Urban Mass
Transportation
Administration

Field Testing of Electronic Registering Fareboxes

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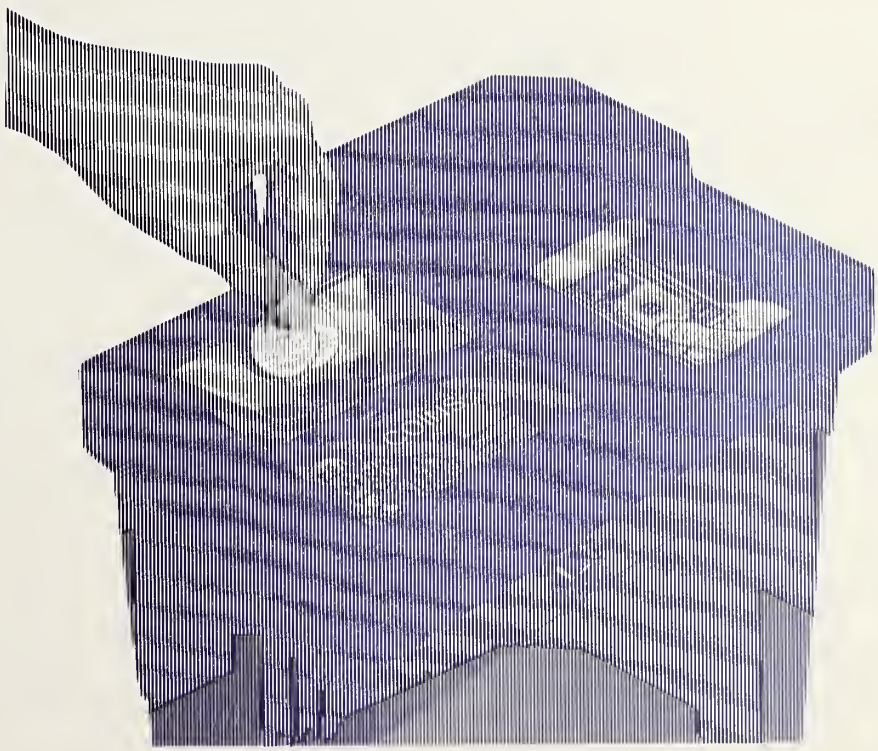
Final Report



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Kathryn E. Derr and Michael G. Ferreri

9. Performing Organization Name and Address

Booz, Allen & Hamilton, Inc.*
Transportation Consulting Division
7315 Wisconsin Avenue
Bethesda, Maryland 20814

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16. Abstract

This study is one element in an UMTA-sponsored program to achieve more uniform data collection, analysis and reporting among the transit systems and to improve communications about fare collection issues such as bill handling. This report presents the findings of a field test and evaluation of electronic registering fareboxes at the Detroit Department of Transportation (DDOT). It is pointed out that the farebox evaluation was conducted at a time when many U.S. transit systems are raising adult base fares to $1.00 or more and are facing a large increase in the number of bills collected and counted daily. Thirty-two fareboxes were tested on one bus route, which was Woodward Avenue. This route was selected because it generates a high volume of dollar bills. The farebox specification called for a 600-bill cashbox capacity. The principal objective of the farebox evaluation was to determine the extent to which bill-handling fareboxes could increase fare revenues and improve revenue security. The study objectives are as follows: 1) to determine the accuracy of the total fareboxes serving Woodward Avenue in counting total revenue; 2) to determine the accuracy of individual fareboxes in counting revenue; 3) to determine the reliability of the farebox; 4) to determine the labor requirements for farebox and vault receiver maintenance; 5) to determine the frequency of service interruptions due to farebox jams and/or road calls for farebox repairs; 6) to determine the impact of the farebox on DDOT revenues; and 7) to determine the impact of the farebox on revenue security.

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PREFACE

This evaluation of the performance of electronic registering fareboxes was conducted as part of the bus transit fare collection program being conducted by the Transportation Systems Center (TSC) Office of Research and Analysis. The work was sponsored by the Urban Mass Transportation Administration (UMTA) Office of Bus and Paratransit Systems.

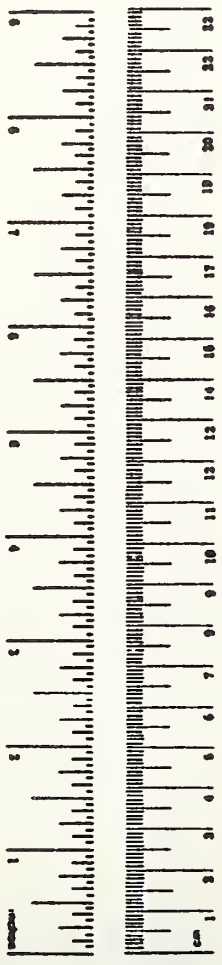
Technical guidance for this study was provided by the contract technical monitor, Joseph S. Koziol of TSC. Additional technical guidance was provided by Claryce Ossman, the Detroit Department of Transportation's project manager for the study and Vincent R. DeMarco of the UMTA Office of Bus and Paratransit Systems.

The Booz, Allen officer in charge of this assignment was Michael G. Ferreri. Kathryn E. Derr was the project manager.

METRIC CONVERSION FACTORS

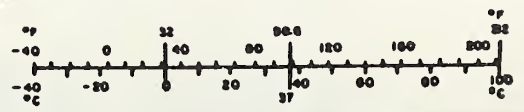
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



C O N T E N T S

F I G U R E S

T A B L E S

EXECUTIVE SUMMARY

This report presents the results of a field test of electronic registering fareboxes at the Detroit Department of Transportation. The fareboxes were operated in transit service on one heavily traveled bus route, Woodward Avenue. Data on farebox performance was collected daily by DDOT operating and farebox maintenance staff. The principal issues examined during the study were the farebox's ability to reduce pilferage, improve revenue security, operate reliably and handle a large volume of dollar bills.

KEY FINDINGS

1. The GFI Farebox Has Increased Revenues on Woodward Avenue

   The mean revenue per rider on Woodward Avenue with the GFI farebox increased by 18 percent over operations with the Cleveland farebox, from an average $.44 per passenger to $.52 per passenger.

2. The GFI Farebox Has Substantially Reduced the Problem of Mutilated and Torn Currency

   Some bill mutilation still occurs when an over-full cashbox is removed from the farebox and a bill is accidentally torn. However, there were no half dollar bills deposited into the GFI farebox by passengers.

3. Revenue Security Is Very High with the GFI Farebox

   From the time the fareboxes were installed by DDOT in November 1984 until the end of the test period in May 1985, there were no board actions for revenue pilfering from the GFI equipment.

4. At the End of Six Months of Operation, the Counting Accuracy of the GFI Fareboxes Ranged from 93.9 to 99.9 Percent

   During the last 14 days of the six month farebox operation period, the combined daily accuracy of the fareboxes ranged from 93.9 to 99.9 percent. This accuracy level is an improvement over earlier poorer readings but is still short of the desired consistent accuracy of 99 percent.

5. On the Average, One Farebox Was Capable of Operating 4.4 Days Between Equipment Failures

At the end of a six month operating period there were 129 equipment failures for 566 farebox operating days, or one failure per farebox every 4.4 days. The principal locations of the failures were the bill stuffer, the bill transport and the coin mechanism.

- The bill stuffer continues to become jammed with bills and tickets. This jamming is typically caused either by an over-filled cashbox or a failure in the stuffer such as bent fingers, a ruptured spring, or bent shaft. The stuffer has difficulty processing DDOT transfer tickets which are slightly thicker than the other tickets.

- The bill transport averaged nine equipment failures per week over the last five weeks of the test period. Causes of failure are tickets and bills jamming at the top of the transport, tickets becoming misaligned and lodging under the belt and tickets lodging in the inspection window.

- The coin mechanism averaged two equipment failures per week. Occasionally, two coins will double up and jam the coin reader or lint will block the light emitting diodes (LEDs) thus causing an inaccurate coin reading.

6. Detroit DOT's Passengers Are Causing a Large Number of Farebox Jams

At the end of the six month farebox operating period, passenger-caused jams were equal to 74 percent of the number of failures attributed to the equipment. Over a five week period there were 129 failures attributed to faults in the equipment and there were 95 passenger-caused jams. Passengers cause farebox jams by:

- Inserting folded dollar bills or tickets into the coin slot.

- Inserting strips of tickets or stapled tickets into the bill slot.

- Inserting a dime wrapped inside a dollar bill into the coin slot (one adult fare plus a transfer costs $1.10).

- Inserting folded bills into the bill slot.

This high level of passenger-caused jams is partly due to the fact that the farebox is only installed on one route and many passengers remain unfamiliar with its operation. Fleet-wide installation of a bill accepting farebox is expected to reduce the frequency of passenger caused jams.

7. Both the Frequency and Duration of Farebox Repairs Declined over the Farebox Test Period

The total maintenance and repair actions on the GFI farebox declined from an average of 61 actions per week in November and December to 45 per week in late April and early May. The time spent in performing these repairs also declined, from an average of 9.5 hours per week to 2.5 hours per week. These labor hours include all component removals and replacements and simple repairs. Since the fareboxes are under warranty, more extensive repairs are performed by GFI at the company's plant. At DDOT, the repair or replacement of a farebox component takes an average 3.5 minutes, according to the repair times reported by the farebox technicians.

RECOMMENDATIONS

1. DDOT Should Proceed with Fleet-wide Installation of Bill Accepting Fareboxes

Despite some technical difficulties, the new farebox has proven that it can reduce revenue losses due to short fares and pilferage and increase revenue security. The frequency of jams currently experienced with the GFI farebox is expected to decrease after fleet-wide installation when DDOT's passengers become more familiar with the farebox operation. The electronic registering farebox offers a potential for lower cost revenue collection than the current Cleveland fareboxes due partly to the better condition of dollar bills received.

2. DDOT Should Consider the Costs and Benefits of Substituting Tokens for One or All Three of Its Fare Tickets

DDOT increased the size of the transfer ticket to make it more compatible with the farebox, however, the transfer tickets are still causing jams in the bill stuffer. Also, the high volume of tickets collected daily may be reducing the remaining available bill capacity of the cashbox. The introduction of tokens as a replacement for the tickets will reduce farebox jams and increase bill handling capacity. In addition, the tokens can more easily be counted by machine. Currently, tickets are counted in two ways, either individually by hand or by weighing them on a scale.

3. The Farebox Equipment Specifications Should Require an Enhanced Bill and Ticket Handling Capacity

The present bill stuffer design should be modified to improve its paper handling capacity if tickets are retained by DDOT as a fare media. The bill stuffer is a recent enhancement to the GFI farebox; much of the component's development has been the direct result of in-service testing experience in Detroit. The bill stuffer design is not yet adequate to handle the large volume of bills and tickets collected daily by DDOT.

4. DDOT Should Consider Increased Incentives for Operators to Prevent Passenger Caused Farebox Jams

Many of Detroit's farebox maintenance actions are due to passengers inserting bills or tickets into the coin mechanism. Such farebox abuse is discouraged at the Chicago City Transit Authority by disciplinary action against coach operators. DDOT should explore the feasibility of instituting stricter requirements for its operators to observe and enforce proper fare insertion procedures.

1. OBJECTIVES OF THE EVALUATION

This report presents the findings of a field test and evaluation of electronic registering fareboxes at the Detroit Department of Transportation (DDOT). The farebox evaluation was conducted at a time when many U.S. transit systems are raising adult base fares to $1.00 or more and are facing a large increase in the number of bills collected and counted daily. The Urban Mass Transportation Administration provided financial and technical assistance to this farebox study so that the results could be published for the benefit of other transit systems with fare collection problems similar to those of Detroit.

This chapter describes the revenue problems experienced by Detroit that constituted the need for effective ways to deal with the dollar bill, the objectives of the study, and the study participants.

1.1 THE NEED FOR THE STUDY

The Detroit Department of Transportation raised the adult base fare on July 1, 1983 from $.75 to $1.00. This fare change caused a dramatic increase in the number of dollar bills collected daily and compounded several previously recognized and growing problems:

- Revenue Losses Through Short Fares. Passengers increasingly inserted folded or crumpled half dollar bills into the circa 1940 Cleveland fareboxes. Estimated losses due to these short fares approached $1,200 per day.

- Farebox Jams and Equipment Damage. The Cleveland fareboxes were not designed to handle the large volumes of dollar bills that followed the fare increases. Jams increased substantially and delays in transit service occurred as supervisors responded to road calls to unjam the fareboxes.

- Reduced Revenue Security. The inability of the existing revenue handling equipment to contain the volume of bills being received led to an increase in revenue security breaches by the transit system.

In an attempt to address these problems, the DDOT decided to test in revenue service technologically improved fare handling equipment designed to accept dollar bills as well as coins, tokens, and tickets. An expected result of the test was a recommendation on the type of equipment which would successfully reduce revenue losses at DDOT and reduce current related farebox operating and maintenance requirements.

1.2 FAREBOX EVALUATION OBJECTIVES

The principal objective of the farebox evaluation was to determine the extent to which bill-handling fareboxes could increase fare revenues and improve revenue security. The study objectives were outlined in a test plan which was prepared and adopted at the beginning of the project. The key study objectives and corresponding evaluation measures documented in that plan are shown in Table 1-1. Study objectives included determining the accuracy, reliability, maintainability, and security of the fareboxes. The test plan is reproduced in Appendix A.

1.3 PROJECT PARTICIPANTS

The organizations that participated in the study include UMTA, the Transportation Systems Center, the Detroit Department of Transportation, and Booz, Allen & Hamilton Inc.

The Urban Mass Transportation Administration (UMTA) funded the study under the UMTA Section VI program. UMTA's Office of Bus and Paratransit Systems provided sponsorship of the study.

Transportation Systems Center (TSC), U.S. Department of Transportation, is conducting the bus transit fare collection program, which is addressing three major problem areas in bus transit fare collection: bill handling, farebox limitations, and lost revenues. TSC provided technical guidance to this field test of fareboxes in Detroit.

Detroit Department of Transportation (DDOT). Farebox operations and all data collection for the study were accomplished by DDOT staff. In addition, DDOT provided information on the manufacturer's responses to technical problems in the fareboxes.

Booz, Allen & Hamilton Inc. Booz, Allen developed the farebox test plan, performed the farebox test data analysis and prepared the study findings and recommendations.

TABLE 1-1. FAREBOX EVALUATION TEST OBJECTIVES AND PERFORMANCE MEASURES

Test Objective	Performance Measure
1. Determine the accuracy of the total fareboxes serving Woodward Ave. in counting total revenue.	. The daily total accuracy of all farebox meter readings combined.
2. Determine the accuracy of individual fareboxes in counting revenue.	. The results of individual farebox audits.
3. Determine the reliability of the farebox.	. Total failures per week for the fareboxes. . Average number of operating days per farebox per failure.
4. Determine the labor requirements for farebox and vault receiver maintenance.	. Total labor hours required for farebox maintenance.
5. Determine the frequency of service interruptions due to farebox jams and/or road calls for farebox repairs.	. The frequency and duration of farebox jams and road calls.
6. Determine the impact of the farebox on DDOT revenues.	. The average revenues per rider on Woodward Avenue.
7. Determine the impact of the farebox on revenue security.	. The number of board actions against employees for pilfering from GFI fareboxes.

