, analyze these processes, and determine possible sources of discrepancies between data and actual counts of revenue. It was also an effort to determine how well the equipment itself was working. It is important to note that these tests were not an attempt to determine, expose, or in any way suggest revenue loss due to *mishandling*.

This work is supported by the Federal Transit Administration under Contract No.: IL-06-0077.

I. COMPANY PROFILE:

The Chicago Transit Authority (CTA) is a 24-hour, 7-day-a-week public transportation agency providing service to the entire city of Chicago and eleven (11) surrounding suburbs. This service is provided using both bus and rail systems, and covers 2,092 miles of bus routes and 215 miles of rail tracks.

The bus system serves 12,900 bus stops while the rail system connects 142 stations. Combined, the two systems provide approximately 530 million passenger trips yearly, and collect over $350 million in revenue. Bus farebox receipts account for approximately 80% of the total fare revenue collected [1].

The CTA is made up of several different departments, each headed by a vice-president. Each department plays a vital role in fulfilling CTA's main goal: To provide convenient, efficient public transportation service to the Chicago metropolitan area.

The Finance department of the CTA handles all aspects of the CTA that deal with receiving, distributing or investing monies. This includes payroll, funds used for purchasing, fare media sales, etc. For the purpose of this report, only the bus fare revenue collection aspect will be addressed.

Sections of the Finance department that handle the fare revenue collection aspect are: Treasury, Revenue Equipment, and Central Counting. Each section has a special and necessary place in the revenue processing system.

A. Finance Department, Treasury:

The Treasury section of the Finance department is responsible for the field collection of revenue. For the rail system, collections are made from the turnstiles and vending machines by Treasury personnel. (The agent and conductor's revenues are currently handled by a different department, but will soon be handled by the Treasury section of the Finance department.)

For the bus system, Treasury personnel are not directly involved with removing the cash from the buses to the vaults. The Maintenance section of the Operations Administration department provides this service to Treasury. Operations personnel move the actual vaults from

the vault islands to the Central Counting location. Each vault contains the revenues of many fareboxes.

The Treasury section is also responsible for handling all receipts of fare revenue not collected in the field. This would include pass and token sales from designated outlets and CTA facilities.

B. Finance Department, Revenue Equipment:

The Revenue Equipment section is comprised of two areas: the Technology subsection and the Maintenance subsection, and is responsible for the operational design, procurement, testing, installation and maintenance of all revenue equipment for both bus and rail. This equipment includes bus fareboxes, collection vaults, turnstiles, agent's registering equipment, fare media vending machines and the computer network involved in obtaining all data associated with revenue equipment. The bus fareboxes and associated equipment are the equipment tested for this report.

The Revenue Equipment section is also responsible for data collection concerning ridership and revenue collection. A computer-controlled electronic data collection system is currently in use for the bus system and will be described in detail later in this report.

1. Revenue Equipment Technology:

The Revenue Equipment Technology subsection is responsible for operational design, procurement and testing of all revenue equipment used by the Chicago Transit Authority. The functional specifications for equipment are defined by this group as well.

Revenue Equipment Technology is also responsible for the maintenance of computer components in the field and office associated with Revenue Equipment, and is responsible for revenue collection data analysis and management.

2. Revenue Equipment Maintenance:

The Revenue Equipment Maintenance subsection is responsible for all maintenance of and procurement of parts and material for revenue collection equipment such as fareboxes, turnstiles,

vaults, parking lot gates, etc. This subsection includes both field personnel and shop operations. Revenue Equipment Maintenance is also responsible for installation of new/replacement equipment on buses and at rail stations, and for tracking all revenue collection equipment throughout the system.

C. Finance Department, Central Counting:

The Central Counting section of the Finance department is responsible for counting all collected revenues. This includes all turnstile, agent, vending machine and bus farebox receipts.

The cashboxes collected from the turnstiles and vending machines, the vaults gathered from the bus garages and the bags collected from the rail terminals for the agent's and conductors are all brought to Central Counting where they are opened and the contents are counted.

D. CTA Bus Garages:

1. Operation of Bus Garages:

In addition to normal maintenance functions, the bus garages serve as the "storage area" for off-duty buses. Here, bus operators check in and start their assignments. When an operator boards his/her bus at the start of a shift, it has been cleaned, washed, checked for major problems and the farebox has been cleared of revenue.

When an operator takes a bus out on a specified route for a specified number of trips, this operator is completing a *"run"*. Runs are usually the same for all weekdays. There are also Saturday and Sunday schedules. On holidays, CTA uses the Sunday schedule.

When an operator brings a bus back to the garage for whatever reason, it is standard operating procedure that the bus goes through the *vault island* first where its farebox is cleared of all revenue. In addition, when buses are moved for maintenance reasons or moved to another garage as a supplement, they are required to first go through the vault island upon arriving at that garage.

2. Locations of Bus Garages:

The nine (9) bus garages in the CTA's system are located throughout the city of Chicago. While none of the garages are located in the downtown area, they are sufficiently spread throughout the city to serve all areas. There are three (3) garages on the north side of the city, three (3) on the south side and three (3) in the "central" area of the city.

II. BUS FARE COLLECTION OPERATION:

(See Section entitled *"Photographs"*)

A. Operation of the Electronic Farebox:

The mechanical aspect of the electronic farebox collection procedure is based on a closed system. In a closed system, once a passenger deposits a fare, the money cannot be handled by human hands until it is counted and prepared for shipment to the bank.

With older fareboxes, the CTA experienced problems with dollar bills becoming stuck in the top part of the farebox, and in the area between the inspection plate and the cashbox. Jammed fareboxes and exposed bills became a regular occurrence. In addition, the farebox was non-registering requiring the driver to count the deposited fare.

The farebox (and associated systems) currently in use by the CTA was installed in 1985. It was manufactured by GFI/GENFARE and is called the "CENTSaBILL " farebox, named for its ability to process both coins and bills. It is also fitted with an integrated swipe magnetic card reader. It solved many problems that were resident in the older system. The new farebox can accept dollar bills and count them. All U.S. coins and as many as three different sized tokens can be accepted and counted. Furthermore, the driver can register different types of passengers using a numeric keypad located on the driver's side of the farebox. There is an alphanumeric Light-Emitting Diode (LED) display, also located on the driver's side of the farebox, which aids in confirming deposited fares and registration keys.

The counting and registering systems on these fareboxes are microcomputer controlled. This provides invaluable fare collection and ridership information that is easily retrievable.

The collection system consists of many components including the farebox itself and the receiver vaults. The farebox contains a cashbox where the bills and coins are stored separately after a passenger inserts a fare and the passenger is registered by the driver. The receiver vaults are where the cashbox is emptied and are located at a certain point at each garage facility referred to as a *vault* or *pulling island* where the

cashboxes are removed from the fareboxes and emptied into the receiver vault.

1. Operation of the "CENTSaBILL " Farebox:

A boarding passenger may pay the required cash fare by inserting tokens, coins and/or dollar bills into the farebox. A passenger may also pay the required fare by using a magnetically encoded pass, a flash pass or a transfer.

The coin mechanism in the farebox measures the diameter of the coins inserted into the coin slot and the velocity that the coins are traveling to determine their value. The coin mechanism has the capability to read the coins whether they are inserted one at a time or in groups. The calculated diameter of the coin is compared to the known diameter of acceptable coins or tokens. If it is a coin, a "value" is assigned to that coin corresponding to its true face value.

The bill mechanism in the farebox measures the length of the paper inserted. If the paper is the length of a dollar bill, within certain tolerances, then it is counted as $1.00. In the farebox computer, a bill is defined as being 4.5" to 9.5" long. This accommodates the tolerances mentioned above. The actual length of a dollar bill is approximately 6.125". Tickets are defined as 2.5" to 4.5" long. A "bill too short" definition is applied to paper that is 1.25" to 2.5" long. The bills must be inserted one at a time. Anything inserted that is shorter than a dollar bill (passes, folded bills) is assigned no value and registered as a ticket in the computer memory.

Both the coin and bill mechanisms are equipped with inspection areas where the money is stopped in a vertical manner such that the driver may inspect the money and verify its validity. Since the mechanisms do not provide extensive tests on the inserted money, the driver's inspection serves as an extra step to limit the amount of counterfeit or invalid coins and bills.

The farebox will automatically count and total all revenue inserted, with or without any action from the operator. However, the farebox computer software will allow "classification" of the

revenue as it is processed by the farebox. Nine of the keys on the numeric keypad are used to classify and record different fare types such as full fare with transfer, reduced fare, transfer received, monthly pass, full token, etc. Each key is preprogrammed with either a revenue value, or a tally feature where no monetary value is used (such as transfer received).

When inserted into the farebox, the fare totals are displayed on the driver's side of the farebox using a series of seven-segment LED's. In addition, the information is stored on the farebox's computer RAM (Random Access Memory).

When the driver presses one of the keys on the numeric keypad, the appropriate fare amount is subtracted from the displayed (deposited) amount. If the displayed amount is identical to the amount associated with the pressed key, the revenue is dumped into the cashbox, the memory records the fare type, and the display resets to zero.

If the displayed amount is less than the keyed amount, then the indicated fare type is shown to the driver on the display, the money remains in the inspection area, the displayed amount does not change, and there is no record made in the memory. The passenger must then insert the balance of the required fare, or the bus driver must dump the money that has already been inserted.

If the displayed amount is more than the keyed amount, the appropriate fare amount is subtracted from the displayed amount, a record of the transaction is made in the computer memory, and the money remains in the inspection area until the balance of the inserted money is accounted for or dumped by pressing a "dump" button. All revenue dumped using the "dump" button is recorded in the memory as "unclassified revenue." In addition, the pressing of the dump button is recorded in a "dump count" register.

If a passenger inserts a fare and it is not registered within sixty (60) seconds, the monies will automatically dump into the cashbox without action from the driver. The amount that was counted will be added to the RAM record of total revenue

collected, but will not be attributed to any particular fare type. The monies will also be added to the "unclassified revenue" record.

In addition, there are sensors located near the top of the coin inspection area. When numerous coins stack up in this area and touch these sensors, the coins are automatically dumped into the cashbox so that there is no interference with the coin mechanism.

The magnetic card reader saves time and effort for both the bus operator and the passenger. The magnetic stripe technology provides adequate security and relieves the driver of pass verification duties.

With the current fare structure in effect, however, there is a new variation to the pass user. A passenger is required to deposit 25¢ with the use of a monthly pass. When a valid pass is swiped and the 25¢ is deposited, this automatically activates the opening of the inspection plate, and the money drops directly into the cashbox. This does not allow the driver to inspect the money. Later inspection of slugs revealed that there are many slugs which will register as a quarter in the bus coin mechanism. A passenger using a pass has the opportunity to use "fake" quarters and avoid the 25¢ pass usage charge.

2. Generation of Route/Run Records:

A Route/Run record is a series of specific register readings which correspond to the amount of revenue and passenger counts for a given bus route or even a specific run. A Route/Run record is generated whenever a new event occurs in the farebox. The farebox has forty-six event types defined, which include driver log-on, security alarms, and maintenance diagnostics. Also included in event types is the switching from Peak to Off-Peak mode (a designation to indicate rush hour). The farebox also has up to six programmable time stamps which will create a new route/run record when a specified time of day occurs.

B. Operation at the Vault Island:

1. Transfer of Farebox Data to Computers:

All the information in the various revenue and passenger count registers is stored in the farebox RAM. This information is read with a device referred to as a *"data probe"*. The data probe is a self-contained, hand-held unit which is cable connected to a computer located in a room designated for Revenue Equipment personnel. This room is located very close to each vault island. The probe has an LED and a photo-transistor mounted at its end.

The probe receives light pulses generated and transmitted from within the farebox. These "light pulses" are the data collected by the farebox in optical form. Within the probe, the pulses are converted to electrical pulses and transmitted via cable to the probing computer. When the data is checked and accepted by the computer, an acknowledge signal is transmitted by cable and probe back to the farebox.

This process is called "probing". Each time a bus leaves the street and pulls into a bus garage, policy dictates that the farebox on that bus is probed at the vault island so that all data may be collected and all revenue can be removed. All data stored since the farebox's last probing is downloaded to a *probing computer* located inside of the room occupied by Revenue Equipment Maintenance field personnel. This information is then sent via modem to a central computer, called the *Network Manager*, where all garages farebox information is handled. The probing computer and the Network Manager will be explained in the next section. In addition, the receiver vaults (described below) are communicated to the probing computer via the vault island computer. This computer is located in the same room as the probing computer. (Please see *Diagram II*).

The transmitted data includes the unique electronic identification carried by each cashbox. The computer also identifies the vault that the cashbox was dumped into, and how much revenue should have been collected in a particular vault.

2. *Transfer of Farebox Revenue to Vaults:*

Located on the vault island is a large steel housing called a *shroud*. The purpose of the shroud is to house and secure the *receiver vaults* into which farebox receipts are dumped. These

shrouds are bolted to the vault islands so that they are permanently fastened.

When a bus pulls through the vault island, the box-puller records the bus number and farebox number on a form. When the receiver vault is picked up by a vault truck, this form is stored and locked in a small compartment at the top of the receiver vault. This serves as a paper record of what the probing computer records automatically.

After recording the farebox information, the box-puller then probes the farebox with the data probe. After the probe computer receives and acknowledges that the data has been sent, it transmits an electronic lock code to the farebox which unlocks the farebox pedestal cashbox door.

The box-puller can now remove the cashbox. In order to remove the cashbox from the farebox, the cashbox lid must be closed. Once removed, the cashbox is turned upside-down, inserted into a receiver vault, and the cashbox handle is turned to the unlocked position. The receiver vault door is then closed, and the receiver handle is turned 360 degrees clockwise.

As the handle is turned, it locks the receiver door. This prevents the receiver from being opened until the end of the vaulting operation. A timer is activated to insure that the cashbox has sufficient time to empty. There is a time delay of five (5) seconds to allow all of the revenue to fall from the cashbox. There are two lights on top of the shroud. A red one activates when the timer begins, and a green one activates when the timer ends indicating that the cashbox may be removed.

The cashbox lid is held in place while the cashbox housing is pulled into the vault cavity thereby allowing the contents of the cashbox to fall into the vault.

The box-puller then turns the receiver handle back into its original position, which pulls the cashbox forward closing the lid and unlocking the receiver door. The receiver door is opened, the closed cashbox is removed and returned to the bus farebox. Note

that the bills and coins are kept separate in the cashbox as well as the receiver vault.

An interlocking system within the receiver prevents the contents of the vault from being exposed at any time before arrival at Central Counting. A security lock is used to lock the receiver access door of the vault.

C. Bus Data Collection System:

1. Function of the Probing Computer and the Network Manager:

The main purpose of the probing computer is to record the information collected by the fareboxes while they were in service.

As each farebox is probed and its data sent to the probing computer, the computer appends the information to a file which contains the information from all fareboxes probed that day. This file is "closed" at 3:00 a.m. every day and a new file is created to start storing the information from the fareboxes probed on the new transit day. Then, each of the nine computers at the nine bus garages is called by the Network Manager, and the "closed" data file for the previous day is transmitted from the garages. It is at the Network Manager that the data is verified and checked for discrepancies.

The data analysts require a password to gain access to the Network Manager. A program on the Network Manager called Data Check is used to verify and check the files for discrepancies. This program compares the route/run records with a "master list". The master list is a separate running total of all the revenue and passenger information, while the route/run records are individual event totals.

The sum of each field in all the route/run records should equal the master list for each of those same fields. If Data Check finds that a probing has one or more problems, it will identify them and attempt to "repair" the discrepancies. For example, if the data showed that a cashbox collected 9,999 quarters, or some other impossible case, Data Check will see this as incorrect. It will then

mark the probing record so that when the information is printed, it shows that Data Check attempted to modify the records.

Any probe record that passes these tests is then subject to a second test. Data Check will compare the master list with a list of maximum values for each field. If any such field is too large, Data Check will flag the condition. It does not modify the master list in this case.

D. Operation at Central Counting:

Vaults are collected from the bus garages on a daily basis. These vaults are delivered on vault trucks to Central Counting where they are unloaded and prepared for emptying and counting. Once emptied, these vaults will be returned to the bus garages where they will be used again. (Note: There are cases where the vaults are not exchanged promptly at garages, and they arrive at Central Counting overloaded.)

Once at Central Counting, the vaults are recorded and tagged with the name of the garage they originated from.

When a vault is ready for processing, Central Counting personnel first remove the bin which holds bills. This bin is marked with the name of the garage and put aside until it is ready to be sent to the bill processing area.

1. Central Counting Building Layout:

The Central Counting facility is located in a two-story building that was originally built in the year 1906 as a bus barn. On the first floor, it was designed as a bus driver check-in facility in the past. Currently, it is used as the coin processing and counting area. Also, located on the first floor are the storage vault and the supervisors' office. The first floor also accommodates the token packaging area. Separating the coin counting and token packaging area is the drive bay where trucks and other security vehicles enter Central Counting. It is on the first floor that all pickups and deliveries of receiver vaults, revenue, etc. are made.

The second floor was an auditorium and waiting room for the transportation personnel and it is currently used as the bill

processing area and the rail revenue processing area. These two sections are divided by a partial wall. Also, located on the second floor are the manager's office and the administrative office.

Both floors have lunchrooms, men and women's restrooms and locker rooms.

2. *Handling of Coins:*

The vault itself is hoisted and placed upon a platform which is attached to a large CTA-built coin sorting machine (internally referred to as the "shaker" because it sifts the coins through several huge plates by mechanically shaking the plates). A small door at the bottom of the vault is unlocked and opened. The coins inside the vault fall freely into a square funnel-shaped receptacle where they are sifted through to a conveyer belt and are transported to the coin sorting machine.

As the coins are sorted, they are sent through individualized chutes and fall into electronic coin counters. The counters serve the dual purpose of counting the coins and verifying the validity of the coin once they leave the coin sorting machine. These counters have bags which hang underneath the machines and catch the coins after they have been counted. Each counter is set up to handle a different denomination of coin or token. The counters are also set up to pause once a certain number of coins are counted so that coin monitoring personnel may replace a full bag with an empty one. Full bags are sewn shut, weighed, labeled and prepared for shipping to the bank where they will be deposited.

3. *Handling of Bills:*

The procedure is to place the bill bins into the large vault until they can be processed on the second floor. Exceptions to this procedure are when the vault is already full and cannot accept more bill bins or when specific vaults are being segregated for a special count The bill bins, after being removed from the vaults, are sent to the second floor of the Central Counting Facility through use of a dumb waiter or moved into a large stationary

vault for safekeeping until they can be processed. The contents of the bill bins are emptied onto one of four processing tables. The processing table personnel have one duty: to straighten and "face" the bills so they may be counted quickly. ("Facing" the bills is required by the bank where the revenue is deposited. A processing fee is charged for bills not faced in the same direction.) In addition, any mutilated bills, public aid vouchers, transfers, foreign material, trash, and denominations other than $1.00 are separated from the stacks at the processing tables.

The actual counting of the bills is done by bill counting machines. Each machine requires one person to operate it. After the bills are counted, they are wrapped in "bricks" of $2,000.00 each. These bricks are then grouped and wrapped in plastic. Each plastic bundle holds ten (10) bricks ($20,000.00).

The bundles are then ready for shipment to the bank for deposit.

4. *"Flash" Sheets:*

At the end of a counting day, a balance sheet is generated called a "flash" sheet. (Please see *Table I*). This sheet utilizes the revenue information collected by the bus data system and matches it against what was actually counted on a vault-by-vault basis. This sheet is signed by the Manager of Central Counting and sent to the vice-president of Finance.

III. FARE STRUCTURE OF THE CTA BUS SYSTEM:

Before a bus farebox can become operational, a driver must log on using the "#" key, and must enter an identification number and run number. Once this is done, the driver must set the farebox in the appropriate "mode" of operation. On the bus system, there are four modes of operation. They are: Off-peak, Peak, Bypass and "Lift". Each mode sets the farebox registration features differently. Some of the keys on the keypad take on different values (or no value) depending on which mode the farebox is in.

It is important to note that the bus operator activates these modes manually through the keypad. This is driver-activated so that there are limited complaints by passengers who board near the same time at a particular stop. For example, a passenger boarding at 5:59 a.m. should technically pay less than someone boarding behind him at 6:00 a.m. The driver can allow the passengers at a particular stop all board for the same fare then change the mode between stops.