Source: "Fare Collection Equipment Evaluation and Test Plan for the Detroit Department of Transportation", Booz, Allen & Hamilton Inc., November 13, 1984.

2. DESCRIPTION OF DETROIT OPERATING ENVIRONMENT

Thirty-two electronic registering fareboxes were procured from General Farebox Inc. (GFI) and tested by the Detroit Department of Transportation on one of the transit system's most heavily traveled routes. Analysis of the performance of the fareboxes extended over 4 months. This chapter describes the farebox operating environment at DDOT.

2.1 DETROIT DEPARTMENT OF TRANSPORTATION

The Detroit Department of Transportation (DDOT) provides transit service to the City of Detroit and the surrounding metropolitan area. Communities neighboring Detroit such as Livonia, Northland, Oak Park and East Detroit are served by the transit system. DDOT connects downtown Detroit with Tiger Stadium, the State Fairgrounds, Wayne State University, Rouge Park and most major industrial and professional centers within a radius of 15 miles from the downtown area.

DDOT operates over 600 coaches on 59 local routes and 19 express routes. At the time of this study, 342 buses were scheduled for the a.m. peak and 366 buses were scheduled for the p.m. peak. One of the busiest routes, Route 53 -- Woodward Avenue, was selected as the site for field testing of the GFI fareboxes.

2.2 DESCRIPTION OF TEST ROUTE

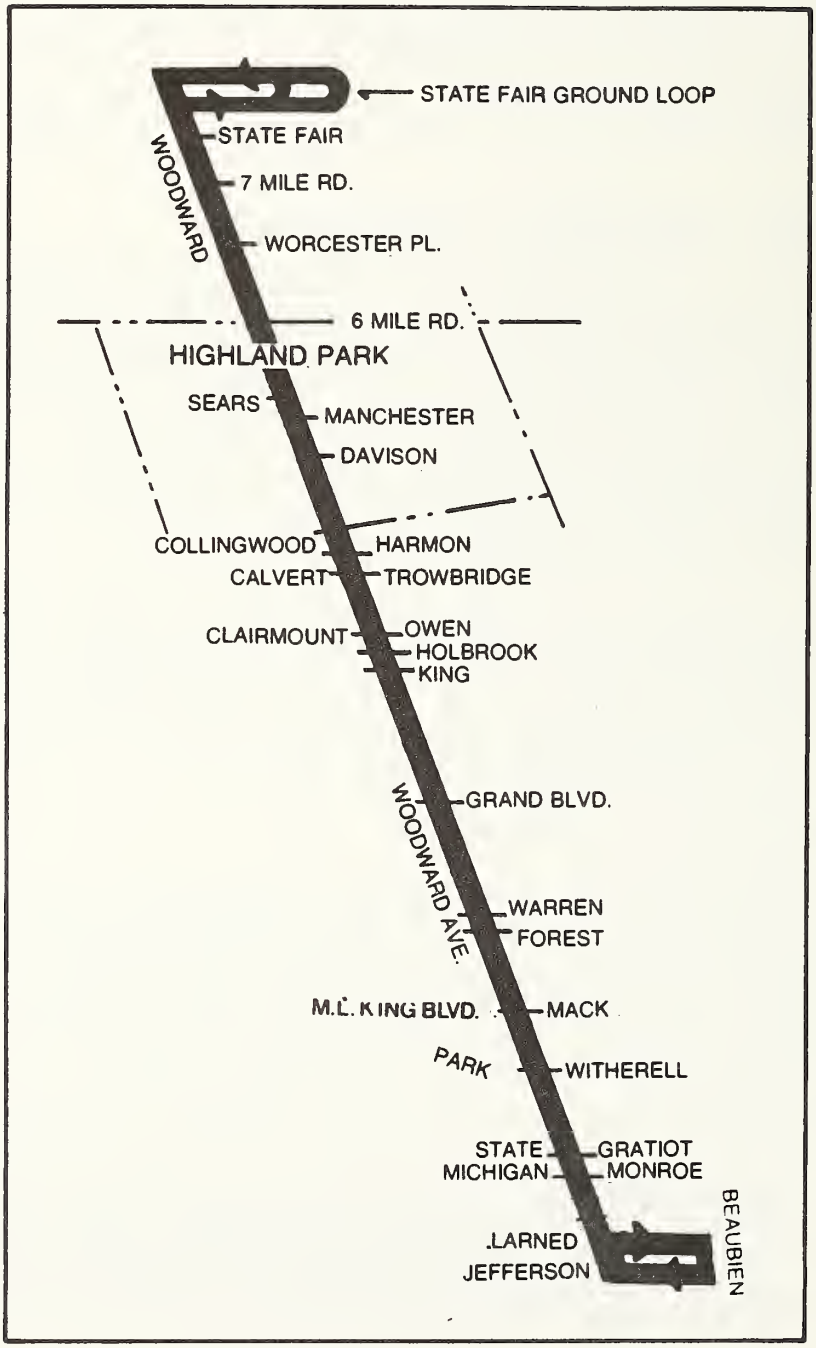
The Woodward Avenue route was selected as the site for trial operation of the electronic fareboxes because (1) it is one of the most heavily traveled routes and (2) it generates a high volume of dollar bills. The route has 32 scheduled runs per day. The maximum number of coaches scheduled for peak periods on Woodward Avenue is 18.

Characteristics of the route include the following:

- Route Length. A round trip on the Woodward Avenue route covers 18.04 miles. The route runs from the Fairgrounds north of Seven Mile Road to the downtown area and back to the Fairgrounds (see Figure 2-1).

- Hours of Service. Buses run on Woodward Avenue 24 hours a day. The first run of the day pulls out at 3:45 a.m.; the last run pulls in at 4:20 a.m.

FIGURE 2-1. WOODWARD AVENUE BUS ROUTE



- Headways. The minimum headway on Woodward Avenue is 7 minutes; the maximum headway is 20 minutes.

- Bill Volume. Typically on a weekday approximately 6,000 dollar bills are collected on Woodward Avenue. On a weekend day this number ranges from 1,600 to 3,000. Bills constitute approximately 70 percent of Woodward Avenue currency and coin revenue.

- Percent of Total DDOT Revenue. Woodward Avenue currency and coin revenue ranges from 7 to 10 percent of total DDOT daily cash revenue.

All buses operating on Woodward Avenue are serviced at Gilbert Terminal, one of three bus terminals operated by DDOT. A small building located at the terminal called the Boxhouse is where the buses pull in for farebox vault pulling. The vault pullers at the Gilbert Terminal Boxhouse are presently handling both GFI and Cleveland vaults.

3. START-UP ACTIVITIES AND TEST SCHEDULE

The most important activities undertaken by DDOT in preparation for the farebox installation were public education to familiarize Detroit transit riders with the GFI electronic farebox equipment, and coach operator education on the proper operation of the fareboxes. The following sections describe these preparations. The test schedule for the entire project is also presented.

3.1 TRANSIT RIDER FAMILIARIZATION WITH THE GFI ELECTRONIC FAREBOX

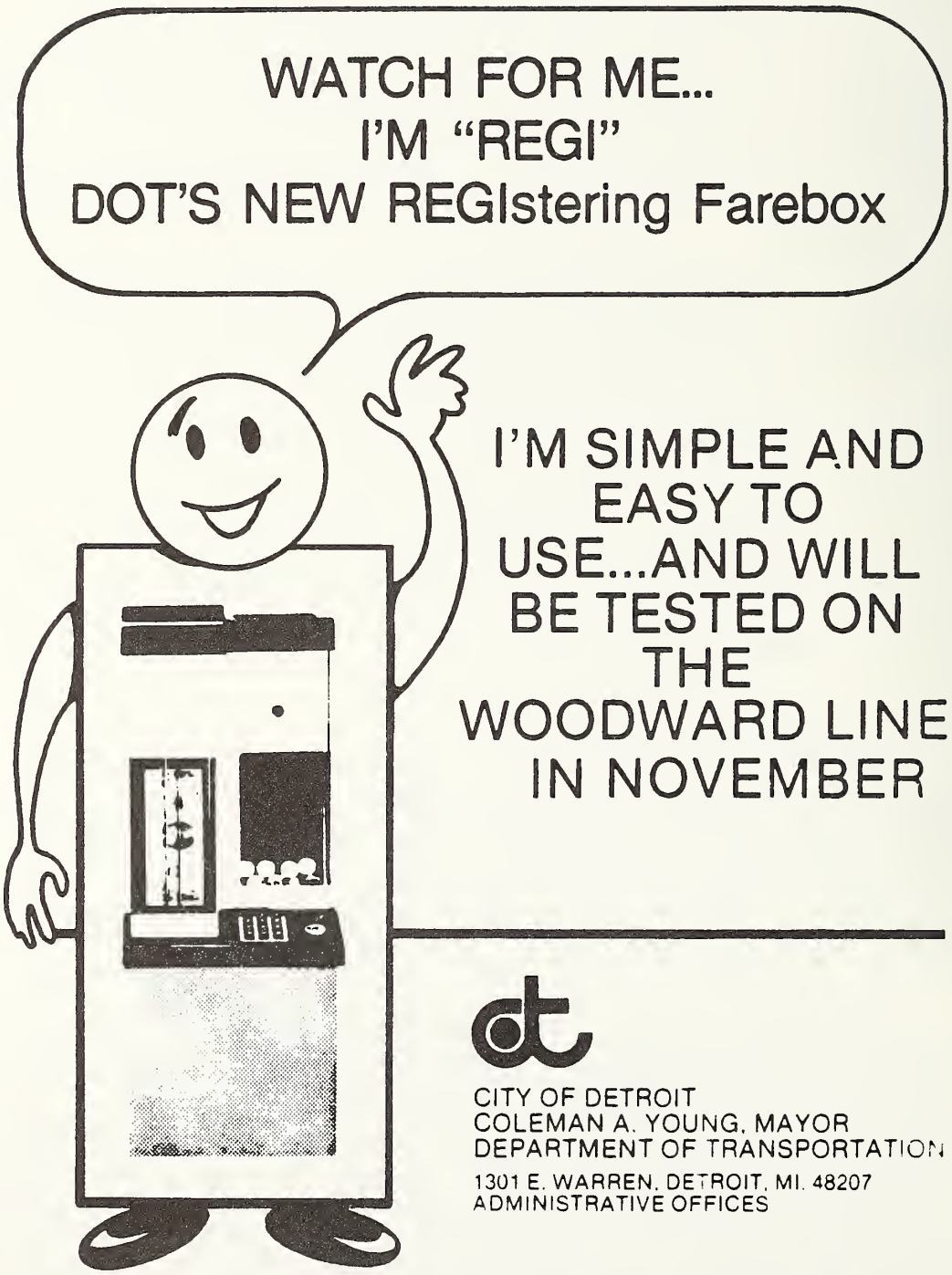
DDOT carried out a comprehensive patron introduction and education program for the new GFI electronic farebox equipment. The program was composed of six elements:

- Initial Introduction Flyers
- Public Service Announcements
- "Take-One" Introduction Flyers
- "How-to-Use" Instructional Brochures
- Demonstration Programs
- Press Conference.

The first public notice of the impending GFI electronic registering farebox installation and pilot test program was accomplished through an introductory flyer. DDOT introduced the nickname "REGI" and effectively promoted a personality for the farebox to focus patron attention. Flyers were passed out by DDOT employees at major boarding areas along the Woodward Avenue service route. A sample of the flyer is presented in Figure 3-1.

The initial flyer was supplemented by radio public service announcements and a second informational flyer. The radio announcements informed the public at large that the new GFI fareboxes would soon be operating on the Woodward Avenue service route. A second "TAKE-ONE" information flyer was circulated by all DDOT coach operators during systemwide operation. Flyers were also distributed to Detroit citizens at neighborhood community centers, public libraries, and other major institutions and public buildings. This second flyer reinforced the "REGI" theme used in the initial flyer.

FIGURE 3-1. INITIAL INTRODUCTION FLYER



A "How-to-Use" GFI electronic farebox instructional brochure was developed by DDOT and distributed by all DDOT coach operators during systemwide operation just before and during the initial start-up of GFI farebox use on Woodward Avenue. In addition, the instructional brochures were distributed by DDOT employees at major boarding areas on the Woodward Avenue service route. The "How-to-Use" instructional brochure is shown in Figure 3-2 (Front) and Figure 3-3 (Back).

From November 7 through November 30, public demonstrations of GFI farebox operation were conducted at twelve locations along or adjacent to the Woodward Avenue service route. These demonstrations given by DDOT gave the public the opportunity to see GFI fareboxes in operation. The formal introduction of the fareboxes took place when the Mayor of Detroit, Coleman A. Young, held a Press Conference on November 15 to officially announce the new farebox equipment's installation on DDOT buses.

Even with the patron introduction and education program, DDOT experienced a significant number of in-service GFI farebox operating disruptions due to passengers improperly depositing their fares in the farebox. In the first weeks of GFI equipment use, passenger induced jams included:

- Coins being placed into the dollar bill transport
- Folded dollar bills or tickets placed into the dollar bill transport
- Dollar bills or tickets placed into the coin mechanism.

Over time, it is expected that increased passenger exposure to the GFI farebox will reduce improper placement of fares.

3.2 DDOT OPERATOR EDUCATION ON THE PROPER USE OF GFI ELECTRONIC FAREBOX EQUIPMENT

DDOT carried out a comprehensive operator education program for the use of the new GFI electronic fareboxes. The program included three training activities:

- Training in farebox operation for DDOT supervisors given by GFI personnel
- Three days of training for DDOT coach operators given by DDOT supervisors

FIGURE 3-2. "HOW-TO-USE" BROCHURE (FRONT)

"Regi"

...your new electronic farebox, is the latest in fare collection equipment

What you should know:

- Regi accepts one dollar bills, either side up. Just lay dollar bill flat and feed into slot indicated "Bills."
- Regi accepts any combination of coins that totals the exact fare. Just insert in "Coin Only" slot. Do not use Canadian coins or currency.
- Regi displays individual passenger fares, making it easier for the driver to collect the correct fare from each passenger.
- Regi will "beep" when it totals (registers) the required adult fare.

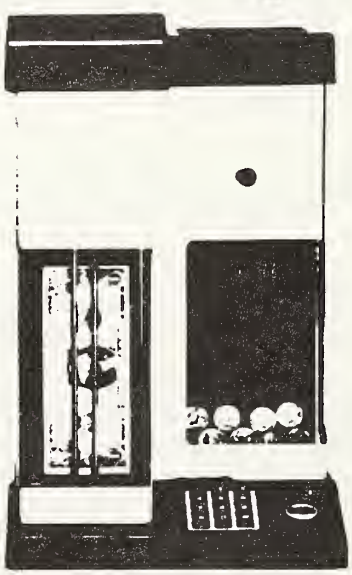
Remember... exact fare required

Have your fare (dollar bills unfolded) ready before boarding the bus.