For reference, the keypad values are displayed to the driver in the following chart, known at CTA as a "bingo card":

[1] $1.20 --------- $1.50	[2] $1.50 --------- $1.80	[3] Transfer received
[4] 55¢ --------- 65¢	[5] 70¢ --------- 80¢	[6] Pass
[7] Pass + 25¢	[8] Free riders	[9] 25¢
[*]	[0] Holds monies displayed (60 seconds)	[#]

The key designations are:

1	-	Full fare, no transfer
2	-	Full fare with transfer
3	-	Transfer received
4	-	Reduced fare, no transfer
5	-	Reduced fare with transfer
6	-	Pass
7	-	Monthly Pass plus 25¢
8	-	Free Riders
9	-	Express Bus Surcharge
*	-	Tally key for special counts such as free riders on New Year's Eve

Note that the "#" key has no function in registering fares. Also note that keys 3, 6, 8 and "*" have no value associated with them, and serve only as tally keys in all modes.

A. **Off-Peak Mode:**

The off-peak mode is the most commonly used of the four modes. "Off-peak" refers to the time of day when bus ridership is lowest. This would be during non-rush hour periods which are from 9:00 a.m. to 3:00 p.m. and 6:00 p.m. to 6:00 a.m. During these periods, passengers paying a full or reduced (half) fare pay the basic bus fares. Keys 1, 2, 4 and 5 on the numeric keypad take on the upper (cheaper) fare value.

When the farebox is in the off-peak mode, for example, key #1 subtracts $1.20 from deposited monies (if deposited monies is greater than or equal to $1.20), and registers one full fare passenger with no transfer.

B. **Peak Mode:**

The peak mode is used during the rush hour periods, when bus ridership is highest. They are from 6:00 a.m. to 9:00 a.m. and 3:00 p.m. to 6:00 p.m. During these periods, passengers paying a full or reduced (half) fare pay the premium bus fare (please note that rail passengers pay this fare set at all times of the day). Keys 1, 2, 4 and 5 on the numeric keypad take on the bottom (higher) fare value.

When the farebox is in the peak mode, for example, key #1 subtracts $1.50 from the deposited monies (if deposited monies is greater than or equal to $1.50), and registers one full fare passenger with no transfer.

C. **Bypass Mode:**

The bypass mode is used by drivers primarily after they have detected a functional problem with the coin mechanism and a supervisor authorizes use of the bypass mode. In the bypass mode, the driver uses a lever to physically move the farebox coin mechanism from its normal operating position. In its new position, the coin mechanism's counting abilities are suspended, and deposited coins are drop directly into the coin inspection area. Bills are still counted by the farebox and the bill revenue is added to the total farebox revenue. However, the driver's alpha-numeric display does not show any revenue amounts.

All fare-registering buttons now take on a tally function, and simply count the type of passenger. The fare must be visually verified by the driver.

The money will not dump into the cashbox unless one of four default "dump" actions occurs:

i. The driver presses the "dump" button located near the numeric keypad
ii. The money sits in the inspection areas for 60 seconds
iii. The coins stack up until they activate the automatic dump sensors
iv. The revenue display counter goes over $9.99

When a bus that has operated in bypass mode arrives at its garage, it is immediately probed, the cashbox is dumped, and a farebox field technician is standing by to perform immediate repairs.

D. **Lift Mode:**

The Lift mode is used only on buses equipped with wheelchair lifts. When a passenger requiring use of the lift boards a bus, the driver puts the farebox in Lift mode. Once the Lift fare is registered, it is recorded as a lift event in memory and the farebox automatically returns to the previous mode.

IV. FAREBOX RECONCILIATION PROCESS PROCEDURES:

It was determined that the most logical way to approach this series of tests was to simulate what happens on a bus that is in service. With this in mind, the entire bus revenue path would be followed, inspected, tested and analyzed from beginning to end.

During these tests, the engineers, analysts and technicians performing the tests would require guidelines and attention to detail that may have seemed cumbersome and unnecessarily tedious to those who performed certain duties everyday. However, all steps taken in these tests were necessary to efficiently analyze the system and produce accurate results.

The purpose of these tests was to follow the collection and reconciliation processes of bus revenue from beginning to end, analyze these processes, and determine possible sources of discrepancies between data and actual counts of revenue. It was also an attempt to determine how well the equipment itself was working. It is important to note that these tests were not an attempt to determine, expose or in any way suggest revenue loss due to *mishandling*.

There were four (4) different tests that were performed in an effort to fulfill the objective of this report. They were:

A. Farebox Registration Test;

B. Farebox Cashbox Revenue Audit Test;

C. Receiver Vault Revenue Audit Test; and

D. Receiver Vault Exposed Revenue Test

A. Farebox Registration Test:

1. Description of the Test:

This test was performed on individual fareboxes at each of the 9 garages in CTA's bus system. A sample size of ten percent (10%) of all fareboxes was used. This produced a sample field of 245 fareboxes.

In this test, buses were selected at random as they were encountered in the garage parking areas. Each bus garage was completed in one day to avoid the possibility of performing the test on the same farebox more than once.

The testing group consisted of two people in order to help minimize mistakes in the test procedure. One of the testers would deposit fares while the other would register them and record problems. In addition, the testing group used security related equipment, such as special locks and keys, to perform these tests. It was determined that the equipment would be safer if protected by more than one individual.

Before each farebox test, the testers would swipe a maintenance pass through the farebox magnetic card reader. By doing this, the data created by the testing would be stored in a separate record. This would ease the data analysis to be performed later.

The test consisted of depositing multiple fares as a passenger would deposit fares. The types of currency used included one dollar bills, quarters, dimes, nickels, pennies, and full and reduced fare tokens. Magnetic passes were also used for the test. The determination of the number of coins, bills and passes used in the test was based on the percentages of coins and bills collected in the field on a daily basis. For example, if 15% of the coins collected on a typical day were full-fare tokens, then the full-fare token test was used to make up 15% of the farebox registration test. Each non-value (tally) key was simply tested in accordance with its key number. (Please see *Table II* for Test Procedure Chart).

A total of sixty-five (65) separate fare registrations were performed on each farebox. As each registration was recorded, any mis-registrations or other problems were noted and used to later reconcile the data collected from these fareboxes.

Most of the fareboxes were probed as part of normal operations within a day of the testing. The information was sent to the Network Manager, retrieved and processed. The analysis and results are included in this report.

It should be noted that there were a limited number of fareboxes that had problems so severe that the test procedure could not be completed. These fareboxes served as examples that bus operators do not always report farebox malfunctions as they occur[1]. The problem fareboxes found during the testing were marked for repair by the testers as they were encountered. The majority of these buses *are included* in the final analysis of results. Only five (5) buses that were encountered had farebox problems so critical that the testing could not be performed at all.

Also note that this was the third time this test was performed. There were two fare changes during the development of this report. Each fare structure changed the testing procedures significantly. For example, in the tests prior to this one, there was no fare type that required a passenger to deposit twenty-five cents (25¢) with a monthly pass. As expected, a few of the limited number of registration problems were associated with this new fare type.

2. Purpose of the Test:

This test was performed in an effort to determine the overall registration accuracy and operational dependability of the fareboxes in the system.

The data analysis would also show the registration accuracy of the computer and the subsequent downloading of information from the fareboxes to the probing computer, and from the probing computer to the Network Manager.

B. Farebox Cashbox Revenue Audit Test:

1. Description of the Test:

This test was performed on individual fareboxes at all nine garages. Fifteen cashboxes were used at each garage for the test. A total of 135 cashboxes were originally collected, of which 133 were used in the subsequent analysis. The two cashboxes

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1 It is standard operating procedures for a bus operator to report all farebox malfunctions upon arriving at the vault island.

that were not used were from fareboxes that had been put in bypass mode by the driver, and would have provided useless data.

In this test, buses were selected at random as they pulled into the vault island for normal vaulting. Each bus was probed as usual. When the cashbox was removed, instead of being dumped into the receiver vault, the testers dumped the cashbox into an "audit cart" which allowed the contents of the farebox to fall freely into canvas money bags. The cashbox was then returned to its farebox.

Each selected cashbox was dumped into a separate bag. These bags were tightly closed with secure fasteners, then tagged with the bus and farebox numbers. The test at each garage was performed on the same pulling island so that the vault number would be consistent and the "test" money could be included in that vault's revenue count when it was processed.

The bags were transported to Central Counting where they were secured until the testers could count the contents on the following day. Two testers were used for this test to minimize human error and increase efficiency. At Central Counting, one tester counted bills while the other counted coins. Once counted, the money was turned over to Central Counting personnel for further processing and preparation for deposit.

The final counts would be compared with the total amount registered and downloaded to the Network Manager.

2. *Purpose of the Test:*

The purpose of this test was to determine the accuracy of total cash registered by the farebox versus actual revenue in the cashbox.

The results of this test would also help to pinpoint the steps in the revenue processing procedure where discrepancies may originate. With this information, steps could be defined as to how to minimize these discrepancies.

C. Receiver Vault Revenue Audit Test:

1. *Description of the Test:*

This test was performed on individual vaults from all nine garages in CTA's bus system. One vault from each of these garages was used for a total of nine (9) vaults. These nine vaults would not be processed as part of the daily routine, but instead as completely separate and special vaults. This measure was taken to ensure the most accurate count.

The bill bins were removed from these vaults and set aside until the testers were ready for them. Before the coins were counted, one of the coin sorting machines was completely cleared of all other coins, slugs, debris and dust. The testers closely supervised the coin counting process making sure that strict guidelines were followed and proper readings were recorded. The cleaning and recording procedures were followed for each of the four vaults.

The bill processing underwent similar supervision. All processing tables and counting tables were cleared of all normal bills, mutilated bills and debris. Each bill bin was assigned to its own processing table. Mutilated bills were counted separately so that the most accurate count was possible.

2. *Purpose of the Test:*

The purpose of this test was to compare the accuracy of the data collected at the vault islands compared to the actual revenue contained in the vaults. Like the other tests performed, it will aid in pinpointing and defining where discrepancies originate in the revenue processing procedures.

By auditing entire vaults, we can compare and analyze data on a larger scale than in the farebox testing. Ideally, the rate of inconsistencies should be constant between the cashbox audit and the vault audit.

D. Receiver Vault Exposed Revenue Test:

1. *Description of the Test:*

This test consisted of observing the vaulting process done at a particular vault between 6:00 pm and 1:00 am, and counting the number of bills that were exposed, completely or partially, during the process. This test was conducted at one vaulting position at each garage for a total of nine (9) observation periods.

The vault island personnel were instructed to handle exposed bills as if the testing personnel were not present. If the box puller discovered exposed bills in a vaulting cycle, the bills were placed in the vault and dumped with no cashbox in the vault.

It should be noted here that six (6) of the nine tests were done *before* a modification to the vault timer was implemented. This modification was made to effect an adjustment that would aid in the timer delay. Before the modification, the timer would occasionally end a vaulting cycle prematurely, possibly hindering proper cashbox emptying.

2. *Purpose of the Test:*

The purpose of this test was to gather data on exposed bills in order to estimate the number of bills that are retained by a cashbox during a normal vaulting cycle. Whereas exposed bills can be removed and manually inserted into the vault, bills retained in the cashbox cannot be manually retrieved and will cause the revenue data to differ from what was actually collected.

Estimation of retained bills would help to identify another source of reconciliation discrepancies.

V. FAREBOX DATA COLLECTION ANALYSIS:

The data from the tests was recorded very carefully. Attention was paid to every detail in an attempt to provide accurate data for thorough analysis and useful information. The following analysis used all of the information provided, whether positive or negative, to give the most complete picture possible of the farebox revenue collection process.

A. Farebox Registration Test:

The test performed on each farebox included a total of sixty-five (65) individual tests. Forty-five (45) of these included a key registration of either a cash fare or a tally or "non-cash" fare. Another ten (10) of these individual tests included a magnetic pass, plus the deposit of twenty-five (25) cents. The farebox automatically records this type of fare and no keys need to be pressed by the operator. The ten (10) remaining individual tests performed were to test the "passback" feature of the magnetic passes.

A comparison between the actual farebox data and what the Farebox Registration Test should have produced in the data shows there are some discrepancies in the final result. The difference between the data and the "test" numbers is caused by coin and bill misreads, keypad keys mis-registration, and human error in the recording of the test itself. (Please refer to *Exhibit I* and *Graph I*).

Keys one (1) through nine (9) fare registrations included cash fares and tally or "non-cash" fares. The overall test procedure should have produced eleven thousand and twenty five (11,025) key counts. The data recorded shows ten thousand, nine hundred and thirty five (10,935) key counts, or a difference of ninety (90) key counts. The accuracy rate for key registration was ninety-nine point one eight percent (99.18%).

Ten (10) of the individual tests included the depositing of a dollar bill into the farebox. The overall test should have produced two thousand, four hundred and fifty (2,450) bills in the data. The data recorded shows two thousand, four hundred and fifty-four (2,454) bills, or a difference of four (4) bills. The accuracy rate for bill registration was ninety-nine point eight four percent (99.84%).

The Magnetic Pass plus 25¢ portion of the test should have produced two thousand, four hundred and fifty (2,450) passes registered. The actual data shows two thousand, three hundred and eighty-one (2,381) passes registered, or a difference of sixty-nine (69) counts. The accuracy rate for magnetic passes plus 25¢ was only ninety-seven point one eight percent (97.18%). The reason for such a poor performance rating was not due to pass reader errors, but to coins being misread or not read at all. The pass plus a quarter fare requires a twenty-five (25) cent (25¢) deposit into the farebox, otherwise the pass is not registered.

The individual tests also included a total of six (6) full fare and one (1) reduced fare token to be deposited into the farebox. The overall test should have produced one thousand, four hundred and seventy (1,470) full fare tokens, and two hundred and forty-five (245) reduced fare tokens in the data. The actual data showed one thousand four hundred and fifty-three (1,453) full fare tokens and two hundred and forty-seven (247) reduced fare tokens, or a difference of seventeen (17) full fare tokens and two (2) reduced fare tokens. The accuracy rate for reading full fare tokens was ninety-eight point eight four percent (98.84%) while reduced fare tokens was at ninety-nine point one eight percent (99.18%) accurate. It should be noted that full fare tokens are the most "misread" coins by the farebox next to Half dollars and Susan B. Anthony (SBA) dollar coins.

B. <u>Farebox Cashbox Revenue Audit Test</u>:

The farebox cashbox Revenue Audit Test consisted of one-hundred thirty-three (133) cashboxes. Fifteen (15) cashboxes were randomly selected from seven (7) bus garage locations, and fourteen (14) were randomly selected from the remaining two (2) garage locations. The contents of each individual cashbox was emptied into a separate bag and the contents were then later counted. The comparison between the actual contents of each cashbox, and what the farebox data recorded had some discrepancies. None of the fareboxes audited had a Bypass alarm or suffered any severe bill transport problems. (Please refer to *Exhibit II* and *Graph II*).

Of the one-hundred thirty-three (133) cashboxes tested, the overall accuracy rates were as follows:

The actual number of pennies counted were twenty-five thousand, and ninety-three (25,093) while the data records showed twenty-four thousand, seven hundred and sixty-five (24,765) counted, or a difference of three hundred and twenty-eight (328) units. The overall accuracy rate for pennies was ninety-eight point six eight percent (98.68%).

The actual number of nickels counted were twenty-two thousand, two hundred and fifty-one (22,251) while the data records showed twenty-two thousand, one hundred and four (22,104) counted, or a difference of one hundred and forty-seven (147) units. The overall accuracy rate for nickels was ninety-nine point three percent (99.33%).

The actual number of dimes counted were thirty thousand, four hundred and fifty-seven (30,457) while the data records showed thirty thousand, two hundred and fifty-three (30,253) counted, or a difference of two hundred and four (204) units. The overall accuracy rate for dimes was ninety-nine point three percent (99.33%).

The actual number of quarters counted were fifty thousand, four hundred and twenty-seven (50,427) while the data records showed forty-nine thousand, eight hundred and twenty-one (49,821) counted, or a difference of six hundred and six (606) units. The overall accuracy rate for quarters was ninety-eight point seven eight percent (98.78%).

The actual number of half dollars and Susan B. Anthony (SBA) dollars counted was twelve (12) and three (3) respectively. The data showed ninety-four (94) Half dollars and twenty-seven (27) SBAs. These two coins sizes are the most misread coins. The half dollars and Susan B. Anthony dollars in the data were probably misread quarters.

The full fare tokens and reduced fare tokens also had a lower accuracy rate than other coins but were still acceptably high. The accuracy rate for full fare tokens was only ninety-eight point one three percent (98.13%) and the reduced tokens were ninety-seven point six seven percent (97.67%) accurate. This lower accuracy to other coins is partially due to the closeness and diameters of full fare tokens to dimes and reduced fare tokens to nickels.

The bills counted were sixteen thousand, five hundred and forty-eight (16,548) while the data showed sixteen thousand, four hundred and

twenty-eight (16,428) counted, or a difference of one hundred and twenty (120) units. The overall accuracy rate for dollar bills was ninety-nine point two seven (99.27%).

C. **Receiver Vault Revenue Audit Test:**

The Receiver Vault Revenue Test consisted of nine (9) receiver vaults. One vault was used from each of the nine bus garage locations. The comparison between the actual counts of these nine vaults and what the farebox data recorded revealed discrepancies. Coin offsets, or non-coin slugs and debris, were also counted and compared to the data to get a better accuracy rate. These coin offsets included foreign coins, game room tokens, foreign tokens, washers and miscellaneous debris found in the vault, but registered as revenue when deposited into a farebox. A total of one thousand seven hundred and eight (1,708) cashboxes were vaulted. Thirty-four (34) of these fareboxes were in bypass, and three (3) fareboxes had severe bill transport problems which generated erroneous bill counts. The exact number of erroneous bills generated is unattainable. (Please refer to *Exhibit III* and *Graph III*).

Of the nine (9) Receiver Vaults the overall accuracy rates were as follows:

The actual number of pennies counted were two hundred and twenty-one thousand, three hundred and twelve (221,312) plus fifty (50) coin offsets which register as pennies in the farebox. The farebox data shows two hundred and sixteen thousand, one hundred and fifty-two (216,152) pennies counted, or a difference of five thousand two hundred and ten (5,210) units. The overall accuracy rate for pennies was ninety-seven point five nine percent (97.59%).

The actual number of nickels counted were one hundred and ninety thousand, four hundred and forty-one (190,441) plus sixty-six (66) coin offsets which register as nickels in the farebox. The farebox data shows one hundred and eighty-seven thousand, six hundred and eighty-six (187,686) nickels counted, or a difference of two thousand, eight hundred and twenty-one (2,821) units. The overall accuracy rate for nickels was ninety-eight point five zero percent (98.50%).

The actual number of dimes counted were two hundred and fifty-six thousand, three hundred and ninety-six (256,396) plus one hundred and

sixty-five (165) coin offsets which register as dimes in the Farebox. The farebox data shows two hundred and fifty-three thousand, and three (253,003) dimes counted, or a difference of three thousand, five hundred and fifty-eight (3,558) units. The overall accuracy rate for dimes was ninety-eight point five nine percent (98.59%).

The actual number of quarters counted were four hundred and twenty-two thousand, two hundred and thirty-three (422,233) plus three hundred and four (304) coin offsets which register as quarters in the farebox. The Farebox data shows four hundred and twenty-four thousand, six hundred and forty-nine (424,649) quarters counted, or a difference of two thousand, one hundred and twelve (2,112) units. The overall accuracy rate for quarters was ninety-nine point five zero percent (99.50%).

The actual number of half dollars counted was one hundred and twelve (112) plus five (5) coin offsets which register as half dollars in the farebox, and Susan B. Anthony dollars counted was twenty-four (24) plus four (4) coin offsets. The farebox data showed one thousand and twenty-eight (1,028) half dollars and two hundred and eighty-two (282) SBAs. These two coins sizes are the most misread coins of all. The half dollars and Susan B. Anthony dollars were probably misread quarters.

The full fare tokens and reduced fare tokens also had a lower accuracy rate than other coins. The accuracy rate for full fare tokens (.650") was ninety-seven point four percent (97.40%) and the reduced tokens (.800") were ninety-five point four five percent (95.45%) accurate. This is partially due to the closeness and diameters of full fare tokens to dime and reduced tokens to nickels.

The total coin and token accuracy rate was ninety-eight point nine six percent (98.96%).

The actual number of bill units counted, including fifty-six (56) transfers found which register as a bill in the farebox was one hundred and thirty-two thousand, seven hundred and nineteen (132,719) while the farebox data showed one hundred and thirty-four thousand, six hundred and eighty-eight (134,688). Or a difference of one thousand, nine hundred and sixty-nine (1,969) bill units. The overall accuracy rate for bills was ninety-eight point five four percent (98.54%).

D. **Receiver Vault Exposed Revenue Test:**

This test consisted of observing vaulting operations at each of the nine (9) bus garages and gathering data that reflected the number of exposed bills that appeared during normal vaulting operations at a particular vault between 6:00 p.m. and 1:00 a.m.. The observation revealed that, while rare, there were instances of exposed bills during normal, proper vaulting operations.

It should be noted that the timer modification did not seem to have much effect on the number of occurrences of exposed bills. There were six (6) garages where the testing was performed *before* the timer modification. There was a total of twenty-two (22) occurrences of exposed bills totaling forty-five dollars ($45.00). At the remaining three (3) garages, the testing was performed *after* the modification to the timer. There were twelve (12) occurrences of exposed bills totaling thirty-seven dollars ($37.00). These numbers suggest that the timer modification did not have a significant effect on the rate of occurrence of exposed bills.

There were three instances (garages) where there were no occurrences of exposed bills during the entire observation period. Two of these instances were at garages tested before the timer modification.

The occurrences of exposed bills were seen at six (6) of the nine (9) garages tested. The number of occurrences at any one garage during the specified observation period ranged from one (1) occurrence to ten (10) occurrences. The number of exposed bills ranged from one (1) to twenty-nine (29). It is important to note that all the bills that were observed exposed were one-dollar ($1.00) denominations.

Of the nine (9) observation periods, the overall results were as follows:

There was a total of thirty-four (34) occurrences of exposed bills out of a total of eight-hundred sixty eight (868) vaulted cashboxes. This gives a three point nine two percent (3.92%) rate of occurrence. (Please refer to *Exhibit IV*).

The total amount of revenue that was seen exposed totaled eighty-two dollars ($82.00) out of a total of $165,765.32 collected by the vaulted

cashboxes. This results in zero point zero five percent (0.05%) of collected revenue appearing exposed during normal vaulting operations.

E. **The Overview of the Total Revenue Accuracy Rates:**

The total coin, token and bill Revenue totals from the four tests performed showed very good results, please see *Graph IV*. The total revenue accuracy rates for each test is as follows:

The Farebox Registration Test should have produced five thousand, seventy-one dollars and fifty cents ($5,071.50) in revenue. The farebox data for this test showed five thousand, fifty-seven dollars and thirty five cents ($5,057.35) recorded, or a revenue difference of only fourteen dollars and fifteen cents ($14.15). The overall revenue accuracy rate for the Farebox Registration Test was ninety-nine point seven two percent (99.72%).

The Farebox Cashbox Revenue Audit Test had a total revenue count of forty-nine thousand, two hundred and twenty-seven dollars and twenty-three cents ($49,227.23) while the farebox data records showed forty-eight thousand, six hundred and seventy-five dollars and five cents ($48,675.05). Or a revenue difference of five hundred and fifty-two dollars and eighteen cents ($552.18). The overall revenue accuracy rate for the Farebox Cashbox Revenue Audit Test was ninety-eight point eight seven percent (98.87%).

The Receiver Vault Revenue Audit Test had a total revenue count of four hundred and twenty thousand, twelve dollars and seven cents ($420,012.07) while the Farebox data records showed a revenue total of four hundred and eighteen thousand, eight hundred and nineteen dollars and sixty-seven cents ($418,819.67), or a difference of one thousand, one hundred and ninety-two dollars and forty cents ($1,192.40). The overall revenue accuracy rate for the Receiver Vault Revenue Audit Test was ninety-nine point seven two percent (99.72%).

The Receiver Vault Exposed Revenue Test showed that the vaulting operations are efficient, and that the occurrence of exposed bills is rare. From these observations, we can conclude that bills retained in vaulted cashboxes have a very small effect on the differences between recorded and actual revenue.

VI. PERFORMANCE OF THE BUS FARE COLLECTION SYSTEM:

The overall performance of the bus fare collection system was good. However, depending on an analyst's point of view, the system could be deemed adequate with much room for improvement.

For example, when considering the size of the Chicago Transit Authority, its service area, its volume of traffic and revenue, the operating environment of the equipment, and the operating costs of the system, the discrepancies might be accepted as unwanted but unavoidable.

When considering the system from an exclusively operational perspective with the knowledge that more accurate (and more expensive) equipment and procedures are available, then the system may appear inefficient and slightly outdated.

The following review of the system performance will be as objective as possible.

A. The "CENTSaBILL " Electronic Farebox:

Although some garages had less farebox problems per bus than other garages, no location was problem free. Six garages had farebox problems that would not allow completion of the farebox testing.

1. Coin Mechanism and Coin Inspection Area:

There were several cases in which the coin mechanism read an incorrect value for a coin or token. Most common among these errors was a full token (.650" diameter) being registered as a dime (.703" diameter) and vice versa. Currently, tokens are valued at $1.20. This mis-registration would result in a $1.10 discrepancy in the data, since the data merely reflects what is registered.

Other cases of "mistaken identity" include (in order of frequency):

- Dimes (.703") and Pennies (.750")
  $0.09 difference

- Nickels (.838") and Quarters (.956")
  $0.20 difference

- Nickels (.838") and Pennies (.750")
  $.04 difference

- Quarters (.956") and Susan B. Anthony dollars (1.052")
  $0.75 difference

- Pennies (.750") and Reduced Fare Tokens (.800")
  $0.54 difference

It is interesting to note that a token mis-registration is both the most common (full fare token) and the least common (reduced fare token) of the "mistaken identity" cases. Initial intuition might expect the token mis-registrations to be the least common overall since the coin mechanism "looks" for holes in the coin to identify tokens.

Misreads can be the result of a number of problems. For example, since the farebox "reads" the diameter of the coins, any lint caught in the coin reader sensors can make a coin appear to be a larger diameter than it actually is. As the coins fall through the coin reader, they usually clear out any lint that may be jammed in the coin sensor, but they may also be miscounted as they push the lint through the sensor.

Another problem found in the coin mechanisms was a tendency to "jam" when coins were deposited in groups. Although most of these jams could be cleared with a finger (if the jam was in the top casting), some of them occurred too far into the mechanism to be cleared easily.

On the farebox there is a "de-jam" button that physically separates the plate mechanisms of the coin mechanism and allows coins to fall freely into the inspection area. Pressing the de-jam button helped to clear the coin mechanism. There were some instances where the de-jam button did not work either, and the mechanism had to be removed and cleared by a technician.

Finally, there were instances where coins did not freely fall past the inspection plate after registration. There were also instances where the inspection plate did not respond properly to fare registrations, and would not dump the coins properly.

2. *Bill Mechanism and Bill Inspection Area:*

There were very few problems found in the operation of bill mechanism. The most significant of these problems was non-registration of deposited bills. There were very rare instances where a bill was inserted, transported directly into the cashbox without stopping in the inspection area, and never registered.

At least one instance was encountered where the bill mechanism would move, but would not transport a bill past the inspection area. Although the problem was never fully investigated, the problem was attributed to a misadjusted or dirty transport belt that carries the paper through the mechanism.

3. *Magnetic Card Reader:*

The problems associated with the magnetic card reader were also limited. There were cases where the card reader would read the card properly on the first swipe, but would register a "misread" on the second swipe. Usually, upon swiping the card again, the card would read properly.

Also, there were a few cases where it was difficult to swipe the card through the reader at all. This was due to improper spacing between the card reader plates and is easily adjustable by technicians.

4. *Numeric Keypad:*

There were cases where the keypad was either too sensitive or not sensitive enough. For example, a "sensitive" keypad may register twice for one press of a key. Alternately, some keys on some keypads required significant force to activate the registration.

5. *Farebox Pedestal Cashbox Door:*

Occasionally, a tester would encounter a cashbox door that would not open completely when the farebox was probed. These doors did unlock and could be forced open, however.

6. *Electronic Aspects:*

There were occasions when the farebox would cease to operate, and a "POWER" message would appear on the alphanumeric display. This would happen despite the fact that the buses were running for all tests in an effort to simulate an in-service bus and avoid this problem.

The data collected by the farebox was accurate, registration errors notwithstanding. Review of the data showed that the farebox recorded the transactions properly. The notes included on the test reports corresponded with the data transmitted to the Network Manager.

B. The Cashbox Receiver Vault:

No mechanical problems were seen with the receiver/vault operation at the vault islands. However, box-pullers who work at these stations on a daily basis complained about receiver handles that were difficult to turn. No other complaints were heard.

It should be reiterated here that there are instances in which the cashbox is not completely emptied when it is dumped, and bill retention occurs. There were several instances during the farebox test procedure where the testers found money in fareboxes that had been probed and cashboxes dumped. Twenty-eight (28) out of two-hundred forty-five (245) cashboxes (11%) had bills in them when inspected by the testers. The total amount found was $195.00. Extended to all buses, approximately $2,000 is probably retained by fareboxes. This money is presumed to be dumped with the next vaulting of those fareboxes.

Occasionally, there is money found in cashboxes that are inside of cashboxes sent to the shop for repair. When the farebox is probed as part of standard operating procedures, the cashbox is checked for currency. If there is money inside of the cashbox, it is removed, the cashbox is audited and the amount of money is recorded and sent to the Central Counting facility.

Once the vault has reached Central Counting, there are other operational aspects that will be discussed later in this document.

The vault design does an excellent job of keeping bills and coins separated inside the vault. There were no instances observed in which bills were found in the cavity designated for coins or vice versa.

As described earlier, once the bill bin has been removed from a vault, the vault is hoisted to a position approximately four feet from the floor to a platform attached to the coin sorting machine. A door located near at the bottom of one side of the vault is opened to allow coins to fall into a feeder funnel.

Observation of this process revealed that some coins do not fall freely from the vault. Edges of the vault and other factors prevent free-fall of the coins. As a result, the remaining coins must be removed manually. The possibility exists that some vaults may not be completely cleared in day-to-day operations.

C. The Data Collection System:

There are many decisions made within the CTA based on data received from the field. The importance of the proper operation of the data collection system cannot be overstated. Decisions based on this information could range from whether to increase service on a particular line to answering questions on fare restructuring plans. Therefore, the overall successful operation of the data collection system was reassuring.

1. Vault Island Computer:

The vault island computer operated without problems. The data retrieved from the records corresponded with the data from each farebox probed with that vault in place. Vault and cashbox identification numbers were read and recorded accurately, and the revenue totals were processed according to farebox registration as expected.

2. Probing Computer:

The probing computer also processed all pertinent data accurately.

3. *Network Manager:*

Data retrieval by the Network Manager was successful.

VII. OPERATION AT THE CENTRAL COUNTING FACILITY:

The operation at Central Counting is integral in CTA's overall goal to continue providing efficient, cost-effective service to the public in that it is here that all revenue is processed.

Due to the importance of paying bills and maintaining a reliable "bottom line", accuracy of revenue processing is critical. In contrast, due to the volume of revenue collected by the system on a daily basis, the constraints of time make speed of processing a vital aspect. The importance of speed is magnified when one considers that although the CTA collects bus revenues seven days a week, Central Counting operates on a weekday schedule.

Speed and accuracy are often not compatible, and Central Counting's efforts toward efficiency are commendable.

A. Coin Counting Process:

Although the coin counting process is monitored by several people, there was some question as to how overall accuracy could be maintained. As mentioned earlier, there is a problem with coins "sticking" in the vault when it is emptied. With speed being as important as it is, it is plausible that the vaults may not be completely emptied on a vault-to-vault basis.

Also, in a typical vault dump, some coins end up on the floor. Despite the fact that they are retrieved and dumped back into the machine, there exist the possibility, and probability, which some coins may be overlooked.

In addition, slugs and other debris rejected by the coin sorting machine and the electronic coin counters are bagged and set aside. Upon retrieval and testing, testers found that most of these slugs register as coins on the farebox. No attempt is made in daily operations to reconcile these registering slugs with the rest of the coinage. This undoubtedly adds to the inaccuracy of the data retrieved through the computers.

B. Bill Counting Process:

The bill counting process begins with the tedious job of processing the collected bills. When the bills are dumped into the vaults at the vault island, they are not stacked or straightened. They simply fall freely into the vault's bill bin. When the bin is pulled from the vault, the bills are lying in a large, unorganized heap. Some are folded and mutilated. There are also transfers, public aid vouchers and other non-dollar bill material in the bin.

Before these bills can be counted by counting machines, they must be manually straightened, "faced", and stacked by hand. A bin that is brought to the bill processing/counting area is dumped onto one of four tables. There are four to six people at the table whose only job is to pick up bills then straighten, face and stack them. This process appears slow and time-consuming, as well as costly. There are typically twenty-four (24) Central Counting personnel performing this aspect of the bill counting process for seven hours a weekday.

Once the bills are straightened and stacked, they are sent to the counting tables. There are three counting tables that utilize two floor model and four table model bill counters. The floor model machines are state-of-the-art and count the bills quickly and accurately. The table models help to efficiently verify certain counts and are used to count mutilated bills.

One questionable procedure in the bill counting process is the practice of combining all mutilated bills, public aid vouchers, transfers, etc. as a daily total, then dividing the total number of mutilated bills among the number of vaults processed that day and attributing the same number of mutilated bills to each vault. This undoubtedly has some adverse effect on the accuracy of revenue totals for these vaults.

Among the non-dollar bills, public aid vouchers and paper transfers are usually found. Bus operators are instructed to direct passengers to insert public aid vouchers into the farebox. These vouchers carry the value of a transfer (30¢) and are treated as revenue. The farebox registers the vouchers as tickets, and assigns no value to them.

Transfers are usually inserted by maintenance personnel who are testing the bill mechanism.

C. Other Procedures:

Designated or limited personnel are assigned or allowed to leave the building during working hours.

No personnel are allowed to leave the facility for non-emergency reasons, except for lunch, during working hours or while revenue is still being processed. In addition, personnel wishing to leave the facility must have written permission from a supervisor.

VIII. DATA INTEGRITY:

The overall results of the data testing were reassuring. The registration and data collection aspects of the system were remarkably accurate. The information collected by the farebox, probing computer, and finally the Network Manager agreed with intended results an overwhelming majority of the time. These results become even more reassuring after reading a statement from a report which contended "...many transit systems experience on average a 10% variance of revenue electronically reported as deposited into the farebox over revenue actually received and counted by the transit system" [2]. This was not nearly the case in this system. The variance never exceeded 5%, except in the cases of counting half dollars and Susan B. Anthony dollars. Most of the tests performed revealed variances of less than 3%. This is equivalent to approximately $20,000 in revenue counted daily.

Analysis of the collected data, therefore, provided very good insight as to where potential and actual problems lie with the system.

IX. SECURITY ASPECTS:

As with all cash-related operations, the temptation and threat of theft is always present and must be addressed without sacrificing operational efficiency. In observing CTA's bus revenue collection process, there were some situations and procedures that were questionable as far as providing sufficient and reasonable security measures.

A. Bus Farebox Operation:

The normal operation of the farebox provides very good security against theft of cash. Once a fare is inserted by a passenger, it is out of the reach of human hands. The one-way motion of the bill transport motor prevents money from being mechanically pushed or pulled out of the machine through the bill transport and coin mechanism.

Once a fare is registered, it is immediately sent to the cashbox where it remains until the cashbox is dumped at a vault island. The cashbox itself is securely locked inside the farebox pedestal until it is probed at a vault island.

When a farebox is probed, it downloads data indicating when the cashbox door was last opened and if and when the cashbox was last removed. These indications are called farebox alarms.

In the instance that the pedestal door is forced open, the cashbox and farebox are keyed in such a way that the cashbox lid must be closed for proper removal of the cashbox. The keying system employs a large key called a *bullet* that is located inside of the farebox (the name "bullet" comes from the key housing's resemblance to an oversized bullet). This key is treated as a high-security item and is not available to unauthorized personnel. In addition, it is standard operating procedure to re-key the entire bus farebox system if a farebox bullet is discovered missing.

If a closed cashbox is somehow removed, the cashbox itself is made of high-strength, heavy gauge plated steel and locking mechanisms which provide the required level of security.

In addition, the normal operation of the data systems provide information verifying that a particular cashbox has been inserted into a particular vault.

B. **Cashbox Receiver Vault Operation:**

The operations at the vault islands are kept secure by a number of safeguards. For example, when a farebox is probed and the pedestal door opens, the box-puller has access to the cashbox but not the *contents* of the cashbox. The cashbox is inserted into the receiver as a closed unit.

To dump the cashbox, the receiver vault door must be closed. When the activating handle is turned to open and empty the cashbox, a secure lock is engaged and the vault and cashbox are inaccessible until the end of the operation. A red light on top of the shroud is activated and remains on until the internal five second timer has expired. At the end of the operation, a green light activates indicating that the timer has expired. When there is no cashbox in the receiver are open, the interior of the vault is covered and inaccessible.

In addition to the operational safeguards built into the system, the vault island activities are monitored by closed-circuit cameras at all times, and recorded on time-lapse video cassette recorders. The monitors and video cassette recorders are located in the garage General Manager's office.

C. **Operation of Farebox Field Maintenance:**

Farebox maintenance personnel who are stationed at the garages are required to do both field repairs and preventative maintenance. They are primarily concerned with the electronic aspects of the farebox, such as the keypad, the alpha-numeric display and the computer components. They are also responsible for the proper operation of the coin and bill mechanisms.

The design of the farebox is such that all of the components mentioned above are contained in the upper portion of the farebox. This area is separate from the cashbox area, which is located in the pedestal, or base, of the farebox. There is no field maintenance or repair procedure which would require or allow access to the cashbox. In addition, the

technicians do not have tools or other means to allow easy access to the cashbox.

The junction connecting the top of the farebox to the pedestal is secured by a high security Medeco lock. Access to the cashbox area would require damage to the farebox.

It should be noted that although the buses are probed and dumped, there are times when the cashboxes are not completely empty. This might be motivation for attempting to check cashboxes for cash. Another motivation for gaining access to the cashbox area could be to obtain the cashbox bullet. As mentioned earlier, attempts to gain access to the cashbox in which the cashbox is removed or the cashbox door is opened will produce a route/run record in the farebox computer.

D. **Operation at Central Counting:**

The Central Counting facility is the source of most concern as far as security if for no other reason than the high volume and high visibility of cash present there. Since the building was not designed for processing money, the facility had to be adapted to accommodate both people and equipment in as secure a manner as the facility would allow. The age and layout of the building limit management's ability to isolate the various operations from people authorized to enter the facility.

Central Counting had multiple provisions defined and set up to maintain a high level of security. Also, there are some basic operational procedures that should be examined.

1. *Coin Counting Procedures:*

When coins are dumped from a vault, they are dumped into a large, open coin sorting funnel. This open funnel allows open access to the coins it holds.

As the coins flow from the vault, some coins become stuck in the vault near the exit chute. These coins are removed manually. In addition, as mentioned before, as coins are processed in the coin sorting machine, some end up on the floor of the area.

2. *Bill Counting Procedures:*

When the bills are ready for processing, they are dumped onto large tables which stand in a monitored area. After processing, the bills are manually transferred to the counting tables.

The counting tables also stand in the same open area as the processing tables. Uncounted, stacked bills sit on tables which face the aisle between the processing and counting tables. Once the bills are counted, they are securely wrapped, tagged and prepared for shipping to the bank. They are placed inside of an on-site vault until armored car services arrive to pick it up.

3. *Audit Procedures for Bill and Coin Counting:*

The audit procedure for revenue counting is a paper audit system throughout all counting processes. There is no computerized audit trail. Human error could play a significant part in discrepancies in revenue reconciliation.

4. *Dress Code Inside Central Counting:*

The Central Counting facility has a dress code for all facility personnel that work with money. They are required to wear a company approved and supplied jumpsuit, devoid of pockets, while on the processing floors. Procedures normally require that these jumpsuits be worn in place of other clothing. Only undergarments are allowed under the jumpsuit.

5. *Entry/Exit - Personnel and Visitors:*

Entry of individuals is governed by a two-door stand-by system which is monitored by a guard twenty-four hours a day. A person must be allowed into the first door by an electric door system into a small enclosed area where he/she may approach the bullet-resistant guard's window. Identification must be provided. If sufficient proof and reason is given and verified, the individual must sign on an electrical sign-in machine that duplicates each signature on a pad located inside the guards booth. Then the individual is allowed through the second door and directly onto the coin counting floor.