Here's

"Regi"

...the DOT's new Registering Farebox



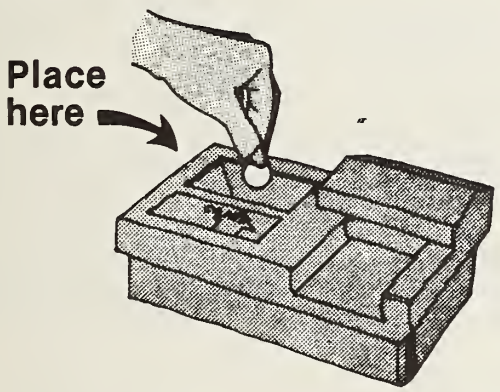
Exact Change Required

CITY OF DETROIT
Coleman A. Young
Mayor
Department of
Transportation

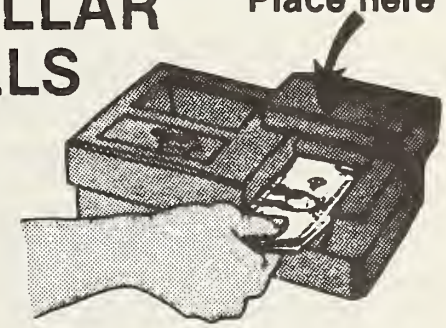
FIGURE 3-3. "HOW-TO-USE" BROCHURE (BACK)

How to use your new "Regi" farebox:

COINS



DOLLAR BILLS

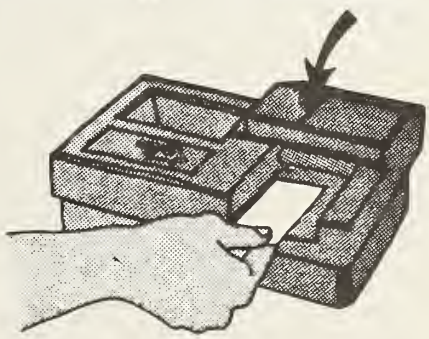


- ***Unfold dollar bills before boarding bus***

TRANSFERS and PASSES

Give or show to driver

TICKETS



Unfold dollar bills before boarding bus

- The documentation and distribution to all DDOT coach operators of answers to questions raised by DDOT coach operators during training.

GFI provided initial training on the GFI farebox equipment in a two hour training program for DDOT transportation supervisory personnel. In addition, GFI and DDOT tailored a standard set of GFI farebox operating instruction materials to the Detroit transit system's fare collection operation. The farebox operating instructions provided a foundation for understanding GFI farebox operation.

To familiarize coach operators with the new farebox equipment, DDOT transportation management set up a three day informal on-site training program. At this time, DDOT transportation management introduced the new farebox equipment, explained its operation, distributed the GFI farebox operating instruction material, and fielded questions from the operators. During question and answer periods, DDOT operators raised many pertinent questions not addressed in the GFI farebox operating instruction material. As a result, a listing of questions and answers was prepared by DDOT transportation management and distributed to the operators.

The transition of operators from Cleveland mechanical farebox equipment to the GFI electronic equipment was relatively smooth. However, operator familiarization gained through actual revenue service was required before the new equipment's operation was fully comprehended.

Operator comments on the efficiency of the new equipment in collecting revenues were positive. Initial coach operations with GFI farebox equipment identified the need for DDOT transportation management to direct the operators to use the new farebox's keypad and properly record passenger category counts. Late reports on farebox utilization and keypad counts confirmed that operators were properly using the keypad.

3.3 TEST SCHEDULE

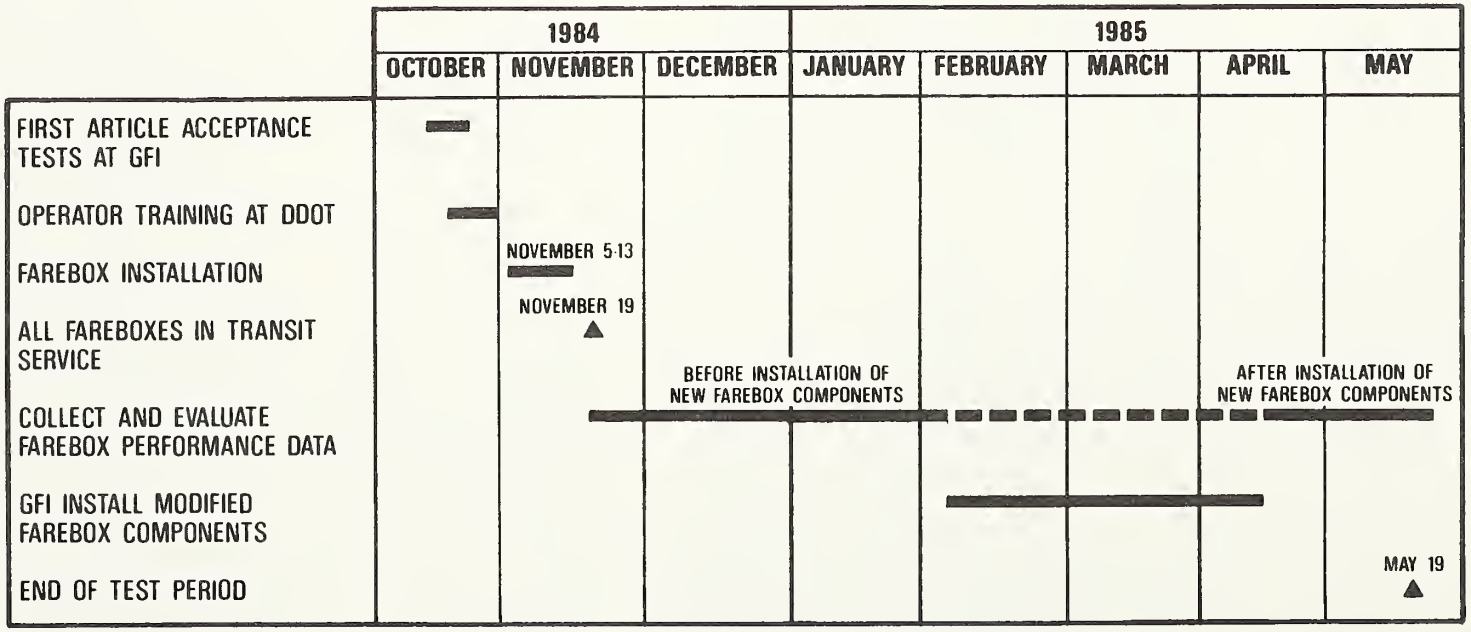
The fareboxes were placed in revenue service at DDOT on November 19, 1984. The test plan called for a four-month data collection period, which was scheduled to conclude March 17, 1985. However, by the end of the third month, GFI determined that several of the farebox's reliability problems could only be eliminated by

installing modified bill transports and bill stuffers into the fareboxes. The data analysis was interrupted until after the new components were installed so that the performance of the improved farebox could be measured.

Figure 3-4 shows the schedule of principal activities during the farebox test period. DDOT staff went to GFI's Elk Grove Village, Illinois plant in October to inspect the first articles, including a farebox and a vault receiver. Training of DDOT mechanics to repair the fareboxes was also conducted at the GFI plant at approximately the same time as the first article inspection. Operator instructor training was subsequently conducted at DDOT by GFI; the instructors trained the coach operators.

The fareboxes were installed in the transit coaches during the period of November 5 to 13 and were placed in transit service on November 19. Data collection on the farebox accuracy, reliability, maintainability, and security was started immediately by DDOT staff and analyzed and reported by Booz, Allen & Hamilton. Data analysis was conducted during the first 11 weeks of farebox operations and then ceased during a 10-week period from February through early April while the modified bill transports and bill stuffers were installed by GFI. The data analysis resumed on April 15 and continued for five weeks until May 19, 1985. A total period of 16 weeks of farebox operations was measured.

FIGURE 3-4. TEST SCHEDULE



4. FARE COLLECTION EQUIPMENT

The Detroit Department of Transportation published a functional equipment specification for the fare collection equipment. In the specification, DDOT stated its intention to evaluate the performance of the fareboxes in revenue service before procuring fare collection equipment for fleetwide installation. The type of equipment procured and subsequent modifications made during the test period are described below.

4.1 EQUIPMENT PROCURED

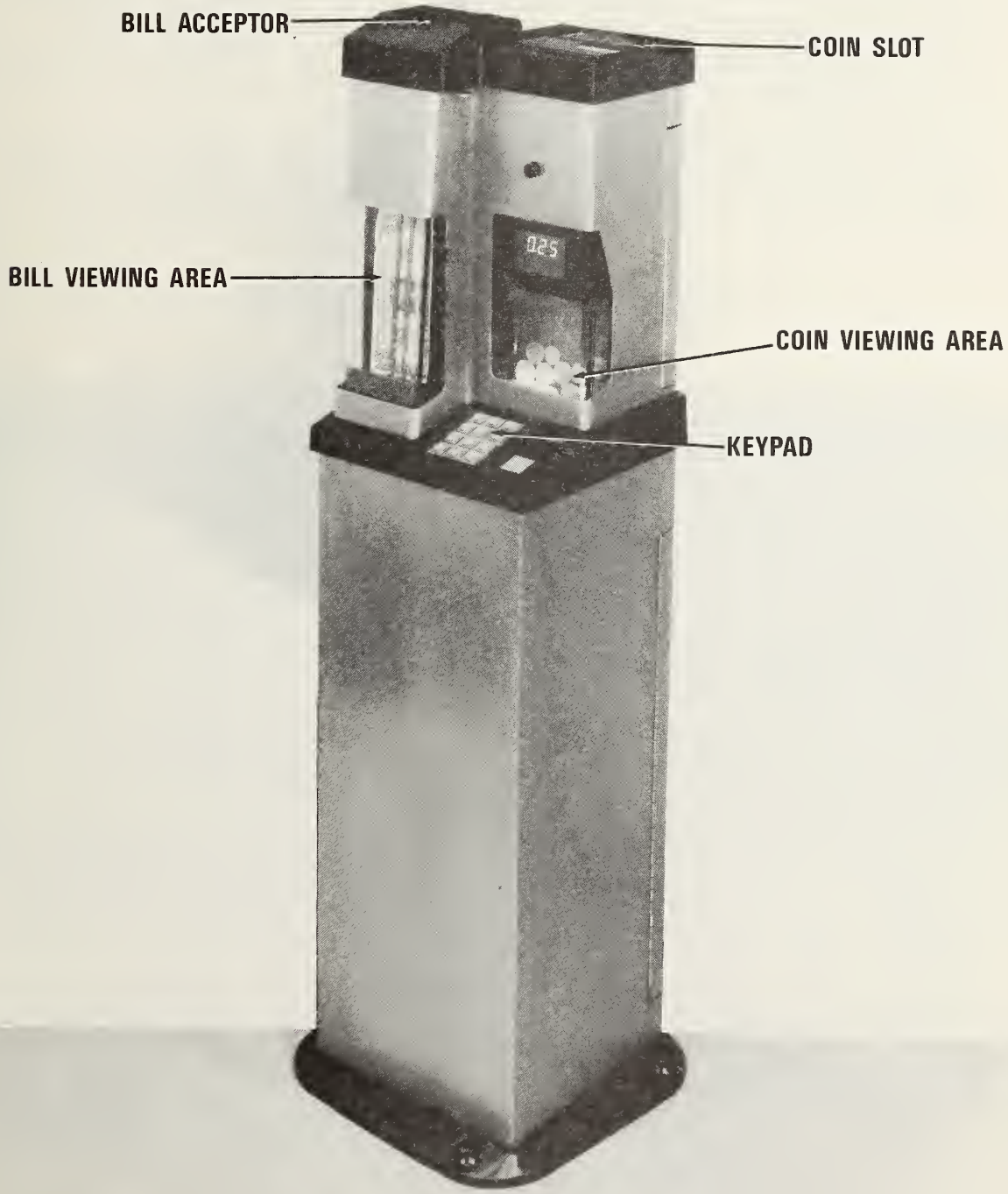
The fare collection equipment was procured from General Farebox Inc. (GFI) through a competitive bidding process. In addition to the equipment, GFI provided training in farebox maintenance and operation to DDOT employees and installed the fareboxes in the transit coaches. The equipment and warranty purchased by DDOT included:

- Thirty-two GFI CentsaBill electronic registering fareboxes, each with a dual-port cashbox with separate compartments for bills and coins, and an electronic lock to provide keyless access to the cashbox.
- Two revenue collection vaults each with a cashbox receiver and mobile revenue collection bin.
- A data system including an IBM-PC microcomputer, printer and software.
- An electronic key and probe to unlock the farebox and transmit the revenue data from each coach to the IBM-PC.
- A set of spare parts including cashboxes, bill transports, coin mechanisms, keypads, driver displays, circuit boards and escrow assemblies.
- A full one-year warranty on the equipment, including all materials, parts, and labor costs associated with the repair of the equipment during that one-year period. Turnaround time for warranty work was specified as a maximum of seven days.

Figures 4-1 and 4-2 show the farebox from the passenger side and from the driver's side.