Visitors are more closely scrutinized before allowed entry to the facility. Once inside, due to the constraints of the building layout, they have access to the coin and bill processing areas.

Central Counting employees who enter are allowed to walk through the facility before changing into the required jumpsuit. Judging from the experience of the testers during observation, it is assumed by Central Counting that an individual that has gained entry is authorized, and is allowed to walk around the facility supervised.

It is normal procedure for the guard to search bags before they leave the facility. Due to the current layout of the facility, limiting access to any of the money counting areas is not possible.

6. *Entry/Exit - Vehicles:*

There are certain procedures that must be followed for a vehicle to gain entry to Central Counting's bay. These procedures are followed under the strictest scrutiny, and under constant surveillance by both camera and security guard.

Vehicle personnel who leave enter the bay must sign in just as if they had been admitted on foot.

7. *Other:*

All areas of the Central Counting facility are under camera surveillance at all times. These cameras can be turned to face different directions or used to take close-up pictures. Time-lapse recording is also in use, however only one area at a time may be recorded during any one span of time.

Monitors are located in the Manager's office on the second floor as well as the supervisors' office located on the first floor and the police room located on the first floor.

X. SECURITY ENHANCEMENT POSSIBILITIES:

There are more elaborate measures that could be taken to ensure the highest level of security available, but in almost every case these measures would be anything but cost-effective.

However, despite the excellent effort by those sections concerned to make the bus revenue collection and reconciliation process secure, there are some suggestions which, if implemented, could improve overall security. Furthermore, these suggestions may indeed prove cost-effective, reasonable and realizable.

A. The Revenue Equipment Technology Group:

The revenue equipment technology group is headed by a Manager. His responsibilities include overseeing all projects related to procuring new revenue collection equipment and projects concerning revenue collection data systems. He is assisted by a group of testing engineers, testing technicians and data analysts. The function of this group is to write specifications for, test and analyze revenue collection equipment.

1. Improvement of the Bus Farebox:

Currently, the CTA is continuing the project of retrofitting all fareboxes to accommodate magnetic card readers [3]. The project is at the point where the card reader is installed and operating on all buses. The Network Manager software, however, is not quite updated to completely adapt to the card readers. Completion of this project will be a major improvement. It will save the CTA money in two ways. First, by using a magnetic card system we reduce, and possibly eliminate, cash revenue, thereby reducing the costs to process revenue[2]. Second, the software will be programmable such that future software replacements are not necessary.

Another improvement could be installing coin and bill mechanisms that perform more tests on the revenue to reduce invalid

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2 Currently, it costs the CTA approximately $22.00 to process $1,000.00 in bills and $1.30 to process $1,000.00 in coins.

currency. This has obvious money-saving advantages and operational disadvantages.

2. *Improvement of the Cashbox Receiver Vault:*

Although the receiver vault has the capability to transmit data while in the shroud at the vault island, ii should also have the independent capability of storing data that can be retrieved at a remote location, such as the Central Counting facility. This data would include cashbox identification (I.D.) and revenue collection information. (See *Central Counting facility: Improvement of audit procedures* below.)

3. *Improvement of the Data Collection System:*

In accordance with the card reader retrofit mentioned above, the data collection system is being redefined so that it is more convenient and user-friendly. In addition, because of the high volume of data collected daily, a huge amount of memory is required to accommodate the system. Addition of multi-media hardware, such as optical disk technology, could answer some of these memory questions.

For additional speed in processing, a mini-computer is recommended. The system should be based on a multi-user, multi-tasking open system approach. An open system offers the convenience of a computer and operating system that is "open" to industry standards. The degree of openness that a system has is inversely related to the amount of proprietary elements that make up the system. An open system approach guarantees that the data system is not restricted to a specific vendor. A multi-user, multi-tasking system allows different users at different locations to use the same applications at the same time. This would eliminate waiting for computer time and running a particular application for different results.

Finally, a networking system among Revenue Equipment, Treasury and Central Counting is strongly suggested. This will create a complete electronic audit loop which will provide checks and balances that should reduce collection discrepancies significantly.

4. Improvement on Operating Procedures:

There are several suggestions as to how to change certain procedures to improve revenue collection and reconciliation.

i. For Day-to-Day Operating Procedures:

- Connect vault and probing computers to camera surveillance system such that the action being performed, the vault number, bus number and cashbox numbers can all be recorded on film with the corresponding time, date and picture.

- Enforce procedures requiring bus operators and box pullers to report farebox problems. Malfunctioning equipment can and will produce unreliable data.

- Make farebox data easily available and understandable to operating personnel management for review of data directly related to their areas and functions.

- Perform operations that clear farebox memory only when instructed to do so by supervisory personnel. Loss of memory in a farebox could result in missed critical information.

- Obtain a receiver vault system that will cease operating when the revenue dumped into it reaches a certain preset amount. This will require the box puller to switch vaulting positions and prevent overloading of receiver vaults.

ii. For Policy Procedures:

- Insure proper initial and refresher farebox operation training for drivers and other related operation personnel.

- Consolidate all farebox functions into one department, including vault island operations.

Consider the most state-of-the-art technology when designing and purchasing new revenue collection equipment. Although resources may not allow immediate procurement of this technology, purchased equipment should be designed such that integration of new technology is feasible and could be implemented should future resources allow.

One example is the use of "smart cards": cards which utilize a passively powered computer chip to store and change information. In a current CTA project called **PCIS** (**P**ayment and **C**ontrol **I**nformation **S**ystem) [4], smart card technology is being used to remove revenue collection recording from paper records to computer records. The card will be used as a debit card which value can be added to or debited from simply by inserting the card into a hand-held computer and following the proper menus.

B. <u>The Central Counting Facility</u>:

The Central Counting facility requires some basic improvements to make the system more secure and more efficient.

1. Improvement of the Coin Counting Process:

The coin counting process should operate on a more secure "closed system" approach. Access to the coin processing area should be restricted to coin counting personnel by a conventional locked door or electronic key system.

2. Improvement of the Bill Counting Process:

Bills should be securely stored and possibly guarded until the bill processing area is prepared to receive them. When the bills are in transport from its originating point to the bill processing area, they should not be easily accessible during transport.

A method should be found to greatly reduce, if not eliminate, the time and resources spent on "bill straightening". Although the solution is probably fare collection equipment or company policy

related, it is at Central Counting that the time-consuming practice is performed.

3. *Improvement of the Entry/Exit Procedures and Dress Code:*

- Entering personnel and visitors should not be admitted directly into any counting or revenue processing area.

4. *Improvement of Visitor Policies:*

- Visitor access to the facility should be limited.

- Visitor access to the revenue processing areas should be strictly limited.

5. *Improvement of Audit Procedures:*

- Implement additional steps to address differences reflected on the "flash" sheet balances.

- Vaults should be probed at the Central Counting facility. This would provide on-site data so that Central Counting personnel could know what to expect from a particular vault.

- The monies from each vault should be segregated in a secure manner.

- Adjust vault totals based on major farebox malfunctions. These malfunctions should be noted on the paperwork filled out by the box-puller as informed by the bus operator at the vault island.

- Account for fareboxes probed but not vaulted due to pedestal doors that did not open or cashboxes stuck in the farebox.

6. *Improvement of Building Layout:*

- In order to develop and implement improved security measures, consideration should be given to redesigning the layout of the Central Counting facility. Following is a list of some improvements that should be considered:

- Physical barriers (walls and security doors) to severely limit access to money counting areas. Access to these areas/rooms should be by some sort of electronic control like swipe magnetic cards or electronic combination locks. The barriers and electronic locks would provide the means to limit access to the money handling areas.

- Relocation of all locker rooms so that once an employee has changed from the work jumpsuit to street clothes, they do not have to pass through money counting areas. This action would provide additional security in controlling personnel entering and leaving money handling areas.

- Additional security cameras for lunch rooms and other non-monitored key areas.

- A larger lunch room facility combining both first and second floor lunch rooms. A larger lunch area away from the money handling areas would provide access control.

- Relocation of the token packaging area to it's own secured room. The room should have security cameras. This action would be consistent with limiting access to areas on a need only basis.

- There is also an immediate need for new office space for supervisory personnel. The work areas are not available at this time due to space limitations and layout constraints.

7. *Computerized counting/tracking system:*

There are also enhancements that the Central Counting management consider necessary in addition to the basic improvements listed above.

In order to develop labor efficiencies and to increase accuracy and timeliness in recording and reporting revenues, the Central Counting facility is interested in acquiring a comprehensive automated counting/tracking system for its bus system revenue processing equipment that has the ability to be expanded and/or interfaced with a total automatic fare collection system.

The system would require the following properties:

- Industrial grade materials due to the dusty environment of the counting room;
- The ability to provide an accurate record of all revenue processed, and break down this information by denomination;
- Security from unauthorized access to the files or programs;
- The ability to effect communications between the system and the current revenue counting equipment.

The bill and coin counting stations would be connected to an administrative file server. The administrative file server would collect data from each work station and allow for the printing of summary reports. The administrative file server would consolidate revenue data by vault, date and CTA garage between the coin stations and bill stations. This server would allow supervision and on-line review of all work done, without waiting for end-of-day summaries. The server would also allow supervision of on-going work without a supervisor having to visit each station.

NOTES:

The CTA is currently in the process of procuring a complete rail revenue collection system [5]. The purpose of this project is to purchase new equipment and integrate the rail system with the bus system so that uniformity and overall fare media security is maintained. All of the improvements incorporated in this project and listed above will require a concerted effort from

CTA management and the full support of the Federal Transit Administration (FTA).

XI. CONCLUSION:

The data and overall results of the testing show that, despite the high volume of revenue and the size of the CTA, the fare registering equipment operates well under most circumstances. Most every test yielded reconciliation rates of over 96% with registrations of half dollars and Susan B. Anthony dollars being the only exceptions.

While these results are not perfect, they are reassuring. They show that a fair percentage of the discrepancies can be attributed to electronic miscounting of full fare tokens which are very close to dimes in size (tokens: 0.650", dimes: 0.706"), and have holes in them. Although no improvement was suggested above, it is possible that the type of token in use by the CTA is a difficult one to read by electronic methods, and perhaps a different style or size of token should be considered.

Results also suggest that failure to include slugs and other false fare media in the counting process contributed to reconciliation problems. A method for counting and valuing these slugs might help to improve balances.

The accuracy rate for dollar bills collected versus dollar bills counted was lower than hoped for. After performing the farebox registration tests, the shortage of bills can be explained, at least partially, to the fact that bills are sometimes retained in the cashboxes when they are dumped at the vault islands. There is an immediate discrepancy since what the farebox data said was collected and what was actually dumped did not match.

With the resolution of these matters and the implementation of the improvements suggested above, the reconciliation of bus revenue should improve. It is important to note that these discrepancies can be explained without investigations into the possibility of employee mishandling of revenue. The bus revenue collection equipment performs well, and the collection system is just a few improvements away from near-perfect reconciliation.

In determination of these improvements there are many aspects of the system that must be considered. While this report is primarily on the electronic data aspects of the bus revenue collection system, there are other aspects involved in maintaining a secure yet feasible revenue reconciliation process. A sound judgement cannot be made based on revenue data alone.

Revenue data can be used for important decisions concerning long and short term financial forecasting, and can be used to insure proper maintenance of equipment and systems. For example, the data was used in this report to help determine the accuracy of the data systems themselves. This was done using a "data collected" versus "revenue counted" basis.

However, when attempting to determine the security of the system on a *"revenue collected"* versus revenue counted basis, there are factors which can effect the overall reliability of the data that require further steps be taken to compliment what the data can show.

Problems with data collection and retrieval can cause the revenue counted to appear *lower* than what the data reports. In other cases the revenue counted can be *higher* than what the data reports. Some of these circumstances include:

A. **Revenue > Data:**

- The coin mechanism is in bypass and the coins collected are not counted and recorded in the data.
- Five ($5.00) dollar, Ten ($10.00) dollar or higher denominations of bills are mistakenly inserted into the cashbox and register as one dollar ($1.00) since the mechanism verifies bills by length.
- Two one dollar ($1.00) bills are inserted at once, one on top of the other, therefore recognized by the farebox as one dollar.
- Because of an electronic malfunction, all memory on the farebox computer is accidentally erased before the bus is probed. All data concerning revenue collected up to that point is lost.

B. **Revenue < Data:**

- A cashbox is damaged and will not open in order to empty into a vault. Since the farebox has been probed, the data is downloaded, but the money is never collected in the vault. The cashbox is sent to shop maintenance where the money is removed and sent to the Central Counting facility.

- A farebox door will not open when probed. This causes the same problems and is handled in the same manner as when a cashbox lid will not open.

- Slugs, foreign coins, transfers and invalid bills which register as valid U.S. currency on the farebox are not included in revenue totals at Central Counting.

- Occasionally, cashboxes which are dumped at the vault islands will retain bills. These bills were recorded in the data, but not counted with the contents of the appropriate vault.

In addition, although this report was not an attempt to determine, expose, or in any way suggest revenue loss due to *mishandling*, it should be pointed out that data alone cannot confirm or dispute theft or other misappropriation of revenue. There are other aspects of the bus revenue collection and reconciliation process that serve to insure a high level of security such that the data that *is* retrieved can be considered reliable.

For example, in the normal vault island operations, when a receiver vault is removed from a shroud, it must be unplugged from the data system interface. Alternately, when a receiver vault is placed inside of a shroud, it must be plugged into the data system interface. Closing the shroud doors without plugging in the receiver vault triggers a siren thereby indicating that the receiver vault is not attached to the data system. This prevents a cashbox from being dumped into vaults which could not recognize and download the cashbox's information.

Another example is the inability to maintain or repair a receiver vault until it has been opened and processed by the Central Counting facility. The receiver vault is designed such that the padlock which holds down the hood is only accessible through the bill bin area. This door to this compartment is locked by a high-security locking mechanism and can only be opened at Central Counting. Once the contents have been removed, the receiver vault is left unlocked and sent out for maintenance.

It is provisions such as these that provide a level of comfort concerning the correlation between what is collected in the farebox and what is actually counted at Central Counting. The combination of data collection and security measures becomes an invaluable and necessary union in successfully operating and controlling a large revenue collections system such as that at the CTA.

XII. REFERENCES:

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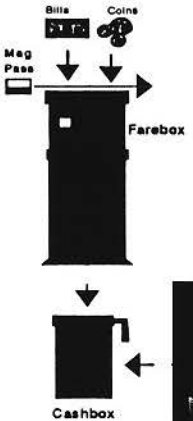
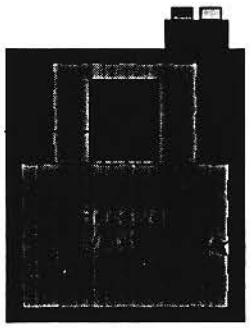
Passengers





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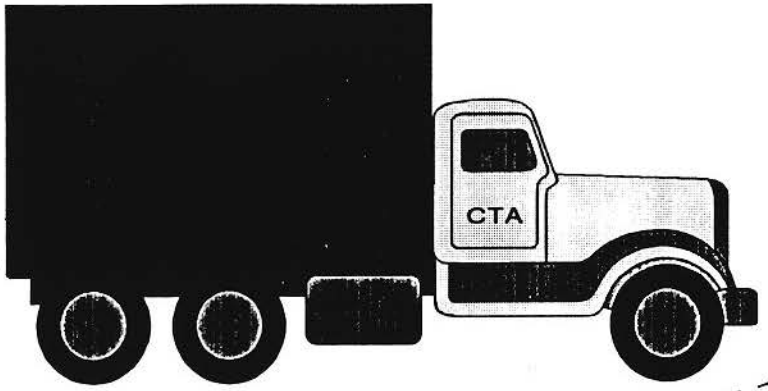
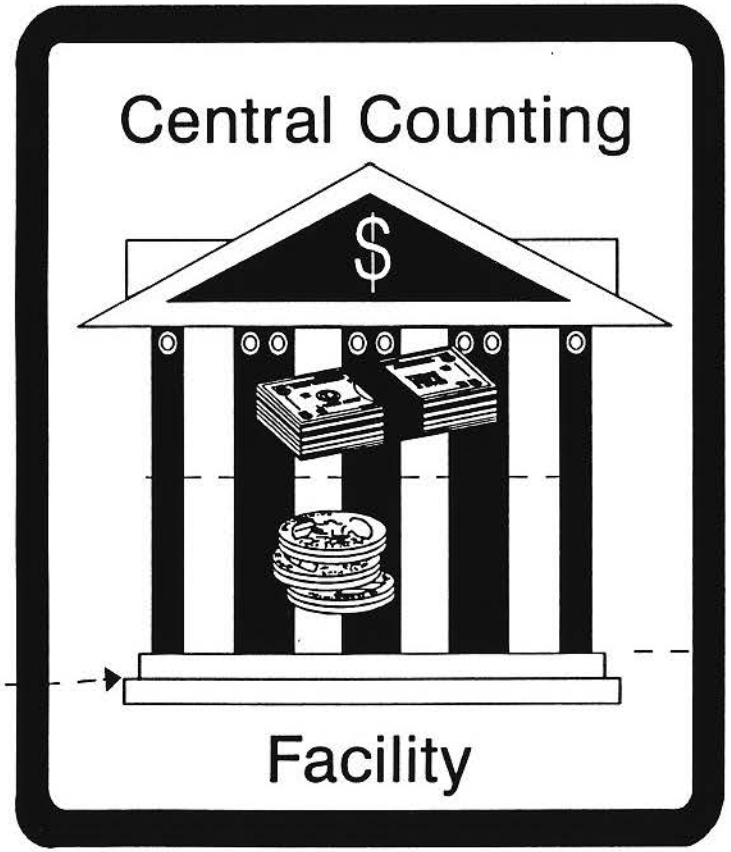
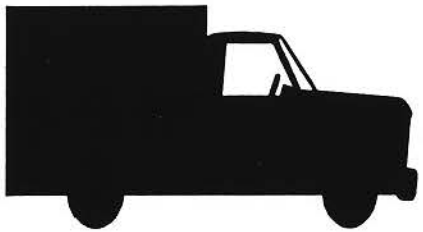
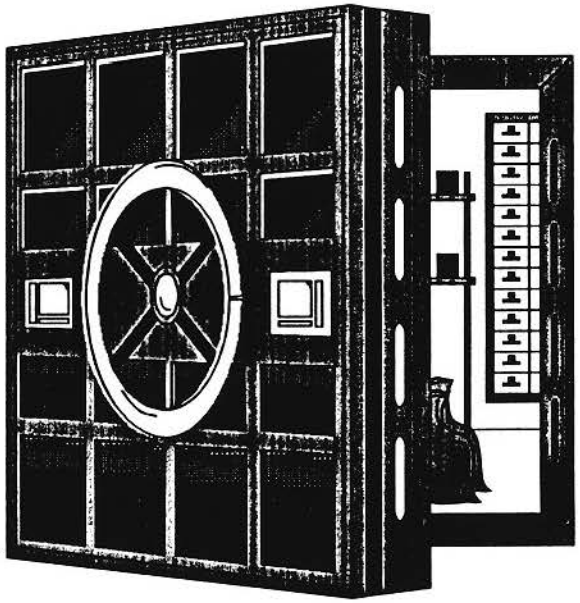


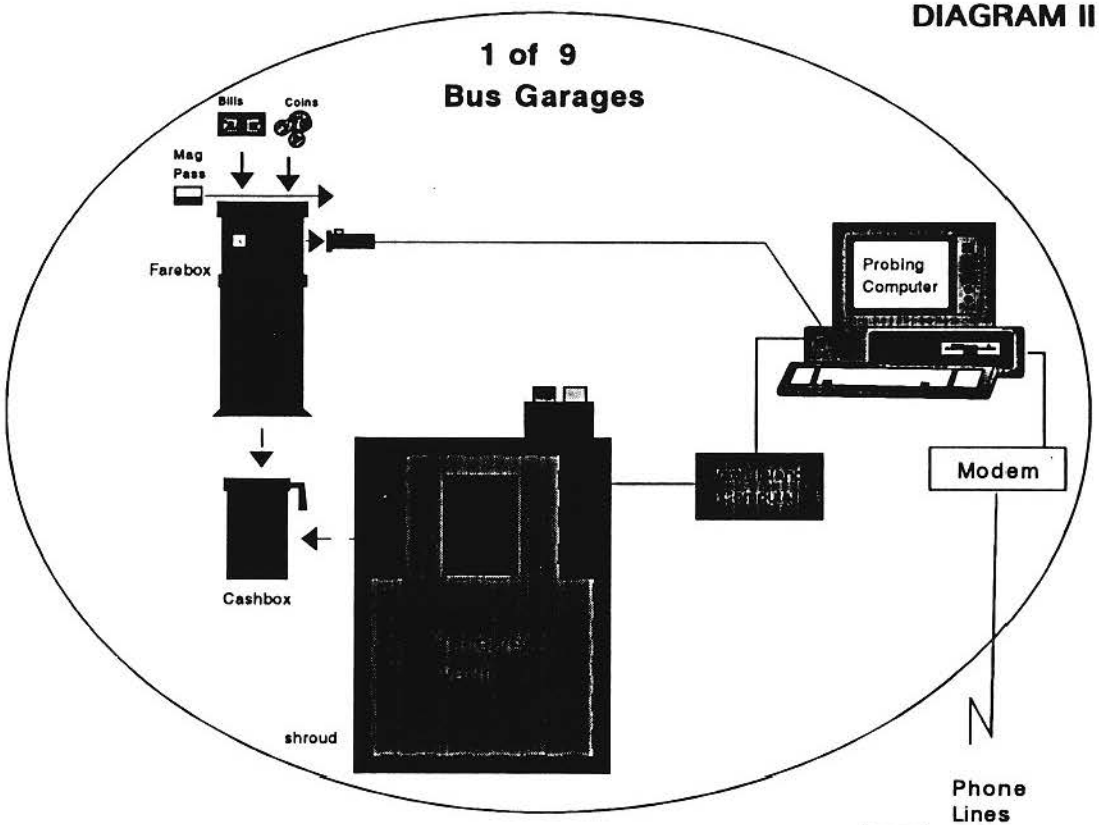


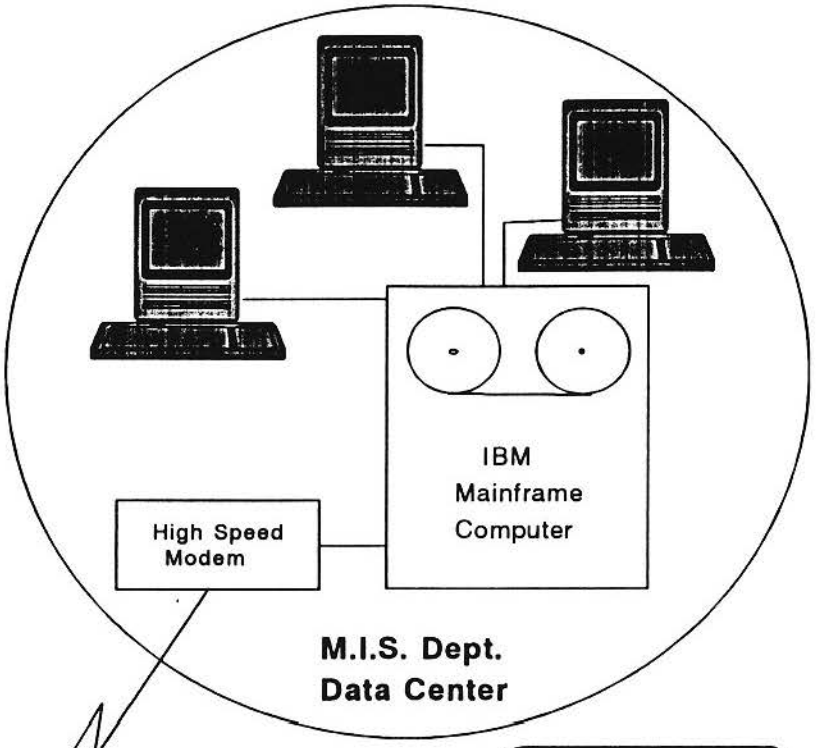
Armored Car Service





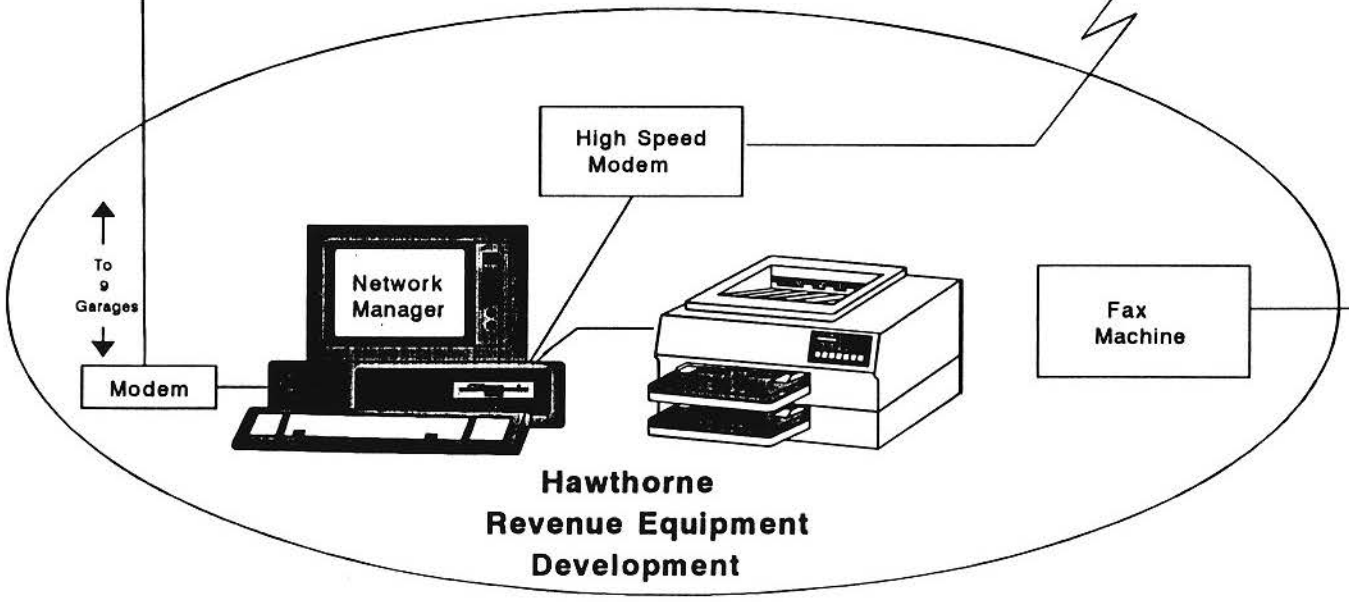
First National Bank





Phone Lines

Dedicated Data Line



Phone Lines

XIV. TABLES

TABLE I

CHICAGO TRANSIT AUTHORITY
TREASURY COUNTING OPERATIONS
TREASURY DEPARTMENT

REVENUE AUDIT FOR CENTRAL COUNTING DAY
11 MONT 13 DAY 92 YEAR

		BILLS			COINS			REVENUE			ACURRACY RATES		
GARAGE	VLT	C.COUN	DATA	DIFF	C.COU	DATA	DIFF	C.COU	DATA	DIFF	BILLS	COINS	REVENUE
103RD	141	12381	11858	523	28865	28190	675	41246	40048	1198	95.78	97.66	97.10
	113	5553	5698	-145	15913	15322	591	21466	21020	446	97.46	96.29	97.92
	0	0	0	0	0	0	0	0	0	0	-	-	-
69TH	159	10582	9733	849	23775	23568	207	34357	33301	1056	91.98	99.13	96.93
	144	16782	17653	-871	28864	37346	-8482	45646	54999	-9353	95.07	77.29	82.99
	0	0	0	0	0	0	0	0	0	0	-	-	-
77TH	120	7552	7418	134	19072	17566	1506	26624	24984	1640	98.23	92.10	93.84
	0	0	0	0	0	0	0	0	0	0	-	-	-
	154	12393	12382	11	30077	29355	722	42470	41737	733	99.91	97.60	98.27
	119	7372	7307	65	16427	15970	458	23799	23277	523	99.12	97.21	97.80
ARCHER	150	5639	5579	60	15977	15792	185	21616	21371	245	98.94	98.84	98.87
	168	3000	3025	-25	9600	9487	113	12600	12512	88	99.17	98.82	99.30
	129	5551	5579	-28	11810	11986	-175	17361	17565	-203	99.50	98.54	98.84
KEDZIE	101	15954	18870	-2916	36637	35470	1167	52591	54340	-1749	84.55	96.81	96.78
	134	11898	12077	-179	26204	25563	641	38102	37640	462	98.52	97.56	98.79
	0	0	0	0	0	0	0	0	0	0	-	-	-
	0	0	0	0	0	0	0	0	0	0	-	-	-
	0	0	0	0	0	0	0	0	0	0	-	-	-
LIMITS	152	13388	13300	88	32391	32046	345	45779	45346	433	99.34	98.94	99.05
	0	0	0	0	0	0	0	0	0	0	-	-	-
	0	0	0	0	0	0	0	0	0	0	-	-	-
NORTH	0	0	0	0	0	0	0	0	0	0	-	-	-
PARK	133	22380	19492	2888	42786	42039	747	65166	61531	3635	87.10	98.25	94.42
	138	4414	4369	45	9842	9723	118	14256	14092	163	98.98	98.80	98.85
	135	4335	4305	30	11314	11138	175	15649	15443	205	99.31	98.45	98.69
FOREST	0	0	0	0	0	0	0	0	0	0	-	-	-
GLEN	147	14536	14336	200	34253	34002	251	48789	48338	451	98.62	99.27	99.08
	102	14365	13807	558	37877	27852	10025	52242	41659	10583	96.12	73.53	79.74
LAWNDALE	0	0	0	0	0	0	0	0	0	0	-	-	-
	125	18595	18575	20	33397	32001	1395	51992	50576	1415	99.89	95.82	97.28
	0	0	0	0	0	0	0	0	0	0	-	-	-
DAILY TOTALS		206670	205363	1307	465079	454417	10663	671749	659780	11970	99.37	97.71	98.22
	*	222						* 222					
ABSOLUTE DATA TO REVENUE VARIANCE				9635			27978			37613	95.34	93.98	94.40

* ADD THIS AMOUNT TO THE DAILY BILL TOTAL AND THE DAILY REVENUE TOTAL TO ACCOUNT FOR LARGE BILL VALUES COUNTED AT CENTRAL COUNTING

REPORT PREPARED BY Mary Beth Laschober

REPORT APPROVED BY _____

TABLE II

Chicago Transit Authority

Bus Garage: _____ Date: _____

Bus #: _____ Farebox #: _____

Log-on and put Farebox in Off-Peak Mode (# 1).

Deposit	Key	✓	Comments	Deposit	Key	✓	Comments
Full Token	1			2 Dimes + 5 Pennies	7		
Full Token	1			5 Nickels	7		
Full Token	1			N/A	8		
Full Token	1			N/A	8		
1 Bill + 2 Dimes	1			N/A	8		
1 Bill + 2 Dimes	1			N/A	8		
1 Bill + 2 Dimes	1			N/A	8		
1 Bill + 2 Qrtrs.	2			N/A	8		
1 Bill + 2 Qrtrs.	2			N/A	8		
1 Bill + 2 Qrtrs.	2			N/A	8		
1 Bill + 2 Qrtrs.	2			5 Nickels	9		
1 Bill + 2 Qrtrs.	2			3 Nickels + 10 Pennies	9		
1 Bill + 2 Qrtrs.	2			Magnetic Pass Tests	N/A		
1 Bill + 2 Qrtrs.	2			→ Slide Pass + 1 Qrtr.	N/A		
Full Token + 3 Dimes	2			Passback → Slide Pass	N/A		
Full Token + 3 Dimes	2			→ Slide Pass + 1 Qrtr.	N/A		
N/A	3			Passback → Slide Pass	N/A		
N/A	3			→ Slide Pass + 1 Qrtr.	N/A		
N/A	3			Passback → Slide Pass	N/A		
2 qrtrs. + 1 Nickel	4			→ Slide Pass + 1 Qrtr.	N/A		
Half Token	4			Passback → Slide Pass	N/A		
2 Qrtrs. + 2 Dimes	5			→ Slide Pass + 1 Qrtr.	N/A		
N/A	6			Passback → Slide Pass	N/A		
N/A	6			→ Slide Pass + 2 Dimes + 1 Nickel	N/A		
N/A	6			Passback → Slide Pass	N/A		
N/A	6			→ Slide Pass + 2 Dimes + 1 Nickel	N/A		
N/A	6			Passback → Slide Pass	N/A		
N/A	6			→ Slide Pass + 1 Dimes + 3 Nickels	N/A		
1 Qrtr.	7			Passback → Slide Pass	N/A		
1 Qrtr.	7			→ Slide Pass + 2 Dimes + 5 Pennies	N/A		
1 Qrtr.	7			Passback → Slide Pass	N/A		
1 Qrtr.	7			→ Slide Pass + 2 Dimes + 5 Pennies	N/A		
2 Dimes + 1 Nickel	7			Passback → Slide Pass	N/A		

Chicago Transit Authority

System Wide (9 Garages) - Farebox Registration Testing

Garage (# tests)	Current Revenue	Unclsd. Revenue	Dump Cnt.	Fare Cnt.	Key 1	Key 2	Key 3	Key 4	Key 5	Key 6	Key 7	Key 8	Key 9	Key *
Test	***20.70***	***0.00***	***0***	***0***	***7***	***9***	***3***	***2***	***1***	***6***	***7***	***8***	***2***	***0***
North Park (38)	786.71	7.86	16	0	263	338	114	77	37	229	262	303	74	0
Lawndale (15)	312.39	7.79	10	0	103	134	45	30	15	90	106	120	30	0
Archer (25)	516.77	3.62	8	0	176	222	75	50	25	150	175	200	50	0
77th St. (33)	681.28	10.53	25	0	229	291	99	65	33	199	229	265	63	0
69th St. (28)	564.56	18.46	30	0	187	238	84	54	25	168	191	224	53	0
Limits (17)	351.21	3.61	8	0	117	150	52	34	18	102	121	136	32	0
103rd St. (28)	583.10	15.50	23	0	195	249	84	56	28	168	195	225	55	0
Forest Glen (31)	639.78	7.63	26	0	211	276	95	61	30	187	215	247	60	0
Kedzie (30)	621.55	9.40	19	0	207	268	90	61	30	181	209	241	59	0
Total (245)	$5,057.35	$84.40	165	0	1688	2166	738	488	241	1474	1703	1961	476	0
Test X 245	***$5,071.50***	***$0.00***	***0***	***0***	***1715***	***2205***	***735***	***490***	***245***	***1470***	***1715***	***1960***	***490***	***0***
Error	($14.15)	$84.40	165	0	-27	-39	3	-2	-4	4	-12	1	-14	0
% Err	-0.28%				-1.6%	-1.8%	0.4%	-0.4%	-1.6%	0.3%	-0.7%	0.1%	-2.9%	0.0%

Key 1 through 9 Fare Registration	
Data Total	10,935
Test X 245	***11,025***
Error	-90
% Error	-0.82%

	Full Tokens	Reduced Tokens	Magnetic Pass + 0.25	Bills
Data Total	1453	247	2381	2454
Test X 245	***1470***	***245***	***2450***	***2450***
Error	-17	2	-69	4
% Error	-1.16%	0.82%	-2.82%	0.16%

Test

Test performed on each Farebox included a total of 65 individual tests. 45 of these individual tests included a key registration of the Fare. Another 10 of these individual tests inluded a magnetic pass + 25 cents. (the Farebox automatically records this fare and no keys need to be pressed by the operator) The 10 remaining individual tests performed were to test the "Passback" feature of the Magnetic Passes.

Total

Total is the Electronic Data recorded by the Farebox during the "test". The difference between the data and the "test" numbers is caused by coin and bill misreads or misregistration, keypad keys misregistration, and Human error in the test procedure itself.

Bus	TTP 1	TTP 2	TTP 3	TTP 4	TTP 5	TTP 6	TTP 7	TTP 8	TTP 9	TTP 10	TTP 11	TTP 12	Total Tokns	Total Tckts	Total Pass	Total Bills
Test	***0***	***6***	***1***	***0***	***0***	***0***	***0***	***0***	***0***	***10***	***0***	***0***	***7***	***0***	***10***	***10***
NPK (38)	0	223	38	0	0	6	0	0	0	370	0	0	261	0	370	383
LAW (15)	1	91	16	0	0	2	0	0	0	143	0	0	108	0	143	150
ARC (25)	0	150	26	2	0	5	0	0	0	248	0	0	176	2	248	250
77 (33)	2	195	33	2	0	15	0	0	0	319	0	0	230	2	319	330
69 (28)	0	160	30	0	0	3	0	0	0	260	0	0	190	0	260	279
LIM (17)	1	100	17	0	0	8	0	0	0	168	0	0	118	0	168	169
103 (28)	1	172	28	1	0	16	3	0	0	276	0	0	201	4	276	283
FGL (31)	1	181	28	0	0	2	0	0	0	297	0	0	210	0	297	310
KED (30)	1	181	31	0	0	19	0	0	0	300	0	0	213	0	300	300
Total	7	1453	247	5	0	76	3	0	0	2381	0	0	1707	8	2381	2454
Test X 245	***0***	***1470***	***245***	***0***	***0***	***0***	***0***	***0***	***0***	***2450***	***0***	***0***	***1715***	***0***	***2450***	***2450***
Error	7	-17	2	5	0	76	3	0	0	-69	0	0	-8	8	-69	4
% Err		-1.2%	0.8%							-2.8%			-0.5%		-2.8%	0.2%

TTP Definitions:

TTP 1	.900 Tokens	TTP 5	Reserved	TTP 9	CTA Weekly Pass
TTP 2	.650 Tokens	TTP 6	Bills Too Long	TTP 10	CTA 5-Day Pass
TTP 3	.800 Tokens	TTP 7	Bills Too Short	TTP 11	CTA Employee Pass
TTP 4	Tickets	TTP 8	CTA Monthly Pass	TTP 12	PACE Pass

Cashbox Audit

Total 9 Garages

Total 133 Fareboxes
Dates - 08/26, 08/27, 10/08, 11/12, 11/13, 11/16, 11/17, 11/18, 11/19, 1992

	Counted	Data	Difference	%
Pennies	25,093	24,765	328	1.32%
Nickels	22,251	22,104	147	0.67%
Dimes	30,457	30,253	204	0.67%
Quarters	50,427	49,821	606	1.22%
Halves	12	94	(82)	-87.23%
SBAs	3	27	(24)	-88.89%
.650 Tokens	10,720	10,523	197	1.87%
.800 Tokens	5,046	4,931	115	2.33%
Dollar Bills	16,548	16,428	120	0.73%
Large Bills	$15			
Mutilated Bills	0			
Total Tickets		109		
Coin Value	$17,024.93	$16,907.40	$117.53	0.70%
Token Value	$15,639.30	$15,339.65	$299.65	1.95%
Bill Value	$16,563.00	$16,428.00	$135.00	0.82%
Total	$49,227.23	$48,675.05	$552.18	1.13%

Total Nine Vault Audit

Date - 10/09/92, & 11/13/92

RVs # 149, 129, 138, 156, 152, 101, 125, 168, 154

	Counted at C.C.	Coin Offsets *	Farebox Data	Difference	%
Pennies	221,312	50	216,152	5,210	2.41%
Nickels	190,441	66	187,686	2,821	1.50%
Dimes	256,396	165	253,003	3,558	1.41%
Quarters	422,233	304	424,649	(2,112)	-0.50%
Halves	112	5	1,028	(911)	-88.62%
SBA	24	4	282	(254)	-90.07%
.650 Token	100,267	110	97,837	2,540	2.60%
.800 Token	43,563	11	41,678	1,896	4.55%
Total Coin and Token Units	1,234,348	715	1,222,315	12,748	1.04%
Dollar Bills	129,803		134,688		
Large Bills (Qty.)	49				
Mutilated Bills **	2,811				
Total Transfers ***	56				
Total "Bill" Units	132,719		134,688	(1,969)	-1.46%
Total Tickets ****	71		2,960	(2,889)	
Coin Value	$143,013.02		$143,804.37	($791.35)	-0.55%
Token Value	$144,280.05		$140,327.30	$3,952.75	2.82%
Coin & Token Value	$287,293.07		$284,131.67	$3,161.40	1.11%
Bill Value	$132,719.00		$134,688.00	($1,969.00)	-1.46%

* Coin Offsets are foreign coins, tokens, washers, and misc. debris offset by the coin counting machine, but registered by the FB.