FIGURE 4-1. VIEW OF GFI FAREBOX FACING THE PASSENGER

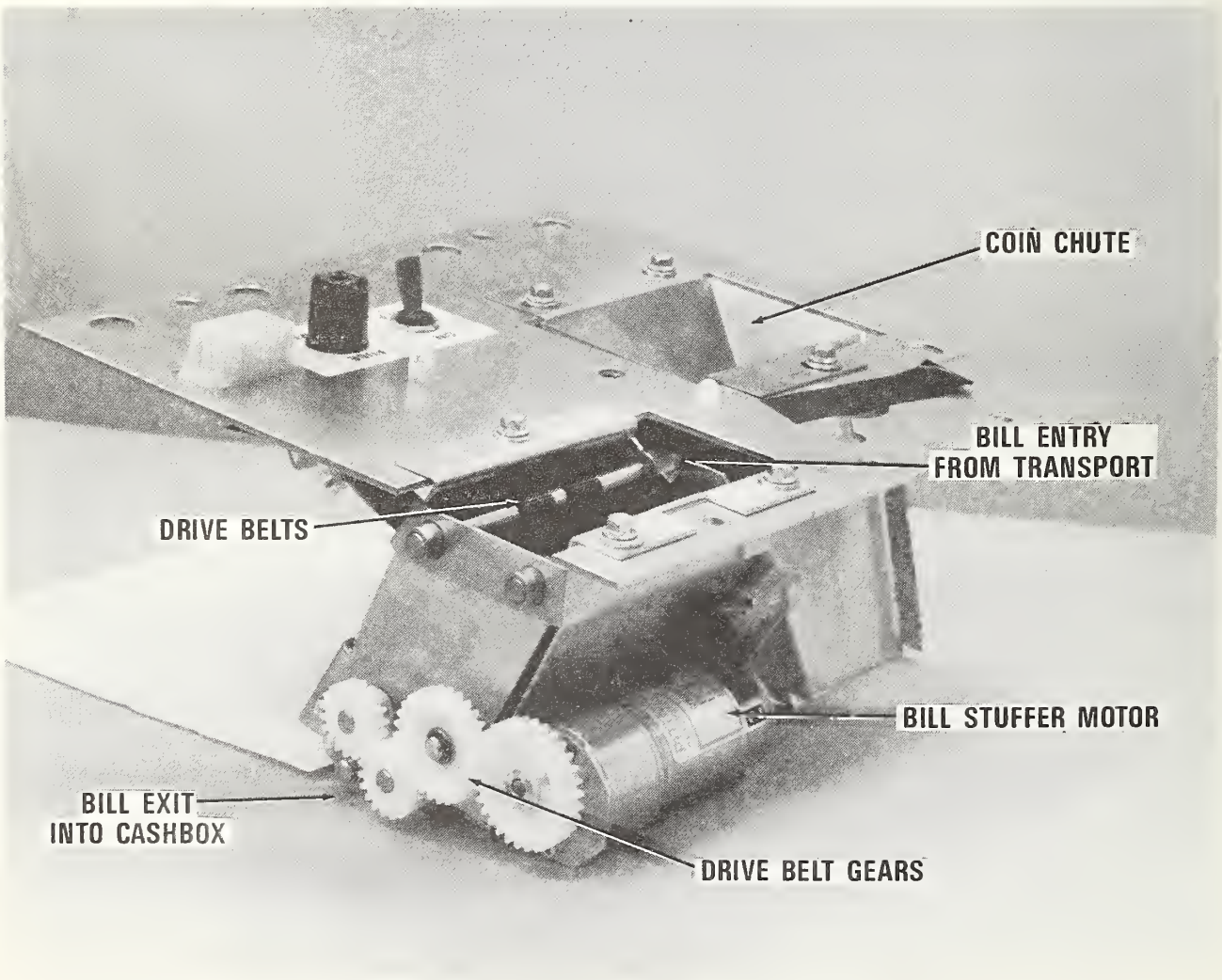
FIGURE 4-2. VIEW OF GFI FAREBOX FACING THE BUS OPERATOR



DDOT's equipment specification required that the fareboxes have the capacity to receive and store 600 dollar bills and $250 in coins. This specification caused GFI to incorporate a new module into its existing farebox to increase the bill capacity. The module, called a bill stuffer, propels dollar bills and tickets into the cashbox by pressing them through rollers. Prior to the introduction of the bill stuffer in the GFI farebox, bills and tickets had simply fallen by the force of gravity from the bill transport into the cashbox.

The bill stuffer assembly is shown in Figure 4-3. As shown, the bills descend from the bill transport into the space between two facing sets of rubber belts which then propel the bill (or ticket) downward into the cashbox.

FIGURE 4-3. BILL STUFFER ASSEMBLY



4.2 MODIFICATIONS MADE TO THE FAREBOXES DURING THE TEST

A number of modifications were made to the fareboxes during the test period. These included replacement of the keypad and modification of the bill transport and bill stuffer. The principal changes are described below.

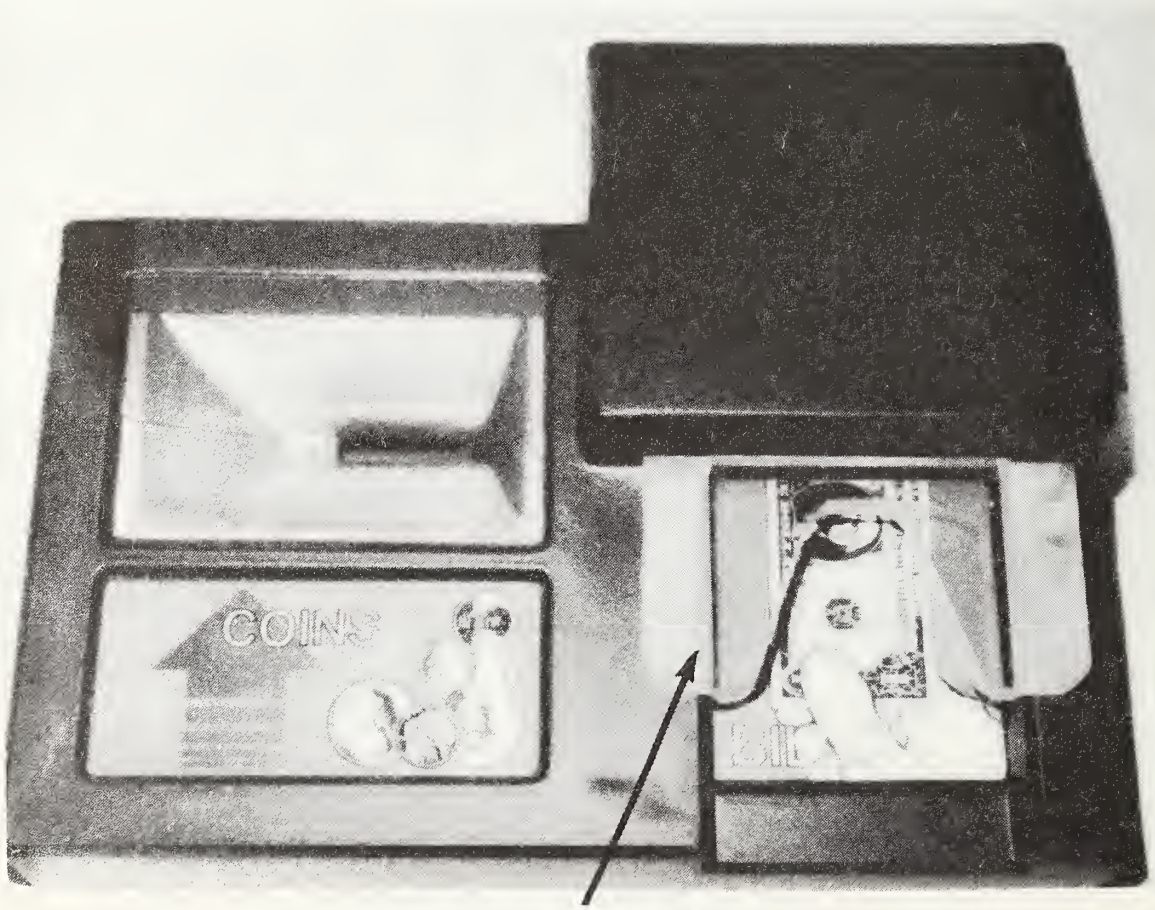
- Keypad. The keypad experienced extreme rapid wear from the outset of the test due to the operators' fingernails gouging the soft plastic keys. A new keypad design with hard rubber keys, shown in Figure 4-4, was substituted by GFI in May. No further problems with wear of the keypad have been experienced.

FIGURE 4-4. IMPROVED KEYPAD

- Bill Transport. The chief operating problem with the bill transport was a malfunction which caused the transport to react to the presence of sunlight and activate the transport motor when no bills were being processed. This caused some bill transport motors to overheat and stop operating. GFI addressed the problem by drilling a small hole in the start sensor plastic shield. This permitted a stronger beam of light to pass from the indicator bulb into the light sensor; when this light beam is broken by a dollar bill or ticket, the transport motor is automatically activated. After the modification, the problem did not recur.

- Bill Insert. GFI installed plastic ticket insertion guides on the farebox to keep the tickets properly aligned in the bill transport. However, the ticket guide blocked proper insertion of dollar bills, and passengers removed the guides to insert the bills. The problem of tickets occasionally becoming misaligned on the bill transport still occurs. The plastic ticket guides are shown in Figure 4-5.

FIGURE 4-5. PLASTIC TICKET INSERTION GUIDES



- Bill Stuffer. Several modifications were made to the bill stuffer to increase its effectiveness in processing bills and tickets. Nylon fiber bushings were installed in place of brass bushings. The diameter of the control wheel was reduced, and space was eliminated between the belt and a back plate. These changes reduced the rate of bill and ticket jams somewhat, but the stuffer continues to have difficulty processing DDOT tickets. DDOT's farebox technicians have suggested changing the current roller design to solid rubber rollers to further reduce bill and ticket jams. GFI currently has no plans to change the bill stuffer.

- Power Board. Failures of the power board included blown fuses. GFI changed the DC to DC converter to reduce the frequency of the blown fuses. A second cause of power board failures is carbon buildup on the contact points on the relays on the power board. This carbon can be periodically removed by the farebox technicians.

- Logic Board. A missing diode in the farebox logic board was responsible for the farebox access doors opening without the farebox being probed. The missing diode was supplied and installed by GFI.

4.3 FAREBOX OPERATING PROBLEMS

The most critical farebox operating problem that remains to be solved is the cashbox bill capacity. Frequently, the bill stuffer becomes jammed when the cashbox is filled, yet the specified 600 bill capacity is not being met. On a typical weekday from 225 to 275 dollar bills are deposited into a farebox. This number may exceed 300 approximately four to six days per month. The highest number of bills found in one GFI farebox was 487. Yet the cashboxes experience bill stuffer jams approximately 12 times per week, some of which appear to be due to the cashbox being full.

GFI's explanation is that the bill capacity requirement did not specify a number of tickets. Typically, from 160 to 200 tickets are collected daily; the highest number found was 273. The cashbox design appears to be inadequate to handle the combination of 300 bills and 200 tickets.

DDOT has demonstrated that a cashbox that is jammed with bills often does not empty completely when it is placed in the cashbox receiver. The bills are compacted so firmly that they do not fall by the force of gravity into the receiver bin below. In response to this problem, GFI installed a mechanism in the receiver to thump the cashbox and loosen the compacted bills. The mechanism, called a "thumper", contains a small hammer that is activated when the cashbox moves over four small bumps in its track as it moves into the receiver. The thumper has cleared up much of the problem but a few bills still occasionally stick in the cashbox.

A second related issue is the inability of the bill stuffer to consistently process tickets. The following are representative of the comments reported by the DDOT farebox technicians after repairing a bill stuffer:

- "Tickets jammed between bill stuffer rollers."
- "Tickets caught in stuffer wheels."
- "Tickets jammed under rollers and torn."
- "12 dollar bills and 5 tickets jammed in the stuffer."
- "3 bills and 7 tickets removed from the stuffer."

Passengers often insert two strips of five ten cent transfer tickets as a ticket equivalent to the $1.00 adult fare. The bill stuffer is not capable of consistently processing these strips of tickets, and it is also occasionally becoming jammed by single tickets.

A problem was experienced with the revenue receiver vaults. Rivets on the receiver housing were loosening and falling out. GFI supplied stainless steel rivets to replace the original aluminum rivets, and this solved the problem.

An additional minor problem in the bill transport involves the start sensor bulb socket. This plastic socket extends too far from the transport housing and tends to be easily broken. A shorter socket would eliminate the breakage. The problem occurs infrequently and a change has not been proposed by GFI.

5. FAREBOX ACCURACY

The accuracy of the GFI electronic farebox equipment was evaluated by means of the following measures:

- Comparison of total daily metered revenues, including tickets, dollar bills, and coins for all GFI fareboxes placed in revenue service with actual total daily counts

- Comparison of revenues for selected individual GFI fareboxes with the actual farebox revenue.

Three statistical measures of variability are used to indicate the average error occurring in farebox metering. They are:

- Mean Percent Absolute Deviation. The mean percent absolute deviation is the average size of the difference between the GFI farebox count and the actual cash count. It indicates the average amount of miscount but does not indicate whether that miscount is high or low.

- Algebraic Mean Deviation. The algebraic mean deviation indicates whether the farebox count is, on the average, higher or lower than the physical cash count, and by what percent.

- Standard Deviation. The standard deviation depicts the spread of values, both in the positive and negative direction, around the mean percent difference.

5.1 ACCURACY OF TOTAL GFI FAREBOX EQUIPMENT IN REVENUE SERVICE

When a farebox is placed in bypass, the registering of coin fares ceases; thus, coin fares deposited are no longer counted. Therefore, the number of times fareboxes are placed in bypass must decrease to a reasonable level before the counting accuracy of the equipment can be reasonably assessed.

The number of times that fareboxes were placed in bypass declined throughout the test period. During November and December of 1984 (the first 6 weeks of farebox operation), an average of 5 fareboxes were placed in bypass

each day. In January, that average declined to 3 fareboxes a day, and by April and May, dropped to an average of 2 fareboxes a day, allowing for a more representative measure of farebox accuracy. The following section discusses the results of the farebox accuracy analysis for April and May.

Table 5-1 presents a comparison of total metered revenues and actual collected revenues on a daily basis from April 15 through May 19. The overall counting accuracy of the fareboxes ranges from a low of 94 percent to a high of 100 percent. The data indicate that the absolute difference between the farebox revenue count and the actual collected revenues averaged 1.8 percent for the 5 week period (down from 10.2 percent in January). Metered cash was slightly lower than the cash count by an average 0.7 percent showing improvement in accuracy from January when actual cash exceeded metered cash by 5 percent.

Table 5-2 presents a similar comparison of metered versus actual collected tickets. Ticket counting accuracy of the GFI farebox typically ranges from 79.2 to 99.8 percent. On 19 out of 27 days, ticket counting was 90 percent accurate or better. Over the 5 week period, the metered ticket count was an average 4.8 percent lower than the actual ticket count.

Tables 5-3 and 5-4 present breakdowns of the total revenues shown in Table 5-1 into bills and coins. Bill counting accuracy ranged from 89.5 to 99.9 percent. On 22 out of 27 days, bill counting accuracy was 96.2 percent or better.

The absolute difference between metered bills and actual bills collected declined from an average of 11.8 percent during January to 2.4 percent in April and May. On average, the metered count was 0.6 percent lower than the actual count which is a marked improvement over a 6.7 percent overage observed in January.

The comparison of coin counts in Table 5-4 shows a decline in the average absolute difference from 8.2 percent in January to 1.2 percent for the period in April and May. Metered coins were an average 0.8 percent lower than the actual count, the same rate of error experienced in January. Overall coin counting accuracy ranges from 93.2 to 100 percent. On 25 out of 27 days, coin counting accuracy was 96 percent or better.

TABLE 5-1. DIFFERENCE BETWEEN GFI DAILY REGISTERED REVENUES AND ACTUAL COUNTED CASH

Audit Date	Number of Bypasses	Total Metered Cash	Actual Total Cash	Difference From Actual Count	Percent Difference
4/15	5	$7872.87	$7926.66	-$53.79	-0.7%
4/16	5	7534.55	7751.22	-216.67	-2.8
4/17	4	6958.48	6811.57	146.91	2.2
4/18	4	6975.19	6947.60	27.59	0.4
4/19	9	7659.55	7869.55	-210.00	-2.7
4/20-24	5	25955.55	26091.58	-136.03	-0.5
4/25	0	6820.27	6975.35	-155.08	-2.2
4/26	1	7256.88	7033.68	223.20	3.2
4/27-28	0	6857.62	7271.46	-413.84	-5.7
4/29	4	5722.68	5689.21	33.47	0.6
4/30	3	6025.41	6121.49	-96.08	-1.6
5/1	3	7195.56	7263.63	-68.07	-0.9
5/2	0	7673.57	7708.09	-34.52	-0.4
5/3	2	8720.41	8773.47	-53.06	-0.6
5/4-5	0	9270.50	9253.75	16.75	0.2
5/6	2	6791.94	6790.59	1.35	0
5/7	2	6300.97	6316.47	-15.50	-0.3
5/8	4	7924.25	7773.05	151.20	1.9
5/9	3	7556.13	7770.65	-214.52	-2.8
5/10	2	6848.86	7081.27	-232.41	-3.2
5/11-12	1	8722.36	9287.10	-564.74	-6.1
5/13	2	5937.51	5973.95	-36.44	-0.6
5/14	2	5367.43	5092.80	274.63	5.4
5/15	3	6427.87	6406.39	21.48	0.3
5/16	2	6202.87	6295.06	-92.19	-1.5
5/17	3	6229.11	6174.15	54.96	0.9
5/18-19	1	7561.75	7704.38	-142.63	-1.85
Mean Percent Absolute Difference					1.8%
Algebraic Mean Deviation					-0.7%
Standard Deviation					2.4%

TABLE 5-2. DIFFERENCE BETWEEN GFI DAILY REGISTERED TICKETS AND ACTUAL COUNTED TICKETS (# OF TICKETS)

Audit Date	Total Metered Tickets	Actual Total Tickets	Difference From Actual Count	Percent Difference
4/15	3219	3582	-363	-10.1
4/16	3688	3951	-263	-6.7
4/17	3732	3689	43	1.2
4/18	3328	3917	-589	-15.0
4/19	3424	3671	-247	-6.7
4/20-24	11213	12202	989	-8.1
4/25	3336	2779	557	20.0
4/26	3228	2838	390	13.7
4/27-28	1885	2102	-217	-10.3
4/29	3011	3093	-82	-2.7
4/30	3331	3520	-189	-5.4
5/1	3559	3853	-294	-7.6
5/2	3696	3703	-7	-0.2
5/3	3482	3599	-117	-3.3
5/4-5	2403	2490	-87	-3.5
5/6	2760	2920	-160	-5.5
5/7	2952	3049	-97	-3.2
5/8	3640	3530	110	3.1
5/9	3416	3633	-217	-6.0
5/10	2856	3054	-198	-6.5
5/11-12	2305	2695	-390	-14.5
5/13	2676	3304	-628	-19.0
5/14	2704	2728	-24	-0.9
5/15	3433	3406	27	0.8
5/16	3201	3484	-283	-8.1
5/17	2771	3497	-726	-20.8
5/18-19	2037	2132	-95	-4.5
Mean Percent Absolute Difference				7.7%
Algebraic Mean Deviation				-4.8%
Standard Deviation				8.4%

TABLE 5-3. DIFFERENCE BETWEEN GFI DAILY REGISTERED DOLLAR BILLS AND ACTUAL COUNTED BILLS (# OF BILLS)

Audit Date	Total Metered Bills	Actual Total Bills	Difference From Actual Count	Percent Difference
4/15	5825	5879	-54	-0.9
4/16	5568	5787	-219	-3.8
4/17	5107	4971	136	2.7
4/18	5161	5137	24	0.5
4/19	5848	5983	-135	-2.3
4/20-24	19371	19502	-131	-0.7
4/25	5084	5120	-36	-0.7
4/26	5553	5336	217	4.1
4/27-28	5258	5681	-423	-7.4
4/29	4215	4186	29	0.7
4/30	4503	4571	-68	-1.5
5/1	5404	5465	-61	-1.1
5/2	5789	5833	-44	-0.8
5/3	6635	6665	-30	-0.5
5/4-5	7065	7057	8	0.1
5/6	5065	5073	-8	-0.2
5/7	4649	4672	-23	-0.5
5/8	5834	5661	173	3.1
5/9	5623	5833	-210	-3.6
5/10	5099	5329	-230	-4.3
5/11-12	6661	7233	-572	-7.9
5/13	4284	4315	-31	-0.7
5/14	3961	3583	378	10.5
5/15	4765	4684	81	1.7
5/16	4526	4613	-87	-1.9
5/17	4673	4612	61	1.3
5/18-19	5723	5853	-130	-2.2
Mean Percent Absolute Difference				2.4%
Algebraic Mean Deviation				-0.6%
Standard Deviation				3.5%

TABLE 5-4. DIFFERENCE BETWEEN GFI DAILY REGISTERED COINS AND ACTUAL COUNTED COINS (VALUE)

Audit Date	Total Metered Coins	Actual Total Coins	Difference From Actual Count	Percent Difference
4/15	$2047.87	$2047.66	$0.21	0.0%
4/16	1966.55	1964.22	2.33	0.1
4/17	1851.48	1840.57	10.91	0.6
4/18	1814.19	1810.60	3.59	0.2
4/19	1811.55	1886.55	-75.00	-4.0
4/20-24	6584.55	6589.58	-5.03	-0.1
4/25	1736.27	1855.35	-119.08	-6.4
4/26	1703.88	1697.68	6.20	0.4
4/27-28	1599.62	1590.46	9.16	0.6
4/29	1507.68	1503.21	4.47	0.3
4/30	1522.41	1550.49	-28.08	-1.8
5/1	1791.56	1798.63	-7.07	-0.4
5/2	1884.57	1875.09	9.48	0.5
5/3	2085.41	2108.47	-23.06	-1.1
5/4-5	2205.50	2196.75	8.75	0.4
5/6	1726.94	1717.59	9.35	0.5
5/7	1651.97	1647.47	4.50	0.3
5/8	2090.25	2112.05	-21.80	-1.0
5/9	1933.13	1937.65	-4.52	-0.2
5/10	1749.86	1752.27	-2.41	-0.1
5/11-12	2061.36	2054.10	7.26	0.4
5/13	1653.51	1658.95	-5.44	-0.3
5/14	1406.43	1509.80	-103.37	-6.8
5/15	1662.87	1722.39	-59.52	-3.5
5/16	1676.87	1682.06	-5.19	-0.3
5/17	1556.11	1562.15	-6.04	-0.4
5/18-19	1838.75	1851.38	-12.63	-0.7
Mean Percent Absolute Difference				1.2%
Algebraic Mean Deviation				-0.8%
Standard Deviation				2.0%

5.2 INDIVIDUAL GFI FAREBOX ACCURACY

Tables showing the results of accuracy checks (audits) performed on GFI fareboxes during 10 weeks from December to January, and parts of May are shown in Appendix B.* The information is organized by coach number; audits of the same farebox are listed sequentially. A total of 139 individual cashbox audits are reported, first for coins and then for bills. In 51 percent of the coin audits and 71 percent of the bill audits, the farebox undercounted the revenue. There were 10 coin audits and 23 bill audits in which the registered revenue exactly matched the cash count. In the majority of cases the counting errors were equal to or less than 2 percent of the actual counted cash; 70 percent of coin audits and 58 percent of bill audits found registering errors of 2 percent or less. Many of the high errors in the appendix tables occurred during a three day period in January 1985. Some of those errors are due to transcription errors in manual recording of the revenues on those days.

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* This information is not available from November 19 to December 2, April 15 to May 12 and May 17 to 19 because individual accuracy checks (audits) were not conducted during those time periods.

6. FAREBOX RELIABILITY

This chapter presents information on the reliability of the farebox. Reliability was evaluated by the following measures:

- Frequency of Farebox Failures
- Mean Time Between Farebox Failures
- Frequency of Passenger-Caused Farebox Jams
- Amount of Service Interruption Resulting from Farebox Failures.

Each is discussed below.

6.1 FREQUENCY OF FAREBOX FAILURES

DDOT records the incidence of farebox failures in a report called "Weekly Summary of Farebox Jams Documented in Service Inspectors Reports." Each failure or breakdown incident documented in this report during the test period was reviewed to determine whether the failure was the result of an equipment problem, a passenger-induced farebox jam, or some type of maintenance. Only those breakdowns attributable to a failure in the equipment are defined as farebox failures in this chapter. This means that a jam caused by a passenger inserting the wrong fare media into the coin mechanism is not a "farebox failure" but a "passenger-caused jam."

Table 6-1 summarizes the farebox equipment failures for the period from April 15th to May 19th. The majority of failures occurred in the bill transport, the bill stuffer, and the coin mechanism (92 percent). The remaining failures were distributed among the various components listed in Table 6-1. A discussion of the principal component failures follows.

TABLE 6-1. NUMBER OF FAREBOX FAILURES

Farebox Component	Number of Equipment Failures per Week					
	4/15-21	4/22-28	4/29-5/5	5/6-12	5/13-19	Total
Coin Mechanism	6	0	1	2	0	9
Coin Escrow	1	0	0	0	0	1
Bill Transport	16	15	3	4	4	47
Bill Stuffer	13	11	11	18	9	62
Bill Chute	0	0	0	0	0	0
Logic Board	1	0	0	1	0	2
Electronic Lock	0	0	0	0	0	0
Power Board	0	1	0	0	0	1
Display Board	1	0	0	0	0	1
Farestand	1	0	0	0	0	1
Fuse	1	0	0	0	0	1
Key Pad/ Control Panel	0	1	0	1	2	4
TOTAL	40	28	20	26	15	129

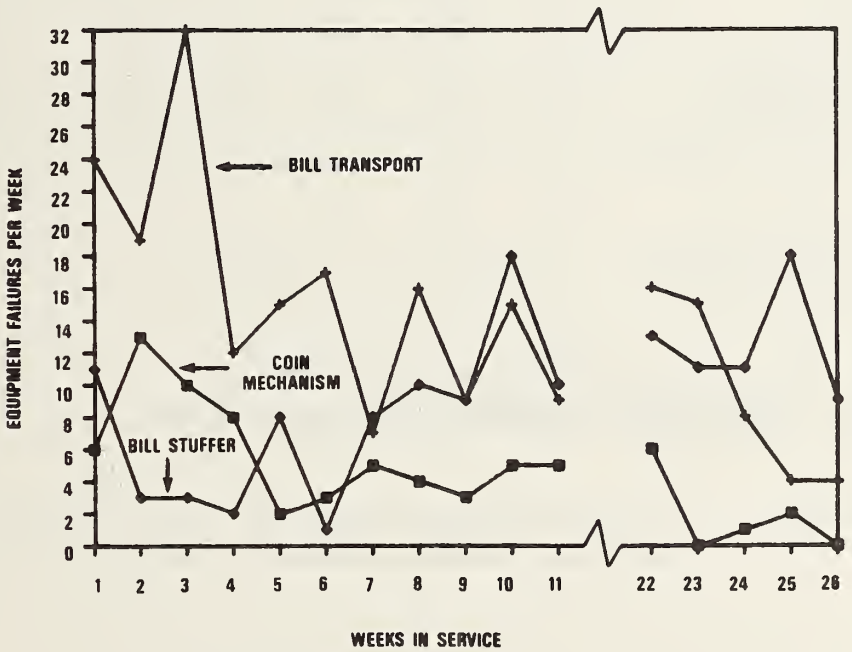
- Bill Transport. For the 5-week period in April and May, the number of bill transport failures averaged 9 per week, a slight improvement over January's average of 11 per week. The bill transport alone was responsible for over 36 percent of all component failures for the period. This percentage declined from its high of 48 percent in November and December of 1984 but remained at 36 percent since January of this year. A frequent cause of failure is the misalignment of tickets on the transport belt. Other causes of failures include tickets lodging in the bill inspection window or under the transport belt, and tickets and bills jamming at the top of the transport. These problems are typically corrected during a short delay in service; the mobile technician either manually removes the material lodged in the transport or removes the transport and replaces it with a spare. The total service delay may be 3 to 5 minutes.

- Bill Stuffer. The number of bill stuffer failures averaged 12 per week throughout April and May (the highest average of all components) versus an average of 11 per week in January. The bill stuffer was accountable for 48 percent of all component failures throughout the 5-week period which is an 8 percent increase over January's average. The stuffer can become jammed with bills and tickets either due to an overfilled cashbox or a failure in the stuffer such as bent fingers, a ruptured spring, or bent shaft. The stuffer also has difficulty processing DDOT adult fare tickets because they are slightly thicker than transfer tickets. The tickets become lodged in the stuffer and frequently are torn by the ridged rollers in the stuffer mechanism. Stuffer failures can be corrected on board the bus with an approximate service delay of 3 to 8 minutes.

- Coin Mechanism. The coin mechanism averaged about 2 failures per week or approximately 7 percent of all equipment failures. This is an improvement over January when the number of equipment failures averaged 4 per week and the coin mechanism was responsible for 14 percent of total equipment failures. Occasionally coins may double up and lodge in the coin reader. Also, lint can enter the coin mechanism and cause the value of the coins to be registered incorrectly.

Figure 6-1 graphically illustrates these trends in frequency of equipment failures. Various other equipment failures occurred randomly throughout the 5 week period but were responsible for only 8 percent of total failures.

FIGURE 6-1. NUMBER OF FAREBOX FAILURES (SINCE PROGRAM START)



6.2 MEAN TIME BETWEEN FAREBOX FAILURES

The mean time between farebox failures is the average number of days a farebox will operate in revenue service before a failure occurs. This average is calculated by dividing the total farebox operating days per week by the total farebox equipment failures for the week. Passenger induced jams are excluded from the calculation.

As shown in Table 6-2, the mean number of farebox operating days between failures ranges from 3 to 7.4 throughout the 5-week period. The cumulative average is 4.4 farebox operating days between equipment failures. This average is consistent with the average that was observed in January.

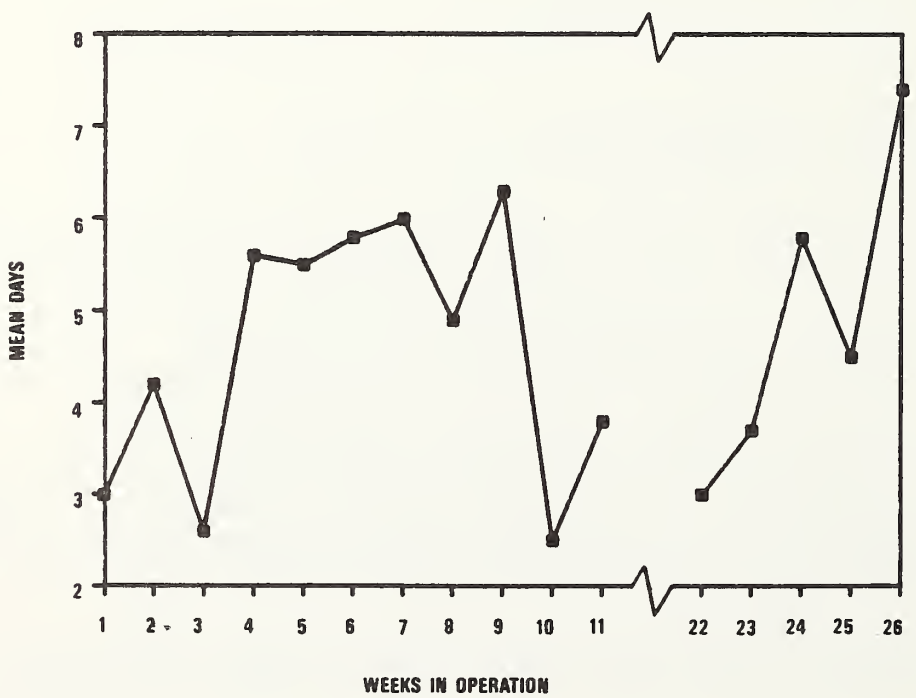
Figure 6-2 shows the mean weekly number of farebox operating days since the beginning of the test program.