** Mutilated Bills are bills that were torn or too worn to be counted by the Bill Counting Machine.

*** Total Transfers are transfers found in the Vault contents.(a transfer is counted as a bill by the farebox)

**** Total tickets are Public Aid Vouchers and torn transfers(too short to count as a bill in the farebox) found in the Vault contents.

1,708 Cashboxes Vaulted, 34 Fareboxes in Bypass, 3 Fareboxes had severe Bill Transport Problems

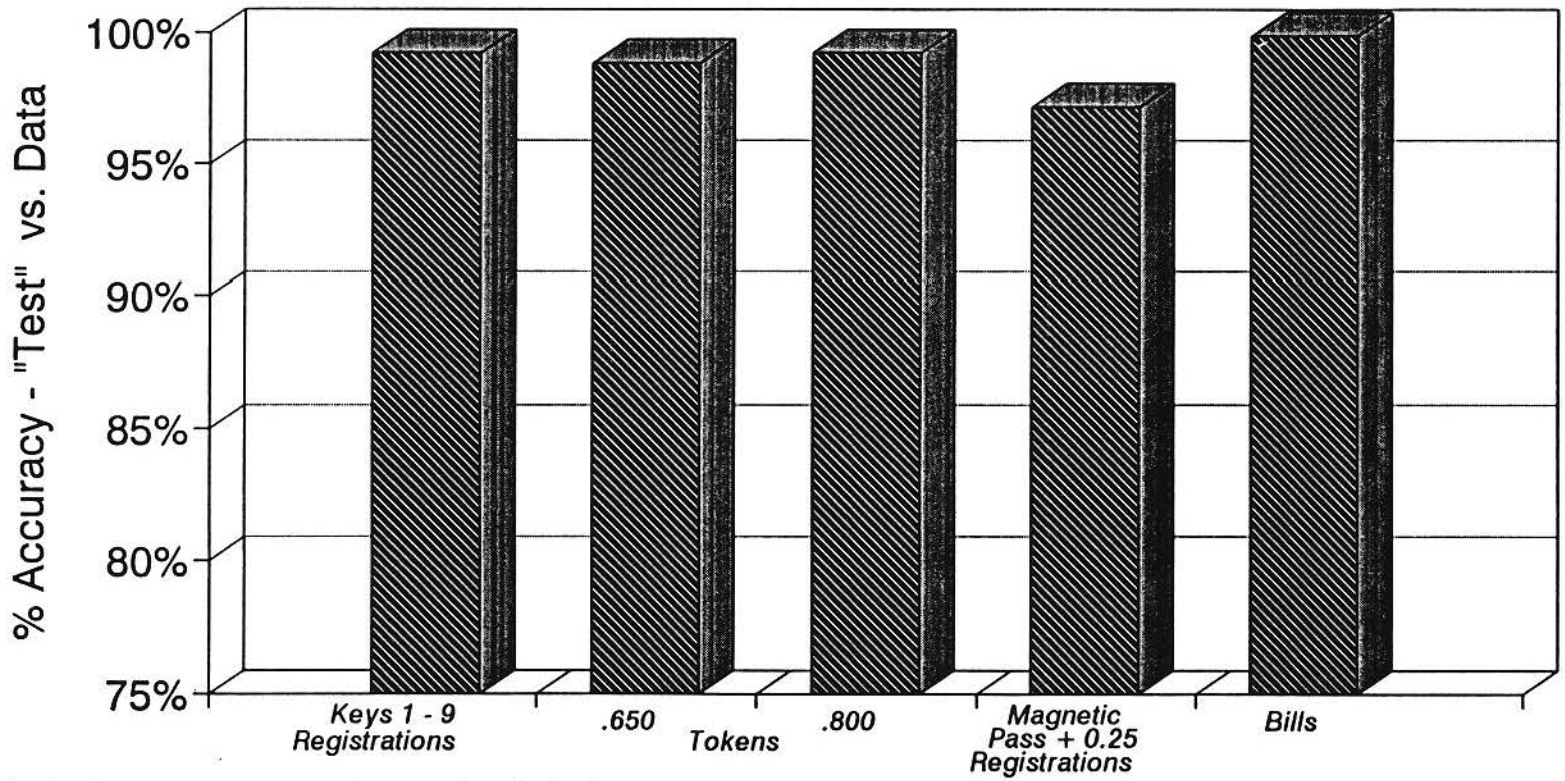
Chicago Transit Authority

Exposed Bills at the Vault Island

GARAGE	DATE	Lane#	# of EXPOSED BILLS	# of OCCURENCES	# of CASHBOXES VAULTED	TOTAL CASHBOX REVENUE	% of OCCURANCE	% of REVENUE
Archer	11/12/92	1	$0	0	64	$6,413.04	0.00%	0.00%
Forest Glen	11/13/92	2	$19	10	91	$20,994.94	10.99%	0.09%
Limits	11/16/92	1	$1	1	105	$18,099.80	0.95%	0.01%
69th	11/17/92	3	$22	8	129	$14,935.00	6.20%	0.15%
Lawndale	11/18/92	2	$0	0	75	$21,201.56	0.00%	0.00%
Kedzie	11/19/92	2	$3	3	58	$15,715.30	5.17%	0.02%
103rd	02/01/93	1	$29	6	122	$24,350.58	4.92%	0.12%
77th	02/02/93	3	$8	6	89	$17,794.76	6.74%	0.04%
North Park	02/03/93	3	$0	0	135	$26,260.34	0.00%	0.00%
TOTAL			$82	34	868	$165,765.32	3.92%	0.05%

Chicago Trasnsit Authority

Farebox Registration Test



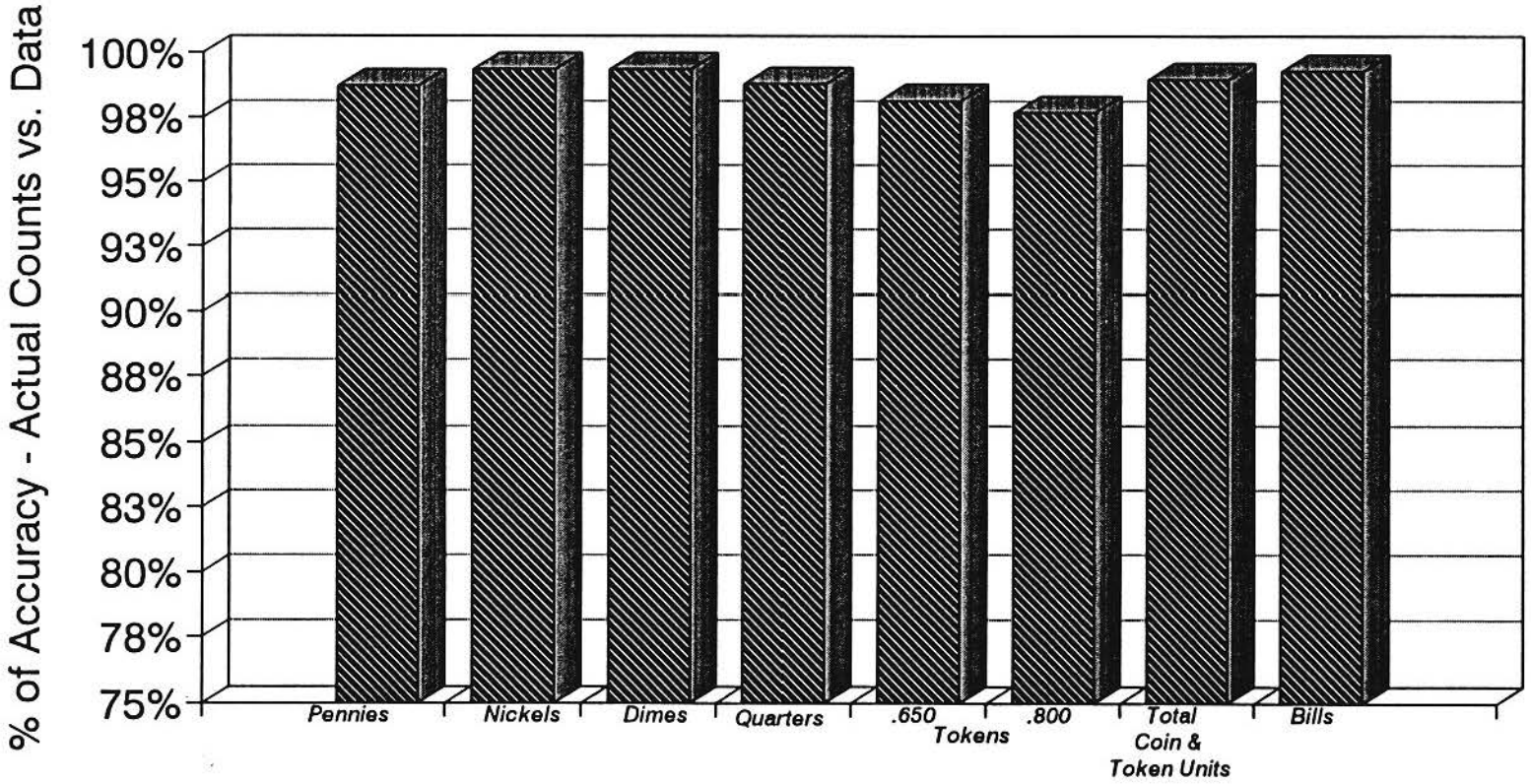
"Test" is what the test procedure should have produced in the data.

245 FBs Tested

Key 1 - 9 Registrations include cash fares and tally or non-cash fares.
Magnetic Pass + 0.25 mis-registrations were primarily due to coin misreads.

Chicago Transit Authority

Cashbox Audit

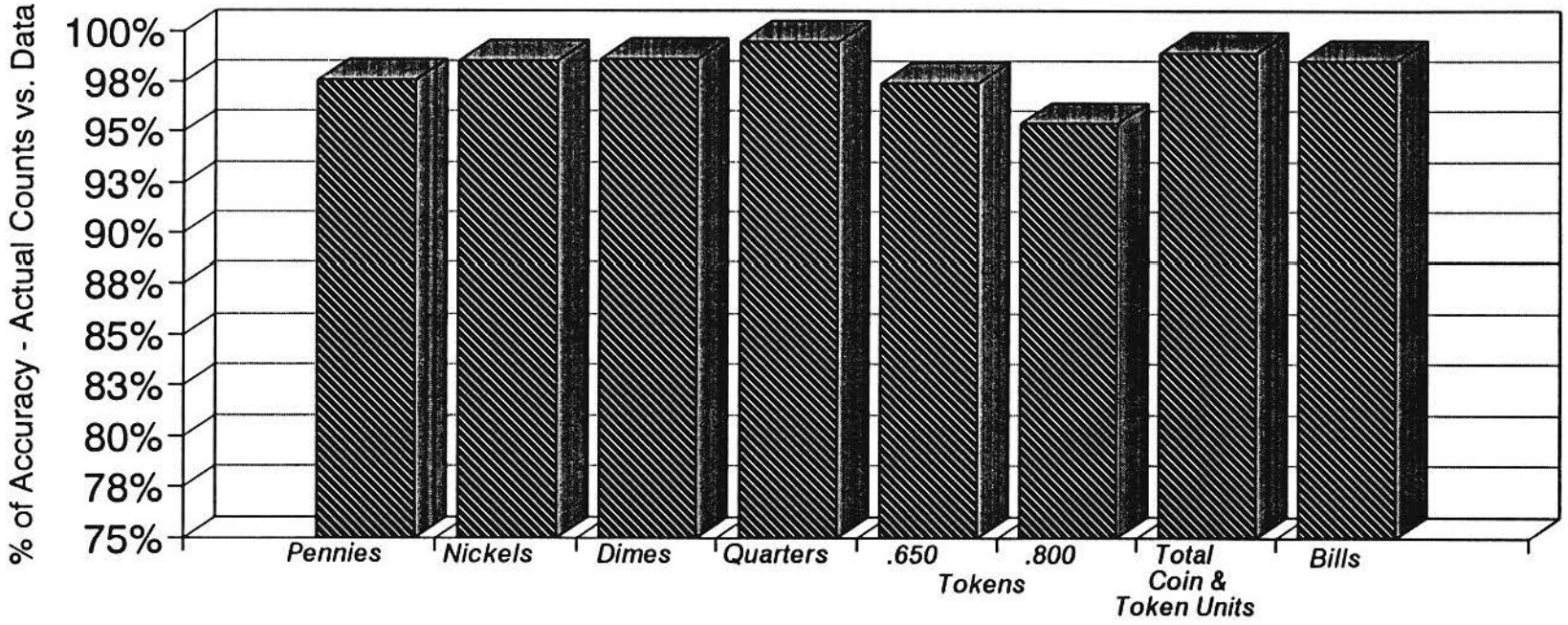


133 CBs Audited

CB Audit had no Bypass or Severe BT Problems involved

Chicago Transit Authority

Receiver Vault Audit



Note: SBAs and Half Dollars were left out of the comparison, but are included in Total Coin & Token Units comparison.

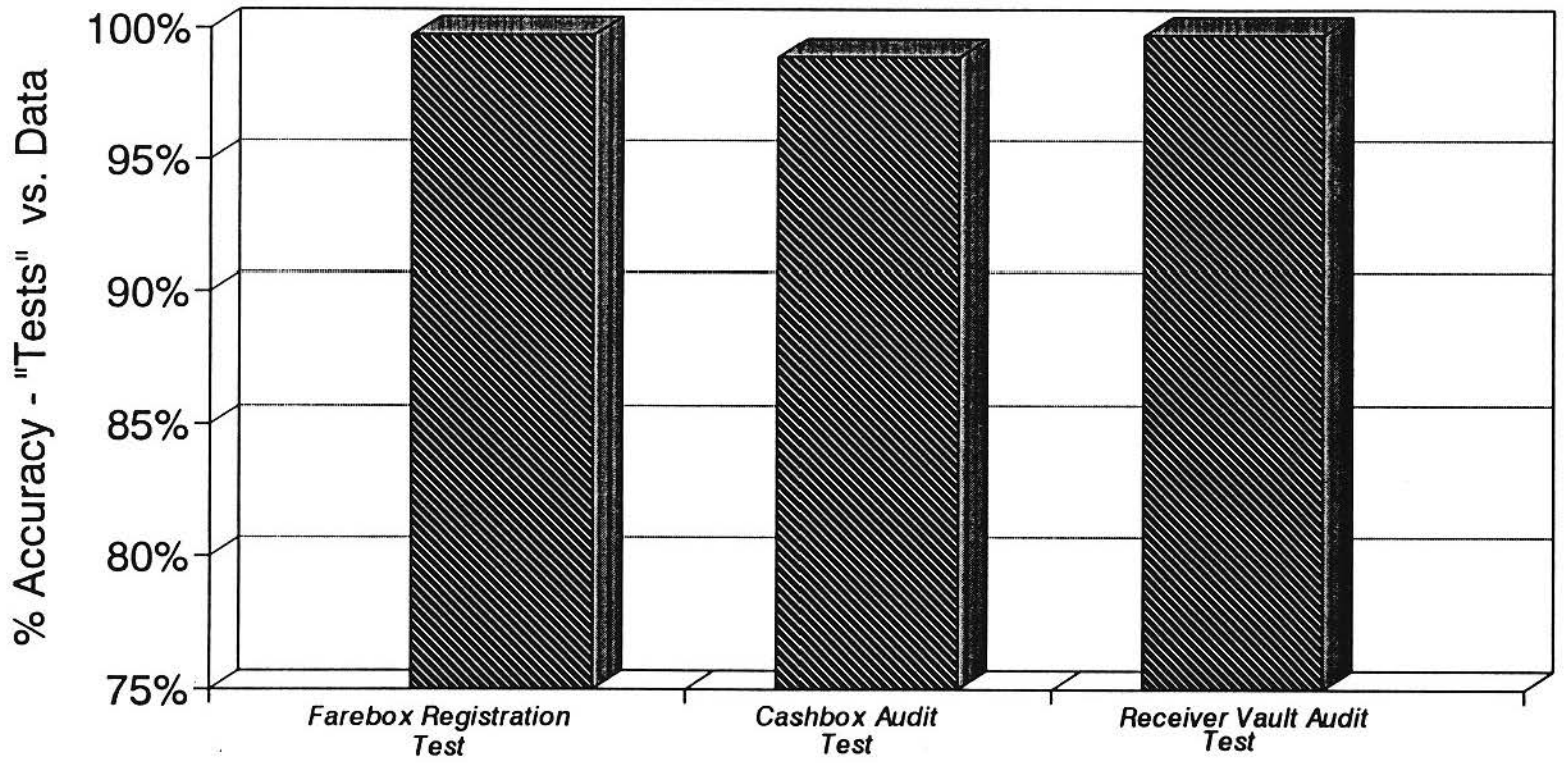
9 RVs - 1708 CBs

34 Fareboxes were in Bypass, and 3 Fareboxes had severe Bill Transport Problems.

Includes Audits for Receiver Vaults 149, 129, 138, 156, 152, 101, 125, 168 and 154.

Chicago Trasnsit Authority

Total Revenue Accuracy



Total Revenu includes Coins, Tokens, and Bill Values.

XVII. PHOTOGRAPHS

Figure 1

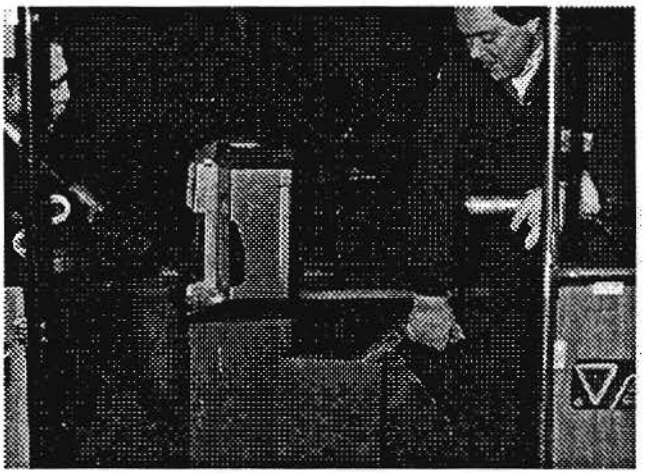


Figure 2

Figure 3

Figure 4

Description:

When a farebox is probed (figure 1), data is sent through the probe to the vault island computer and the probing computer. Probing also unlocks the pedastal door so that the cashbox may be removed (figure 2). The cashbox is turned upside-down (figure 3) and placed inside of the receiver vault where turning a handle causes cashbox contents to be dumped (figure 4).

Figure 5

Figure 6

Figure 7

Description:

A vault truck arrives at a garage with a security guard. The drivers remove reciever vaults from the shrouds (figure 5). The garage General Manager and vault truck personnel sign receipt and vault information forms (figure 6) and secure them inside the receiver vault (figure 7).

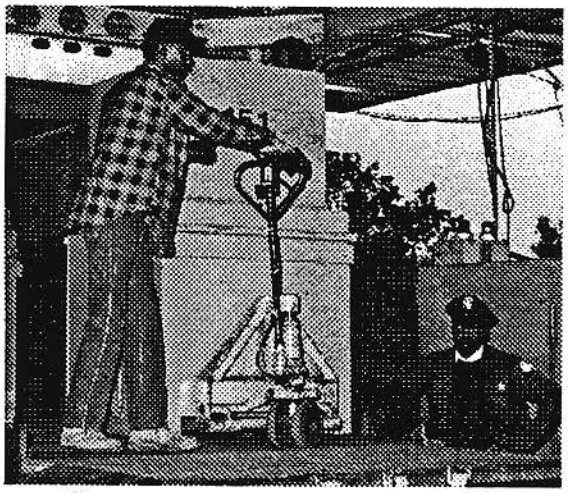


Figure 8

Figure 9

Figure 10

Description:

A full vault is placed on the truck, and an empty one is taken off (figure 8). The empty vault is placed inside of the vacent shroud (figure 9). The truck leaves the garage on route to other garages and the Central Counting facility followed closely by security (figure 10).