TABLE 6-2. MEAN FAREBOX OPERATING DAYS BETWEEN FAILURES (EXCLUDES PASSENGER CAUSED JAMS)

	WEEK					
	4/15-21	4/22-28	4/29-5/5	5/6-12	5/13-19	Total
Farebox Operating Days per Week:[1]						
Mon-Fri	95	81	87	93	82	438
Sat-Sun	25	23	28	23	29	128
Total Operating Days per Week	120	104	115	116	111	566
Total Farebox Equipment Failures per Week[2]	40	28	20	26	15	129
Mean Farebox Operating Days Between Failures	3	3.7	5.8	4.5	7.4	4.4

1 Source: Weekly Operating Fareboxes Report prepared by DDOT.
2 Source: See Table 6-1.

FIGURE 6-2. MEAN FAREBOX OPERATING DAYS BETWEEN FAILURES (SINCE PROGRAM START)



6.3 FREQUENCY OF PASSENGER-CAUSED EQUIPMENT JAMS

Passenger-caused equipment jams have increased since the fareboxes were placed in revenue service. During November and December, there was an average of 13 passenger caused farebox jams per week. During January this number rose to 17 jams per week and in April and May, reached an average of 19 jams per week. The principal causes of these passenger-induced jams are bills and tickets inserted into the coin mechanism. The remainder are folded dollar bills, strips of tickets or stapled tickets inserted into the bill transport. If a folded bill or strip of five transfer tickets successfully travels through the bill transport, it often jams the bill stuffer. Table 6-3 shows the number of passenger-caused farebox jams for the coin mechanism and bill transport modules.

TABLE 6-3. NUMBER OF PASSENGER-CAUSED FAREBOX JAMS

	WEEK					
	4/15-21	4/22-28	4/29-5/5	5/6-12	5/13-19	Total
Coin Mechanism	23	11	22	16	19	91
Bill Transport/ Bill Stuffer	1	0	0	1	2	4
All Jams	24	11	22	17	21	95

Source: Weekly Summary of Farebox Jams Documented in Service Inspectors Reports and Farebox Repair Reports

6.4 AMOUNT OF SERVICE DELAY RESULTING FROM EQUIPMENT FAILURES AND PASSENGER-CAUSED JAMS

In Detroit, a mobile farebox repair van stays on Woodward Avenue to respond quickly to calls from coach operators about farebox operating problems. The farebox repair or component change-off can usually be completed within a few minutes by the technician. The response time plus the repair time is equivalent to the total amount of service interruption. The amount of service interruption experienced is a measure of the impact of the farebox failures on the passengers.

The minutes of service interruption per week from April 15 to May 19 are shown in Table 6-4. For the 5-week period, the mean total service interruptions per week due to farebox breakdowns or jams, were 408 minutes. This is an increase over November and December's average of 375 minutes (6.2 hours) and January's average of 357 minutes (approximately 6 hours) per week. The average service delay for all breakdowns was 9.1 minutes. Equipment failures such as tickets and bills becoming lodged in the bill transport or bill stuffer lead to long delays (average of 13.2 minutes). Passenger-caused jams such as the insertion of a dollar bill in the coin mechanism lead to shorter delays (average of 3.5 minutes).

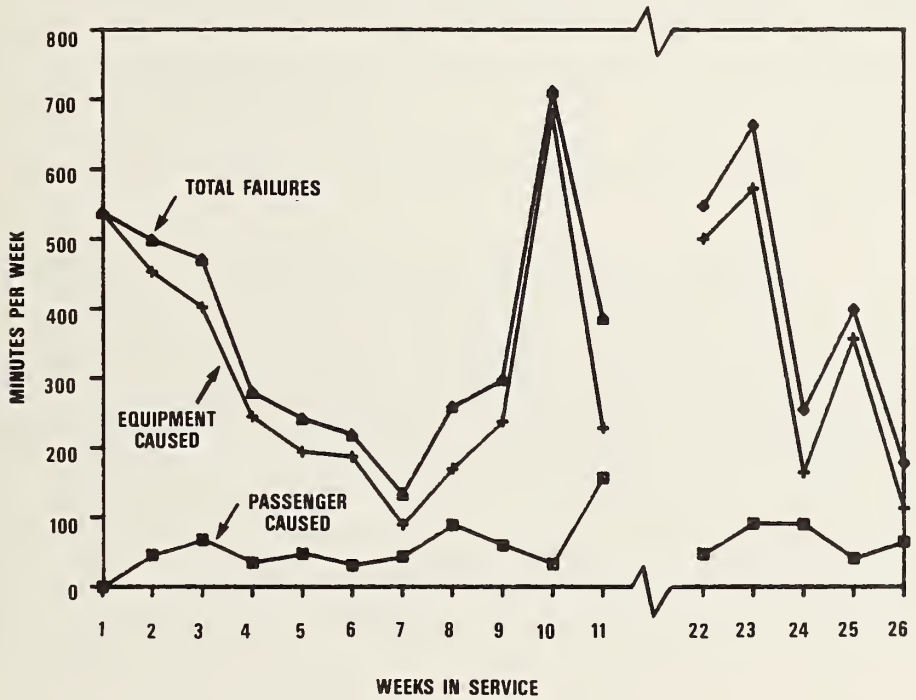
A graph showing the total minutes of service delay for the first 11 weeks that the fareboxes were in operation and for 5 weeks in April and May is shown in Figure 6-3.

TABLE 6-4. MINUTES OF SERVICE DELAY PER WEEK FOR EQUIPMENT FAILURES AND PASSENGER-CAUSED FAREBOX JAMS

Source of Breakdown	4/15-21		4/22-28		4/29-5/5		5/6-12		5/13-19		Total		Average Service Delay
	No. of Min.	Jams	No. of Min.	Jams	No. of Min.	Jams	No. of Min.	Jams	No. of Min.	Jams	No. of Min.	Jams	
Passenger Caused	47	24	91	11	90	22	41	17	65	21	334	95	3.5 min.
Equipment Failure	500	40	572	28	164	20	357	26	113	15	1706	129	13.2 min.
All Breakdowns	547	64	663	39	254	42	398	43	178	36	2040	224	9.1 min.

Source: Weekly Summary of Farebox Jams Documented in Service Inspectors Reports. "Min" indicates the number of minutes of service delay reported for the week.

FIGURE 6-3. MINUTES OF SERVICE DELAY
PER WEEK SINCE START OF PROGRAM



7. FAREBOX MAINTAINABILITY

GFI farebox maintainability was evaluated through analysis of:

- The number of maintenance and repair actions
- The amount of labor time spent on maintenance and repair actions
- The number of farebox modules requiring replacement.

7.1 NUMBER OF MAINTENANCE AND REPAIR ACTIONS

The total number of maintenance and repair actions declined throughout the test period, and in the 5-week period of April and May, reached a low of 225. This is a decrease from 366 actions in November and December and 289 in January. There was an average of 45 maintenance and repair actions per week during April and May which is approximately 22 percent less than the average 58 actions per week in January. Since the fare collection equipment was under warranty, most maintenance and repair actions involved repairs performed on board the bus by mobile technicians.

The components which received the most frequent repairs were the coin mechanism, the bill transport and the bill stuffer which, together, accounted for over 92 percent of all maintenance and repair actions. For the cumulative 5-week period, the number of maintenance and repair actions decreased for every component with the exception of the coin mechanism which experienced an increase of approximately 12 percent. Table 7-1 summarizes the maintenance and repair actions by component.

TABLE 7-1. NUMBER OF MAINTENANCE AND REPAIR ACTIONS FOR GFI FARE COLLECTION EQUIPMENT

Farebox Component	Number of Maintenance and Repair Actions 4/15-21	4/22-28	4/29-5/5	5/6-12	5/13-19	Total
Coin Mechanism	29	13	26	18	19	105
Bill Transport	13	11	6	4	7	41
Control Panel	0	2	0	2	2	6
Logic Board	2	0	0	1	0	3
Bill Stuffer	12	11	13	17	9	62
Display Board	1	0	0	0	0	1
Power Board	2	1	0	1	1	5
Coin Escrow	0	0	0	0	0	0
Cashbox	0	0	0	2	0	2
TOTAL	59	38	45	45	38	225

Source: Detroit DOT Farebox Repair Reports

7.2 LABOR TIME SPENT ON MAINTENANCE AND REPAIR ACTIONS

Table 7-2 summarizes the labor time in minutes spent on maintenance and repair of the GFI fare collection equipment. Over the 5-week period, a total of 767 minutes (12.8 hours) was spent on maintenance and repair actions, a marked improvement over January's total of 1,298 minutes (21.6 hours). The estimated average repair time for all components (calculated by dividing total repair minutes by total repair actions) also decreased from 4.5 minutes in January to 3.4 minutes. During April and May, 87 percent of maintenance and repair time was spent on three components; the coin mechanism, the bill transport, and the bill stuffer.

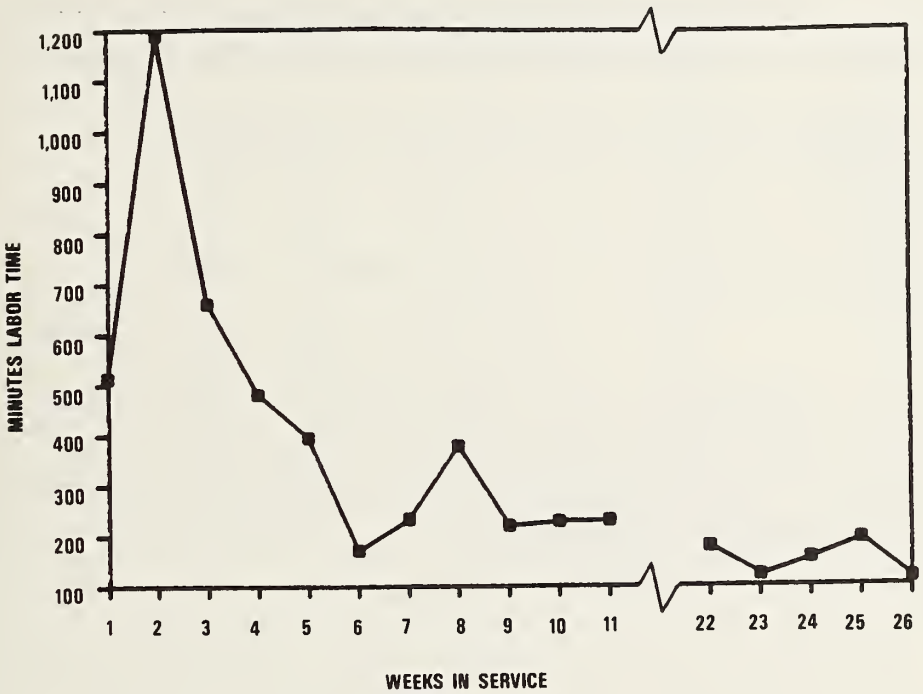
Figure 7-1 shows the continued decrease in total labor time for farebox repair per week. In the second week of operation, labor time reached a high of 1,100 minutes (19.8 hours). In the week of May 13-19, it decreased to an all time low of 116 minutes (1.9 hours). Labor time is reported by DDOT technicians whenever they perform maintenance on the farebox. Most of the work is done onboard the bus.

TABLE 7-2. NUMBER OF MINUTES SPENT ON MAINTENANCE AND REPAIR ACTIONS FOR GFI FARE COLLECTION EQUIPMENT

Component	Minutes Spent on Maintenance and Repair Actions						Average No. Minutes Per Repair
	4/15-21	4/22-28	4/29-5/5	5/6-12	5/13-19	Total	
Coin Mechanism	73	42	83	56	58	312	3.0
Bill Transport	26	29	16	16	10	97	2.4
Control Panel	0	7	0	6	8	21	3.5
Logic Board	7	0	0	55	0	62	20.7
Bill Stuffer	64	42	57	55	37	255	4.1
Display Board	2	0	0	0	0	2	2.0
Power Board	7	2	0	1	3	13	2.6
Coin Escrow	0	0	0	0	0	0	0.0
Cashbox	0	0	0	5	0	5	2.5
TOTAL	179	122	156	194	116	767	3.4

Source: Detroit DOT Farebox Repair Reports

FIGURE 7-1. TOTAL LABOR TIME PER WEEK
(SINCE PROGRAM START)



7.3 NUMBER OF MODULE REPLACEMENTS

Table 7-3 summarizes the total number of farebox modules that were replaced over the 5-week period. This measure indicates spare component usage. The farebox technicians recorded a module replacement each time they removed and replaced a coin mechanism, bill transport, control panel or other component. If the problem in the component could not be corrected by DDOT, then it was returned to GFI for service. Most problems such as jams could be corrected in 3 to 15 minutes by DDOT technicians.

Over the 5-week period, an average of 15 modules were replaced each week. This average has remained fairly constant throughout the course of this study. In April and May, 75 percent of the module replacements were for the coin mechanism and 15 percent were for the bill transport. The remaining 10 percent were distributed among the control panel, logic board and power board components.

TABLE 7-3. NUMBER OF MODULE REPLACEMENTS

Component	Number of Module Replacements 4/15-21	4/22-28	4/29-5/5	5/6-12	5/13-19	Total
Coin Mechanism	12	7	16	8	14	57
Bill Transport	2	4	1	1	3	11
Control Panel	0	0	0	2	2	4
Logic Board	0	0	0	1	0	1
Bill Stuffer	0	0	0	0	0	0
Display Board	0	0	0	0	0	0
Power Board	0	1	0	1	1	3
Coin Escrow	0	0	0	0	0	0
Cashbox	0	0	0	0	0	0
TOTAL	14	12	17	13	20	76

Source: Detroit DOT Farebox Repair Reports

Weekly replacement figures can be used to predict the need for parts on an annual basis. However, a need to replace 57 coin mechanisms over a 5-week period does not necessarily mean that the annual equivalent of 593 spare coin mechanisms would be needed. Such a large number of spare modules would not be required assuming a reasonable turnaround period for repair of each module. Depending on staffing and assuming that the work is done in-house by DDOT (instead of being shipped out to GFI), turnaround time for component repair could probably be reduced from its present 7-10 days to 2-4 days. Hence a reasonable spare parts requirement would be approximately 5 percent of the total initial fareboxes purchased, or 10 spare coin mechanisms, for example, for every 200 fareboxes purchased.

8. FAREBOX SECURITY

The security of fare revenue was evaluated by three measures:

- The number of board actions against DDOT employees for pilfering from GFI fareboxes
- The average revenues per rider on Woodward Avenue*
- Change in total revenue on Woodward Avenue.

8.1 BOARD ACTIONS FOR PILFERING

The purpose of this measure is to compare the effectiveness of the GFI versus the Cleveland farebox equipment in terms of security/pilferage. The new GFI farebox was designed for high security and, to date, has been very effective. As shown in Table 8-1, no board actions have been taken for pilfering in coach operations using the GFI farebox equipment since it was introduced. For the same time period, 13 board actions were taken against employees under coach operations using the Cleveland farebox equipment.

In evaluating these figures, the number of farebox operating days should be taken into consideration.** There are far fewer GFI farebox operating days for the period under consideration due to the fact that only approximately 18 GFI fareboxes were being operated per day. Therefore, a ratio of board actions to farebox operating days yields a more accurate representation of security effectiveness.

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* An increase in revenues per rider is assumed to indicate that the incidence of short fares and partial dollar bills has been reduced.

** The number of farebox operating days is determined by multiplying the total number of coaches operating in a typical day by the number of days under consideration.

The ratios of disciplinary board actions for pilferage to the total farebox operating days for the entire test period are shown in the fifth entry of Table 8-1. As shown, the GFI fareboxes have 0 board actions per 2,886 operating days, and the Cleveland fareboxes have 1 board action per each 4,092 farebox operating days.

TABLE 8-1. RATIO OF BOARD ACTIONS FOR PILFERING TO FAREBOX OPERATING DAYS

	GFI Equipment	Cleveland Equipment
Avg. Farebox Operating Days Per Week*	111	2,046
Number of Operating Weeks	26	26
Number of Farebox Operating Days 11/19-5/19	2,886	53,196
Number of Board Actions for Pilfering 11/19-5/19**	0	13
Ratio of Board Actions to Farebox Operating Days	0/2,886	1/4,092

* These figures are for the week of May 13-19 which is assumed to be an average week.
Source: Detroit DOT, Transportation Operations

** Source: Detroit DOT, Supervisor of Plant Protection

8.2 AVERAGE REVENUES PER RIDER

Table 8-2 presents the average revenues per rider for specific dates on Woodward Avenue in coach operations with Cleveland farebox equipment. On 11/19/84, the Cleveland farebox equipment was replaced with the new GFI farebox equipment.

Table 8-3 gives the average revenues per rider with the operation of GFI electronic farebox equipment on Woodward Avenue. Revenue counts for Saturdays and Sundays are frequently combined by DDOT while passenger counts are conducted over a one-day period only. DDOT counts passengers one Saturday or Sunday and one weekday each month. The passenger count includes all passengers on Woodward Avenue for a 24 hour day.

TABLE 8-2. AVERAGE REVENUE PER RIDER IN COACH OPERATIONS WITH CLEVELAND FAREBOX EQUIPMENT

Day	Date	Woodward Avenue Ridership Count	Woodward Avenue Collected Revenues[1]	Revenues Per Rider
Friday	9/21/84	23,903	$10,284.02	$0.43
Saturday	9/22/84	13,798	5,780.88	0.42
Sunday	10/14/84	5,687	2,751.83	0.48
Monday	10/22/84	21,115	8,649.38	0.41
Tuesday	11/13/84	19,190	9,239.66	0.48
Mean		16,739	$7,341.15	$0.44

[1] Includes the value of coins, bills and tickets collected.

TABLE 8-3. AVERAGE REVENUE PER RIDER IN COACH OPERATIONS WITH GFI FAREBOX EQUIPMENT

Day	Date	Woodward Avenue Ridership Count	Woodward Avenue Collected Revenues[1]	Revenues Per Rider
Wednesday	12/12/84	17,920	$8,956.79	$0.50
Thursday	1/10/85	17,571	6,123.30	0.35
Friday	2/15/85	20,933	12,880.85	0.62
Monday	3/18/85	15,060	10,409.79	0.69
Tuesday	4/16/85	19,737	10,164.22	0.52
Wednesday	5/22/85	21,187	8,805.79	0.42
Mean		18,735	$9,556.79	$0.52

[1] Includes the value of coins, bills and tickets collected.
Source: Detroit DOT, Auditing Division.

A comparison of Tables 8-2 and 8-3* shows that the Woodward Avenue mean revenue per rider was up to $.52, an increase of 18 percent over the mean revenue per rider of $.44 for coach operations with Cleveland farebox equipment. This increase is probably due to the reduction in half bills and mutilated bills after installation of the GFI farebox and the necessity for more patrons to pay the full $1.00 adult fare.

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* It should be noted that Tables 8-2 and 8-3 do not cover the same time periods. Average revenue per rider data for coach operations with Cleveland farebox equipment was not available for the same time period in which the GFI fareboxes were under study.

8.3 CHANGE IN TOTAL REVENUE ON WOODWARD AVENUE FROM 1984 TO 1985

The second and third weeks of May were selected for comparison of total revenues on Woodward Avenue before (1984) and after (1985) installation of the electronic registering farebox. As shown in Table 8-4, revenue on Woodward Avenue for the two week period declined by 1.2 percent after the electronic farebox was installed. A similar comparison for DDOT fleetwide revenues showed that fleetwide revenues during the same period declined by 9 percent. Thus, Woodward Avenue's percentage revenue loss was 87 percent less than the percentage loss for DDOT systemwide. The electronic farebox appears to have contributed to the smaller loss.

TABLE 8-4. CHANGE IN ONE WEEK'S REVENUE ON WOODWARD AVENUE AND DDOT SYSTEMWIDE BEFORE AND AFTER ELECTRONIC FAREBOX INSTALLATION

	Currency and Coin Revenue			
	Woodward Avenue			Total DDOT
	1984	1985	Change From 1984 to 1985	Change From 1984 to 1985
2nd Week in May*	$44,108.65	$41,207.45	-6.5%	
3rd Week in May**	$40,916.90	$42,822.52	+4.6%	
Total	$85,025.55	$84,030.02	-1.2%	-9.0%***

* May 7-13, 1984; May 6-12, 1985

** May 14-20, 1984; May 13-19, 1985

*** For the same two week period: From $1,111,943.28 in 1984 to $1,012,557.51 in 1985

APPENDIX A

FARE COLLECTION EQUIPMENT TEST AND EVALUATION PLAN

FARE COLLECTION EQUIPMENT EVALUATION AND TEST PLAN

For

DETROIT DEPARTMENT OF TRANSPORTATION

Prepared By

BOOZ·ALLEN & HAMILTON Inc.
Transportation Consulting Division

NOVEMBER 13, 1984

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LIST OF EXHIBITS

I. INTRODUCTION

The Detroit Department of Transportation (DDOT) will conduct an evaluation of GFI electronic registering fareboxes in revenue service from November 1984 to April 1985. The fareboxes will be installed on coaches operating on bus route No. 53, Woodward Avenue; they will be the only equipment used for revenue collection on that route during the test period.

DDOT will evaluate the performance of the 32 fareboxes before deciding on the procurement of additional fareboxes for fleetwide installation. The evaluation will involve determining the accuracy, reliability and cost effectiveness of the fare collection equipment, and assessing the ability of the equipment to reduce dollar bill handling costs.

The following individuals and groups have responsibility during the test:

- Detroit Department of Transportation
  - Claryce Ossman, DDOT Project Manager.
  - George Nobles, Superintendent of Operations, responsible for the incorporation of the fareboxes into existing DDOT operations and maintaining schedule adherence.
  - James Fryer, Field Project Manager, also responsible for operator instructors, dwell time checks as needed, and evaluation of first article acceptance tests.
  - Grover Tigue, Modifications to Gilbert Terminal boxhouse to provide a farebox maintenance area and evaluation of first article acceptance tests.

- Harvey Saad, Reconciliation of farebox cash counts with registered revenue, providing cost estimates for determining differences in operating and maintenance costs between the GFI and Cleveland fareboxes.

- Alex Smith, Counting of revenue

- James Ashley, Farebox security, supervision of farebox maintenance

- James Mallett, Farebox maintenance

- Oreese Collins, Removal of existing fareboxes from buses, modifications to buses prior to installation of the fareboxes by GFI.

• Promotion Services Inc. - Public awareness activities including demonstration of "Reggie" and the design of the passenger and driver survey forms.

• Booz, Allen & Hamilton Inc. - Farebox test data analysis and preparation of recommendations for fleetwide procurement.

The objectives of the farebox evaluation are described in the next chapter. The test schedule is presented in Chapter III, plans for data collection are presented in Chapter IV, and selected test procedures are described in Chapter V.

II. DEMONSTRATION TEST OBJECTIVES, PERFORMANCE MEASURES AND DATA REQUIREMENTS

The principal objectives of the farebox test are to determine the extent to which bill-handling fareboxes increase fare revenues and to determine the costs of operating and maintaining the fareboxes. Currently, many bus riders avoid paying the full $1.00 adult fare by depositing torn-in-half, crumpled dollar bills into the farebox. The GFI fareboxes are expected to eliminate this problem, since the driver can identify when a torn or half dollar bill has been inserted. Revenues collected on Woodward Avenue during the test will be compared to the revenue levels before installation of the fareboxes to determine whether an increase has occurred.

The new farebox design is more complicated than the current farebox; the GFI farebox contains electronic circuit boards which enable it to register the amount of fare inserted by each passenger. An important test objective is thus to ascertain the costs to maintain and operate the new fareboxes. This includes an assessment of how often the fareboxes break down and how accurately they record the fares inserted. Additional test objectives include determining whether the fareboxes provide increased revenue security, whether they adversely affect coach operations and whether they reduce DDOT's dollar bill handling costs.

To assist in the evaluation, performance measures have been developed for each test objective. At the conclusion of the test period the test results within each performance measure will be assessed. Exhibit 1 lists each of the test objectives and their associated performance measures and data requirements. During the test, DDOT staff will collect data on farebox performance. This data will be analyzed by Booz, Allen to measure the costs and effectiveness of the new fareboxes.

EXHIBIT 1
Farebox Test Objectives, Performance Measures
and Data Requirements

Test Objective	Performance Measure	Data Requirements
1. Determine the accuracy of the total fareboxes serving Woodward Ave. in counting total revenue.	. The daily total accuracy of all 32 farebox meter readings combined.	. Daily sum of Woodward Ave. farebox meter readings. . Daily total cash count for Woodward Ave. . Running comparison of each cash count with the total meter readings.
2. Determine the accuracy of individual fareboxes in counting bills, tickets and total revenue.	. The accuracy of individual fareboxes in counting tickets.	. Daily farebox ticket count for individual fareboxes. . Ticket count for daily sample of fareboxes.
	. The accuracy of individual fareboxes in counting bills.	. Daily farebox bill count for individual fareboxes. . Bill count for daily sample of fareboxes.
	. The accuracy of individual fareboxes in counting total revenue.	. Registered revenue total for individual fareboxes. . Revenue count for daily sample of fareboxes. . Running comparison of the daily ticket, bill and total revenue counts with the registered totals for the individual fareboxes.

EXHIBIT 1
Farebox Test Objectives, Performance Measures
and Data Requirements

(Continued)

Test Objective	Performance Measure	Data Requirements
3. Determine the reliability of the farebox	. Total failures per week for all 32 operating fareboxes.	. Daily and weekly count of farebox failures with description and cause of each.
	. Average number of operating days per farebox per failure.	. Sum of total fareboxes in operation Monday-Friday, Saturday and Sunday. . Weekly sum of total farebox failures.
4. Determine the labor requirements for farebox operation, cashbox pulling and data recording	. The total labor hours required for farebox operation.	. Weekly sum of farebox operating labor hours for Woodward Ave. route: - Vault Pullers - Transportation Station Workers - Others
5. Determine the labor requirements for farebox and vault receiver maintenance	. The total labor hours required for farebox maintenance.	. Weekly sum of farebox and vault receiver maintenance labor hours: - Maintenance Technician - Other
6. Determine the frequency of service interruptions due to farebox jams and/or road calls for farebox repairs.	. The frequency of farebox jams and road calls.	. Weekly tally of farebox jams and road calls.

EXHIBIT 1
Farebox Test Objectives, Performance Measures
and Data Requirements

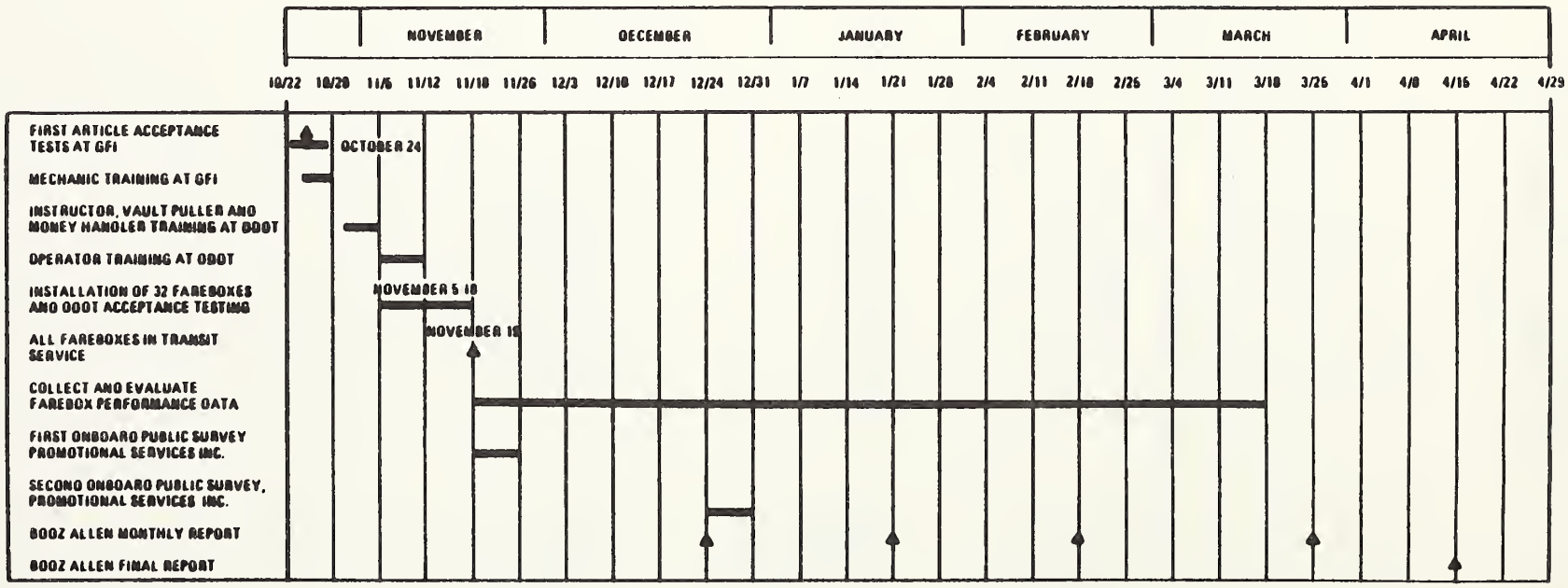
(Continued)

Test Objective	Performance Measure	Data Requirements
7. Determine the impact of the farebox on coach operations.	. The bus dwell time at a particular bus stop.	. Comparison of dwell times for individual bus stops.
8. Determine the impact of the farebox on DDOT revenues.	. The average revenues per rider on Woodward Avenue.	. Weekly count of revenues and associated numbers of riders for Woodward Avenue before and after installation of the farebox.
9. Determine the impact of the farebox on revenue security	. The number of board actions against employees for pilfering from GFI fareboxes.	. Number of board actions against employees serving Woodware Avenue at the conclusion of the test period.