Figure 11

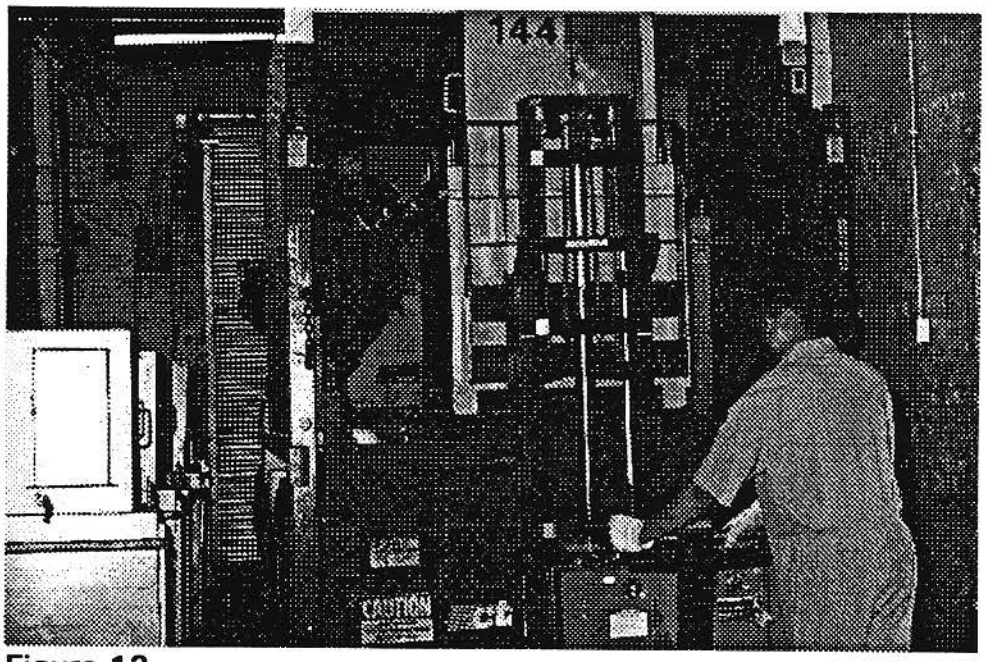


Figure 12

Description:

The vault truck arrives at the Central Counting facility (figure 11) where it is admitted into the drive bay, and its vaults are unloaded by Central Counting personnel (figure 12).

Figure 13

Description:

All Central Counting facility activity is monitored via surveillance camera by the Manager of Central Counting through monitors in his office (figure 13).

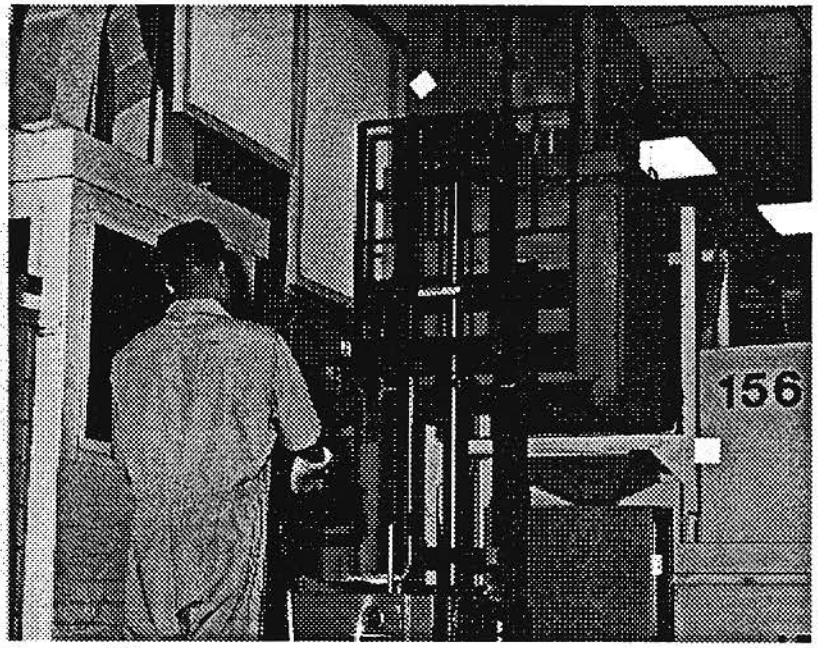


Figure 14

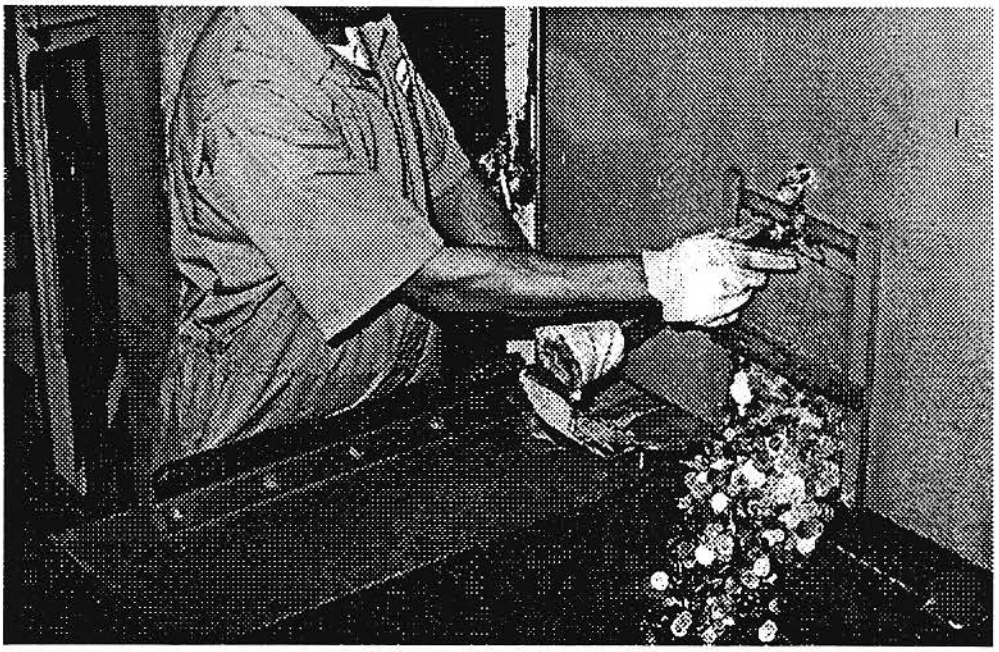


Figure 15

Description:

A full vault is lifted to a platform (figure 14) where a small door is opened and coins inside the vault are allowed to fall freely into a square shaped funnel (figure 15).

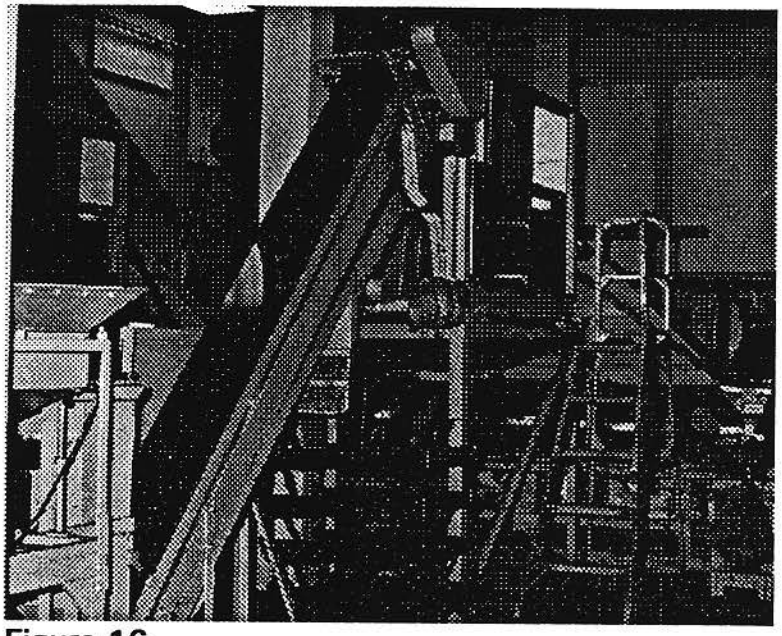


Figure 16

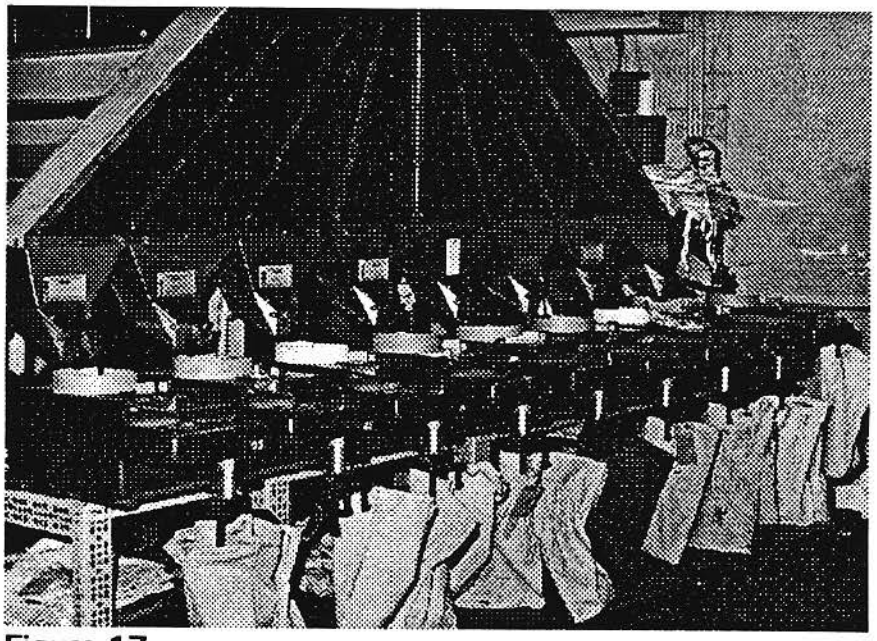


Figure 17

Description:

The coins from the vault fall through the funnel onto a large, inclined conveyor belt and into a huge mechanical coin sorter known by CTA peronnel as the "shaker" (figure 16). The sorted coins fall through chutes and into small electronic counters which have coin bags attached to them (figure 17).

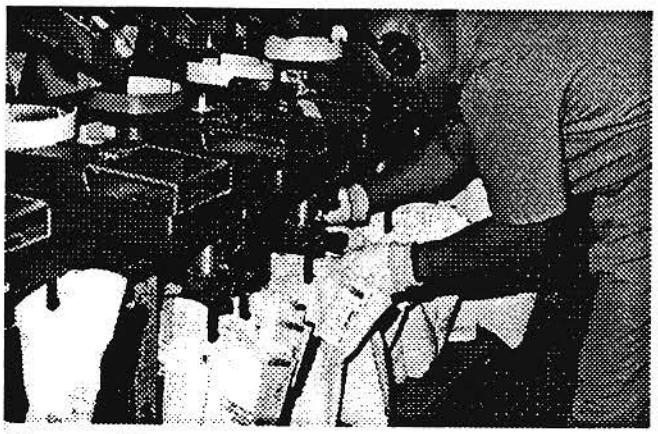


Figure 18

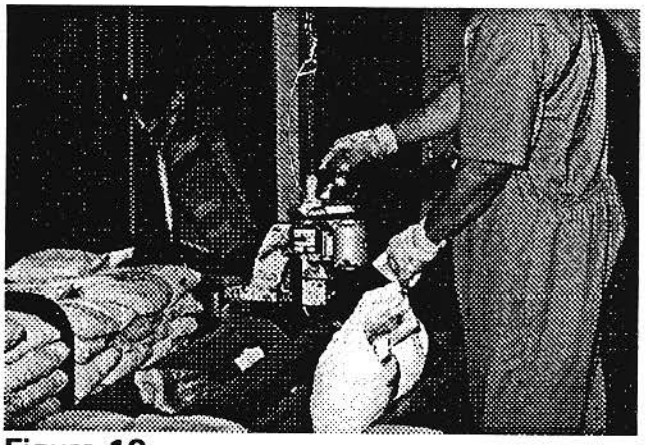


Figure 19

Figure 20

Description:

Full coin bags are removed from the counters (figure 18), sewn shut (figure 19) and stacked ready for transfer to armored car for shipment to the bank (figure 20).

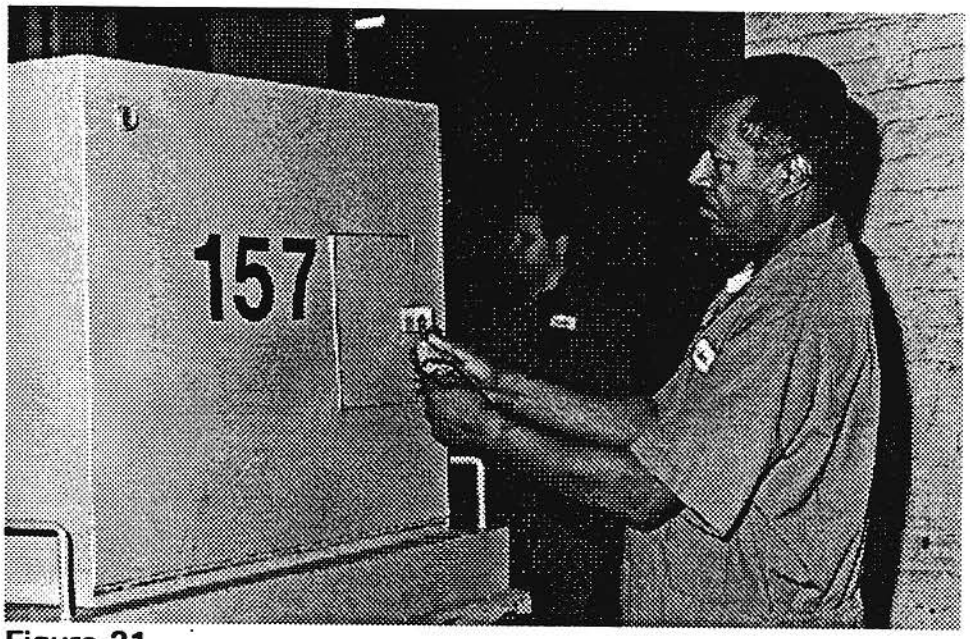


Figure 21

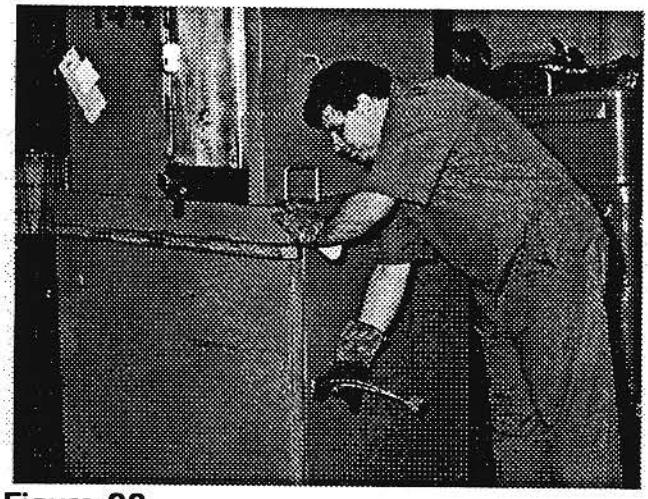


Figure 22

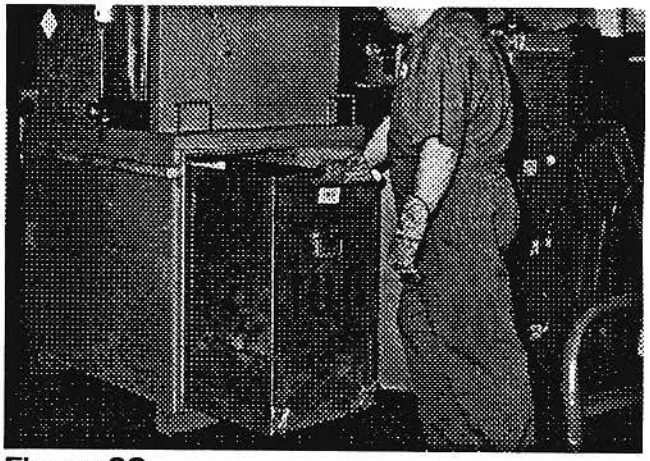


Figure 23

Description:

The paperwork inserted at the bus garage vault island is removed (figure 21). The vault bill storage area is unlocked (figure 22) and the bill bin is removed (figure 23).

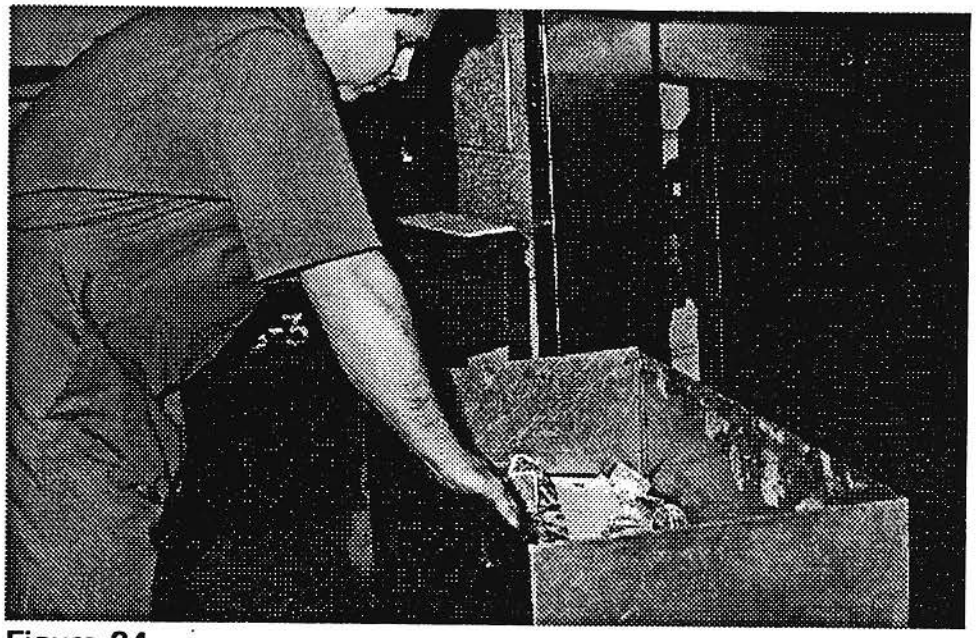


Figure 24

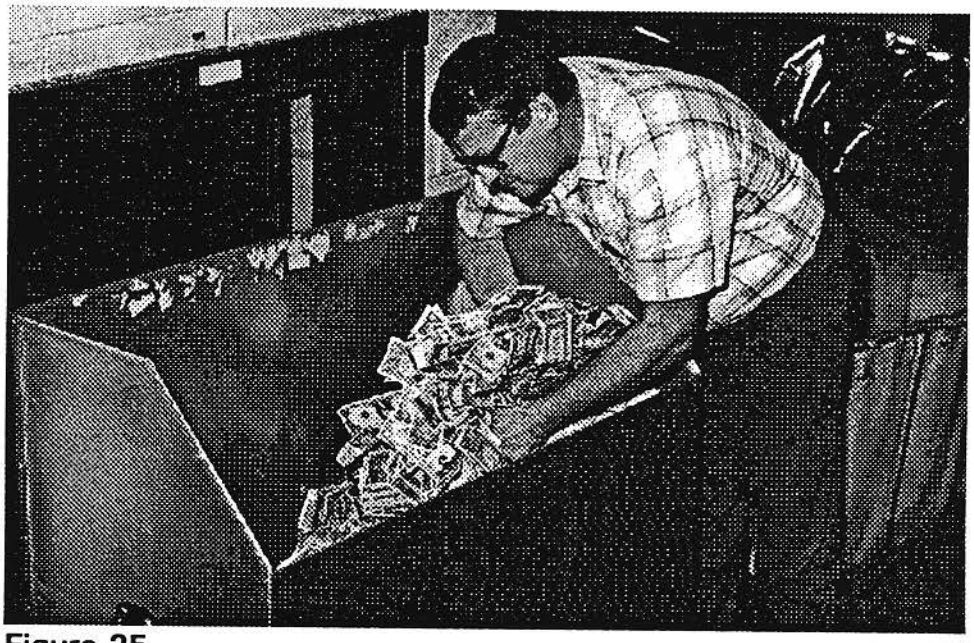


Figure 25

Description:

The bills are sent to the bill processing area via dumb waiter (figure 24) and is received on the second floor (figure 25).

Figure 26

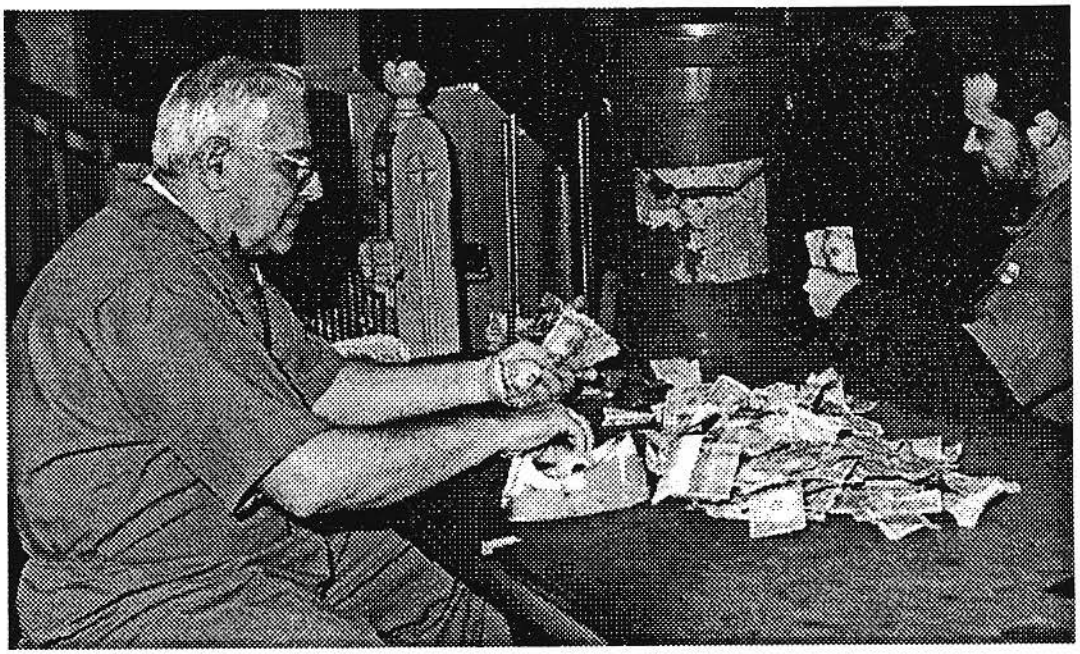


Figure 27

Description:

Each bin is dumped on one of four processing tables (figure 26) where the bills are straightened out and "faced". Non-bill material is also removed here. Worn and mutilated bills are handled at a separate table (figure 27).

Figure 28

Figure 29

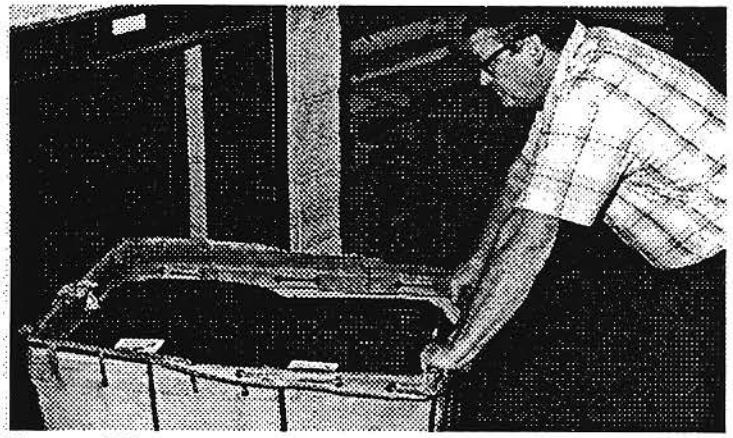


Figure 30

Description:

The straightened bills are counted with state-of-the-art bill counting machines, then wrapped in bricks of $2,000 (figure 28). The bricks are wrapped in bundles of ten to make $20,000 bundles (figure 29), then sent downstairs to the main vault to await deposit (figure 30).

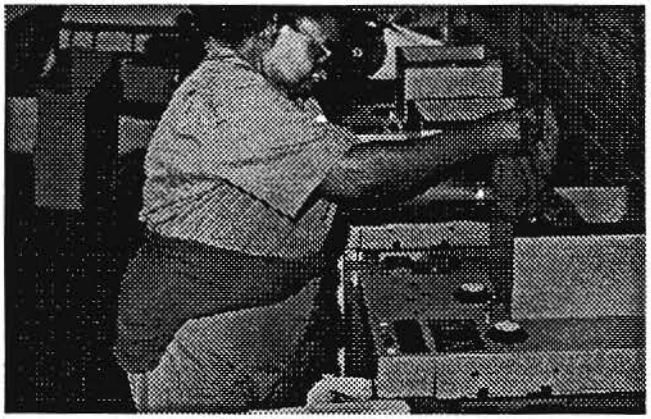


Figure 31

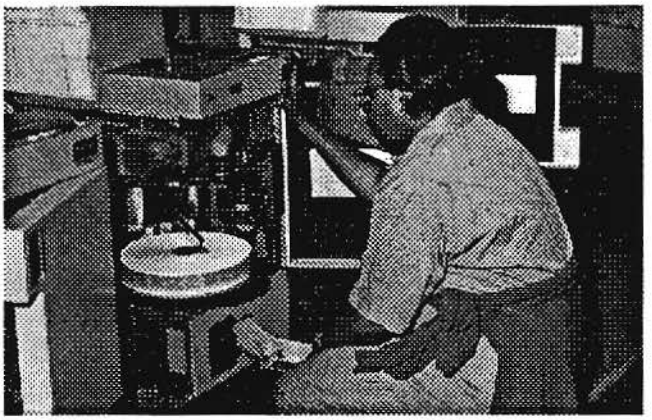


Figure 32

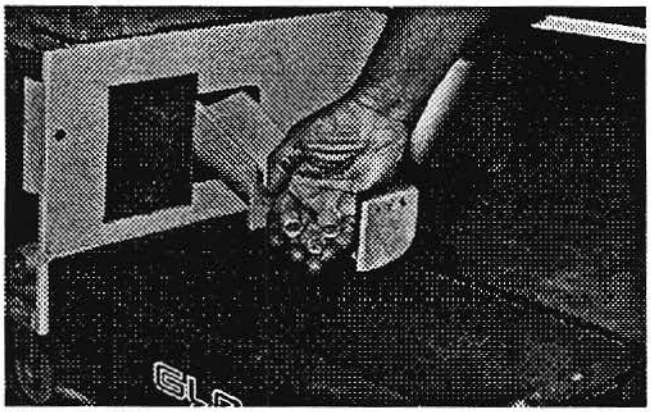


Figure 33

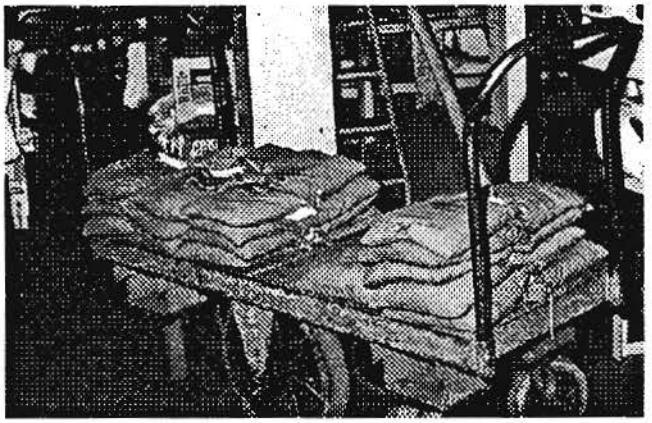


Figure 34

Description:

Tokens that have been sorted and counted on the "shaker" are poured into a token wrapping machine (figure 31). The machine is monitored closely during the wrapping process to minimize trouble and down-time (figure 32). The token wrapping machine securely wraps the tokens in groups of ten (full fare) or twenty (reduced fare)(figure 33). These tokens are sealed in bags to await vendor distribution (figure 34).

Figure 35

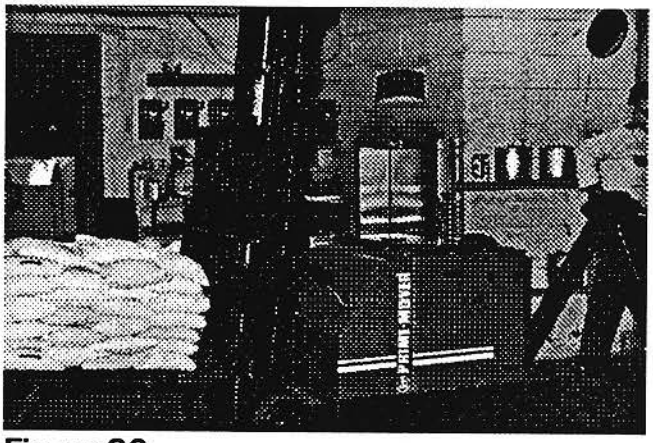


Figure 36

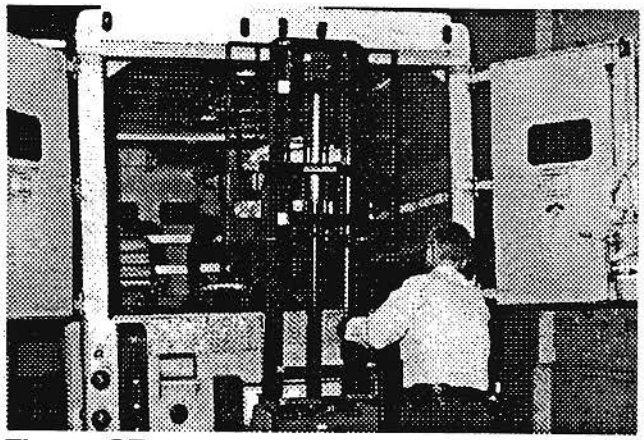


Figure 37

Description:

Processed coins sit ready at the Central Counting facility for pickup by armored car (figure 35). Each pallet weighs approximately 2,500 pounds (over 40 pounds per bag). Armed armor car personnel pick up the coins (figure 36), and places them aboard the vehicle (figure 37).

Figure 38

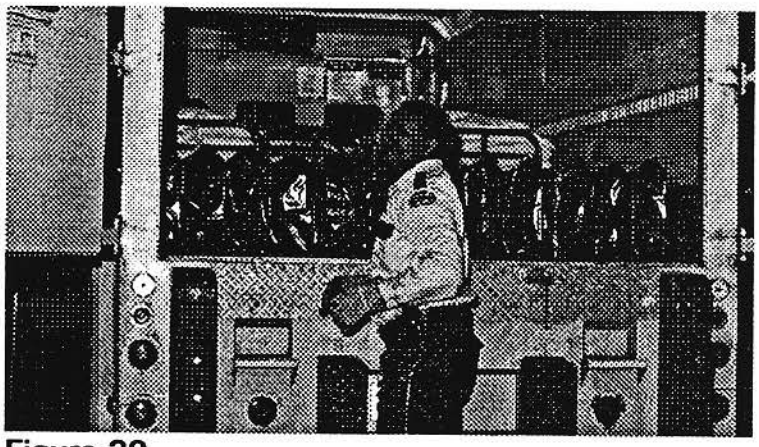


Figure 39

Figure 40

Descripton:

The bundles of bills are collected by armored car personnel (figure 38) and placed on the vehicle with the previously stored coins (figure 39). The armored car service then leaves the Central Counting facility to deliver the money to the bank (figure 40).

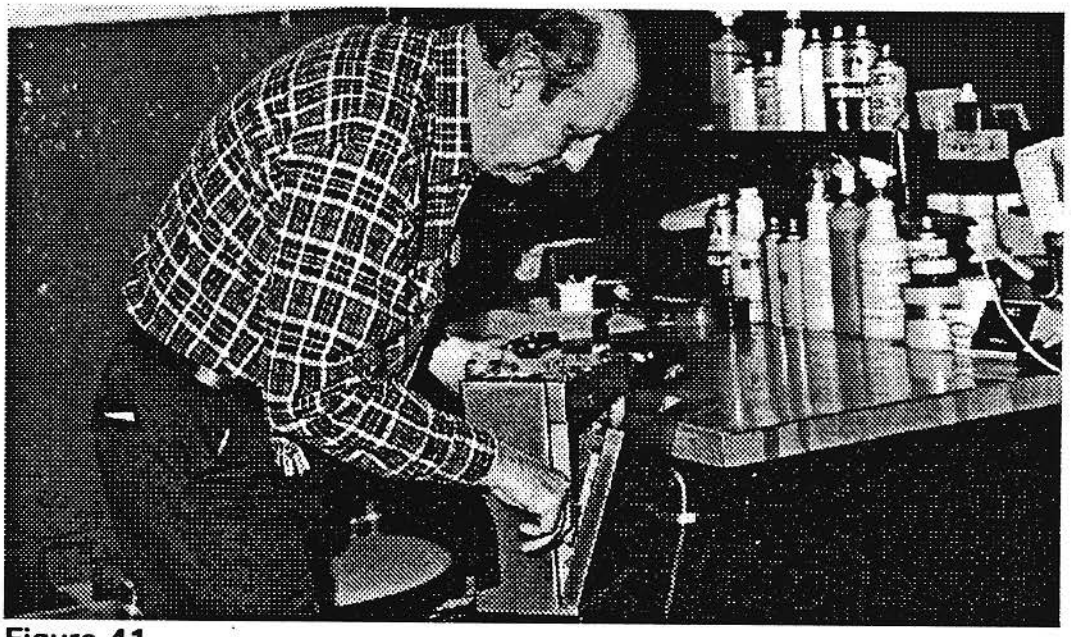


Figure 41

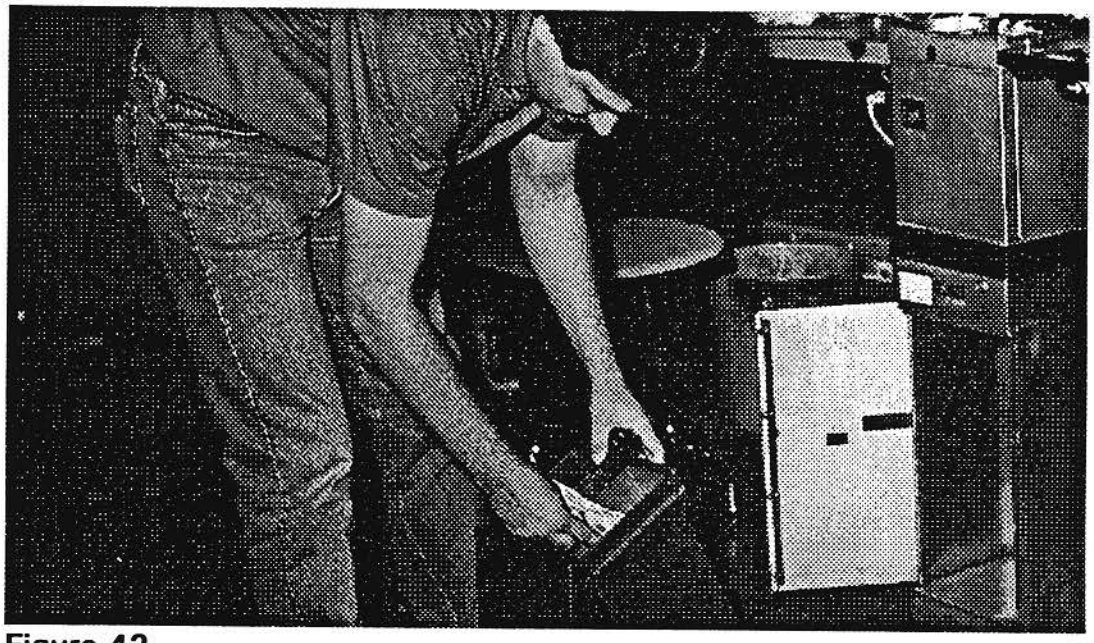


Figure 42

Description:

Farebox maintenance shop personnel repair fareboxes that are too damaged to be repaired at the garages by field personnel (figure 41). Occasionally, a malfunctioning farebox may have a cashbox that has retained money (figure 42). This money is counted and recorded, and the audit trail information is kept on file for later reconciliation with the vault that the cashbox was originally dumped into.

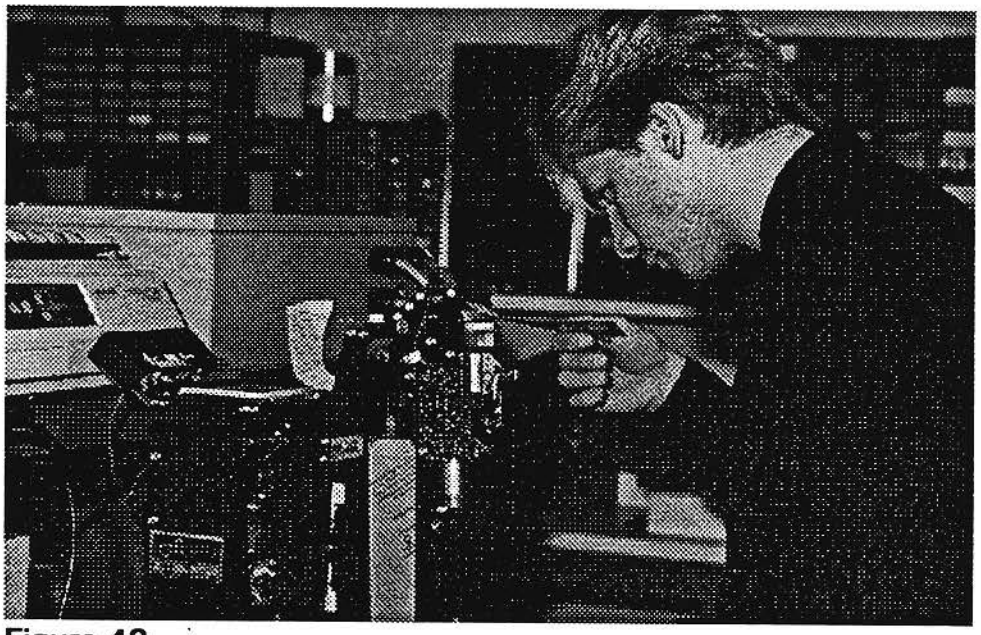


Figure 43

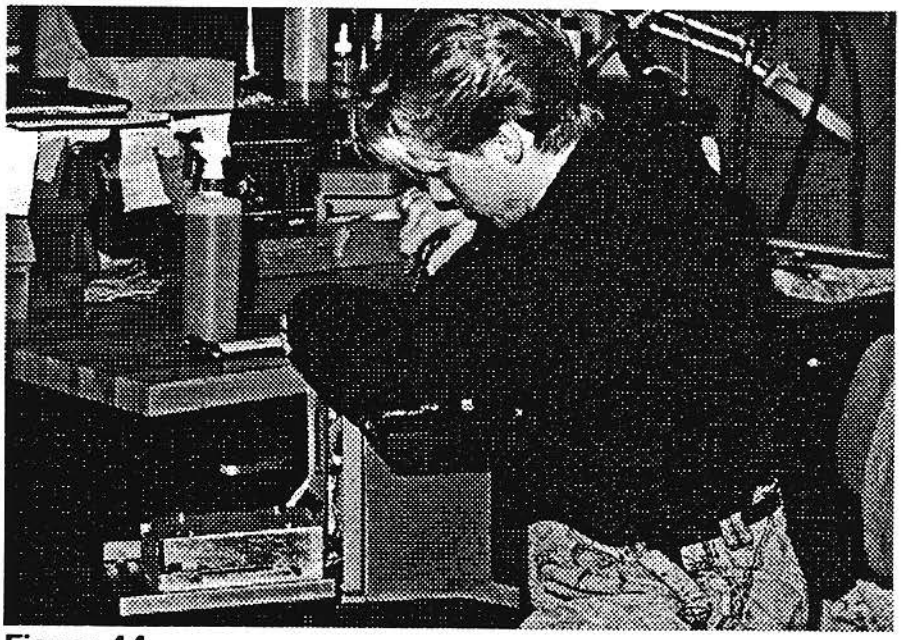


Figure 44

Description:

Farebox maintenance field personnel perform regular testing of equipment to insure proper operation (figure 43) and do on-site repairs at the garages (figure 44).

Figure 45

Description:

The Network Manager controls all the data processing (figure 45). All bus garage probing computers communicate with the Network Manager to provide information from all probed fareboxes.