III. TEST SCHEDULE

The planned test schedule is shown in Exhibit 2. As shown, the fareboxes will be placed in transit service on Monday, November 19 and will be evaluated over a period of 4 months. During that time DDOT staff will collect detailed data on farebox operating and maintenance requirements and costs which will be evaluated by Booz, Allen. The test is scheduled to be completed by March 18. One month after the completion of the test, Booz, Allen will submit a final report with recommendations for fleetwide procurement. The planned data collection responsibilities and forms are presented in Chapter IV.

EXHIBIT 2
Planned Test Schedule



IV. DATA COLLECTION PLAN AND DATA FORMS

Data collection will be accomplished by DDOT staff. Exhibit 3 presents the data collection plan. The plan includes the names of individuals at DDOT who are responsible for data collection in each of the 12 objective areas. For each objective, the test plan lists:

- The performance measure to be used in assessing the performance of the fareboxes
- Data required for the evaluation
- The data forms to be used for data collection
- The individual at DDOT responsible for data collection.

The pages following the test plan contain the data collection forms that will be used. They include:

- Woodward revenue separation report
- Farebox repair report
- Operating Farebox Report
- Operator's trouble report
- Record of fareboxes returned to GFI for repairs.

The computer printout from the GFI data handling system will also be used as a source document for data collection. In addition, DDOT documents such as the dispatcher's road call reports, the service inspector's records on fareboxes unjammed on the road, periodic ride check reports to check bus dwell times and passenger boarding counts, and DDOT accounting records will be used to provide data during the test.

EXHIBIT 3
Data Collection Plan

Test Objective	Performance Measure	Data Requirements	Data Form	DDOT Data Collection Responsibility
1. Determine the accuracy of the total fareboxes serving Woodward Ave. in counting total revenue.	. The daily total accuracy of all 32 farebox readings combined	. Daily sum of Woodward Ave. farebox meter readings.	. Computer printout at Gilbert box house	Bill Wynes/ Benny Brewton
		. Daily total cash count for Woodward Ave.	. Daily Woodward revenue separation report (see Exhibit 4).	Alex Smith
			. Running comparison of each cash count with total meter readings.	Harvey Saad
2. Determine the accuracy of individual fareboxes in counting bills, tickets and total revenue.	. The accuracy of individual fareboxes in counting tickets	. Daily farebox ticket count for individual fareboxes	. Computer printout at Gilbert box house	Bill Wynes/ Benny Brewton
		. Ticket count for daily sample of fareboxes	. Daily Woodward Revenue Separation Report	Alex Smith
	. The accuracy of individual fareboxes in counting bills	. Daily farebox bill count for individual fareboxes.	. Computer printout at Gilbert box house	Bill Wynes/ Benny Brewton
		. Bill count for daily sample of fareboxes.	. Daily Woodward Revenue Separation Report	Alex Smith
	. The accuracy of individual fareboxes in counting total revenue.	. Registered revenue total for individual fareboxes.	. Computer printout at Gilbert box house	Bill Wynes/ Benny Brewton
		. Revenue count for daily sample of fareboxes.	. Daily Woodward Revenue Separation Report.	Alex Smith
			. Running comparison of daily ticket, bill and total revenue counts with registered totals for the individual fareboxes.	Harvey Saad

EXHIBIT 3 (Continued)
Data Collection Plan

Test Objective	Performance Measure	Data Requirements	Data Form	DDOT Data Collection Responsibility
3. Determine the reliability of the farebox	. Total failures per week for all 32 operating fareboxes.	. Daily and weekly count of farebox failures with description and cause of each	. Farebox repair report (See Exhibit 5)	James Mallett
	. Average number of operating days per farebox per failure.	. Sum of total fareboxes in operation Monday-Friday, Saturday and Sunday.	. Daily report on number of operating fareboxes (Exhibits 6 and 7)	James Fryer
		. Weekly sum of total farebox failures.	. Sum of farebox maintenance reports (Report form to be developed)	James Mallett
4. Determine the labor requirements for farebox operation, cashbox pulling and data recording	. The total labor hours required for farebox operation.	. Weekly sum of farebox operating labor hours for Woodward Ave. route: - Vault Pullers - Transportation Station Workers - Others	. Service inspector, vault puller and other farebox operations time sheets (excluding bus operator)	Jim Craig/ James Ashley
5. Determine the labor requirements for farebox and vault receiver maintenance	. The total labor hours required for farebox maintenance.	. Weekly sum of farebox and vault receiver maintenance labor hours: - Maintenance Technician - Other	. Maintenance workers time sheets.	James Ashley
6. Determine the frequency of service interruptions due to farebox jams and/or road calls for farebox repairs.	. The frequency of farebox jams and road calls.	. Weekly tally of farebox jams and road calls.	. Dispatcher's road call report . Service inspectors' records on fareboxes unjammed on road (See Exhibit 8) . Drivers' trouble reports (See Exhibit 9)	James Fryer

EXHIBIT 4
Woodward Revenue Separation Report

CITY OF DETROIT
DEPARTMENT OF TRANSPORTATION

INTERDEPARTMENTAL COMMUNICATION

TO: George A. Nobles, Supt.
Transportation Operations

FROM: Alex Smith, Jr.
Cashier

RE: WOODWARD REVENUE SEPARATION

REVENUE DATE:_____

	THOUSANDS	HUNDREDS	CENTS
CURRENCY	$		
SILVER DOLLARS			
HALVES			
QUARTERS			
DIMES			
NICKELS			
PENNIES			
Total Currency & Coin	$		

TICKETS		NUMBER		AMOUNT THOUSANDS	HUNDREDS	CENTS
ADULTS	.90			$		
STUDENT	.65					
TRANSFER	.10					
"	.05					
Total Ticket Value				$		

Grand Total $_____

TORN HALF DOLLAR BILLS_____

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EXHIBIT 5
Farebox Repair Report

DETROIT DEPARTMENT OF TRANSPORTATION
FAREBOX REPAIR REPORT

Repaired By _____ Date _____

FAREBOX NO. _____ Cashbox No. _____	Inspection Repair Time HRS	MIN	Adjust Only	Replace Parts	Repair Status	Replace /Inven.
COIN MECHANISM						
COIN ESCROW						
BILL TRANSPORT						
CONTROL PANEL						
DISPLAY BOARD						
LOGIC BOARD						
POWER BOARD						
DECALS (Coin/Bill)						
EXTERNAL APPEARANCE						
CASHBOX						

PARTS - MODULES USED AND/OR INSTALLED FOR FAREBOX REPAIR

QUANTITY	DESCRIPTION	PART NO.	REASON/NOTES	WARRANTY IN	OUT

EXHIBIT 6
Operating Farebox Report

To: George. A. Nobles, Supt.
Transportation Operations

FROM: James Fryer
Assn't. Supt. of Transportation Operations

RE: WEEKLY OPERATING FAREBOXES

COUNT DATES: _____ to _____

Day	Number of GFI Fareboxes in Revenue Service
Monday	
Tuesday	
Wednesday	
Thursday	
Friday	
Saturday	
Sunday	
TOTAL	

EXHIBIT 7
Summary of Daily Coach Pullouts
To Be Prepared by TSW

SUMMARY OF DAILY COACH PULLOUTS FOR COACHES EQUIPPED WITH GFI FAREBOXES

WEEK OF _____ TO _____

COACH NO.	MON.		TUES.		WED.		THURS.		FRI.		SAT.		SUN.	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
TOTAL														

Exhibit 8
Summary of Service Inspectors' Reports

WEEKLY SUMMARY OF FAREBOX JAMS
DOCUMENTED IN SERVICE INSPECTORS' REPORTS

Date	Coach Number	Time	Type of Jam	Action

EXHIBIT 9
Operator's Trouble Report

DETROIT DEPARTMENT OF TRANSPORTATION
OPERATOR(S) REPORT - FAREBOX DEFECTS

Bus No. _____ Operator _____

Date _____ Time Reported _____

FAREBOX PROBLEM
- ☐ Will Not Operate
- ☐ Numeric Display
- ☐ Information Display
- ☐ Does Not "Beep"

BILL TRANSPORT
- ☐ Does Not Accept Bills
- ☐ Bill(s) Jam
- ☐ Does Not Count Right
- ☐ Lamp Not Working

INSPECTION WINDOWS
- ☐ Coin
  - ☐ Dirty
  - ☐ Broken
- ☐ Bill
  - ☐ Dirty
  - ☐ Broken

TOP DECALS
- ☐ Coins
  - ☐ Dirty
  - ☐ Missing
- ☐ Bills
  - ☐ Dirty
  - ☐ Missing

COIN MECHANISM
- ☐ Does Not Work
- ☐ Does Not Count
- ☐ Paper Jam
- ☐ Coin Jam
- ☐ Slow Coin Drop
- ☐ Does Not Shut Off

COIN ESCROW
- ☐ Coin Jams
- ☐ Will Not Open
- ☐ Will Not Close
- ☐ Lamp Not Working

DRIVER CONTROLS
- ☐ Dump Button
  - ☐ Not Working
  - ☐ Not Clearing
- ☐ Key Buttons
  - ☐ Not Working
  - ☐ Can Not Set Fares
  - ☐ Can Not Read Data
  - ☐ Can Not Enter R/R

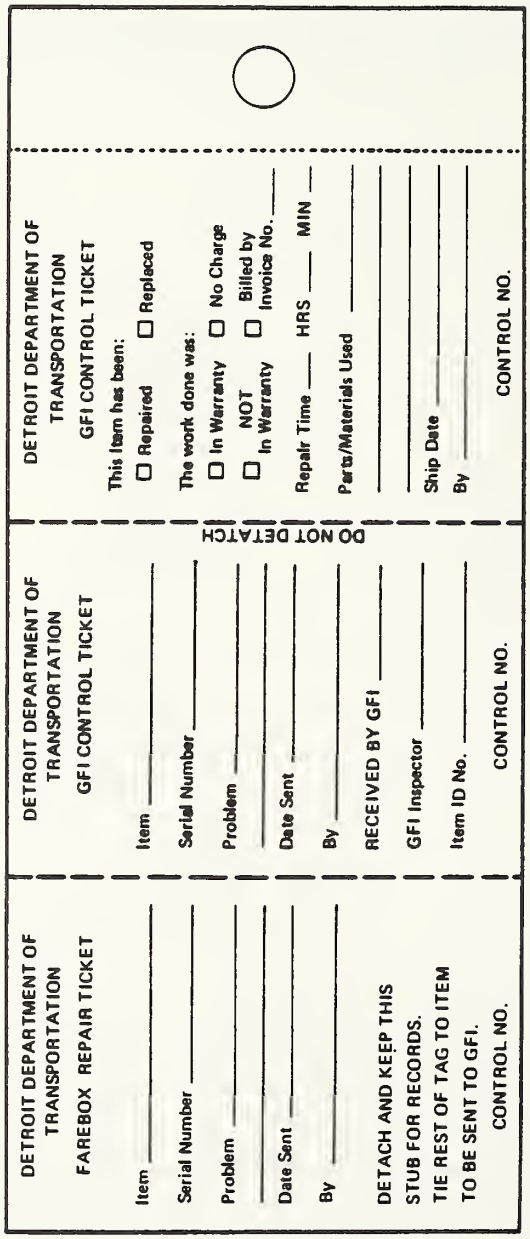
EXTERIOR
- ☐ Base Plate Loose
- ☐ Cabinet Damaged

OTHER _____

_____

_____

EXHIBIT 10
Record of Fareboxes Returned to GFI for Repairs



V. TEST PROCEDURES

The following pages contain selected operating procedures that will be followed at DDOT during the four month test procedure. Equipment operating procedures such as how to probe the farebox and how to operate the farebox computer system are detailed in GFI's equipment operating manuals. The procedures contained here are DDOT guidelines for responding to equipment failures and providing security control. The procedures include the following:

- Procedures for farebox failures while a bus is in service from 6:00 A.M. to 10:00 P.M.
- Procedures for farebox failures while bus is in service from 10:00 P.M. to 6:00 A.M.
- Procedures for service inspectors on Woodward Avenue
- Procedures for farebox pulling at Gilbert Terminal
- Procedures for handling mobile revenue bins
- Key control.

1. PROCEDURES FOR FAREBOX FAILURES WHILE BUS IS IN SERVICE FROM 6:00 A.M. TO 10:00 P.M.

The bus operator will notify the dispatcher if the farebox fails to function properly. Listed below are potential types of failures.

Problem	Operator Instruction	Dispatcher Instruction
Farebox power fails	Call dispatcher	Send relief bus. Instruct driver to wait for change off.
Bill transport will not accept dollar bills	Call dispatcher	Send service inspector to unjam bill transport. Direct operator to wait for service inspector.
Coin mechamisn is jammed	Press coin release lever and "0" button. If still jammed, call dispatcher to notify him that farebox is jammed. Get permission from the dispatcher to put the farebox in bypass.	Instruct driver on unjamming procedures and coin bypass. Send service inspector to attempt to remove jam. If jam can't be removed, service inspector will instruct operator to work with farebox in bypass until a changeoff can be made if possible.
Coin mechanism is not counting correctly	Continue to use farebox. Notify dispatcher. Report problem on trouble report form.	Record farebox problem. Notify farebox maintenance manager and alert him to the problem.
Coin collection plate will not close	Continue to use farebox. Notify dispatcher. Report problem on trouble report form.	Record farebox problem. Notify farebox maintenance manager immediately.
Keyboard not working; Dump button works	Continue to use farebox. Notify dispatcher. Report problem on trouble report form.	Record farebox problem. Notify farebox maintenance manager.
Keyboard and Driver Dump Button not working	Call dispatcher.	Send service inspector. If problem can't be removed, the service inspector will instruct operator to finish trip then get another coach.
Farebox will not beep	Continue to use farebox. Notify dispatcher. Report problem on trouble report form.	Record farebox problem. Notify maintenance department.
Farebox Automatic Dump and Dump Button not working	Call dispatcher	Send service inspector. Instruct operator to wait for a changeoff if possible.

2. PROCEDURES FOR FAREBOX FAILURES WHILE BUS IS IN SERVICE FROM 10:00 P.M. TO 6:00 A.M.

The operator will notify the dispatcher if the farebox fails to function properly. During the late night hours of 10:00 P.M. to 6:00 A.M., the dispatcher will dispatch a relief bus for any farebox failures that block the collection of fares.

If the farebox develops a problem but fares can be collected, the operator should take the bus to the changeoff point and get a changeoff. The operator must fill out a trouble report.

If the farebox develops a problem and fares cannot be collected, the dispatcher will instruct the operator to wait for a changeoff or to pull the bus in. The operator must fill out a trouble report.

3. PROCEDURES FOR SERVICE INSPECTORS ON WOODWARD AVENUE

Each morning the Woodward Avenue service inspector will pick up the farebox key at Gilbert Terminal. He will sign the key out and sign it in when he returns it at the end of his shift.

When notified by the dispatcher of a road call for farebox trouble, the service inspector will proceed to the bus location and attempt to unjam the farebox. If the jam cannot be removed, the service inspector will call for a changeoff bus.

4. PROCEDURES FOR FAREBOX PULLING AT GILBERT TERMINAL

The transportation station worker (TSW) or vault puller at Gilbert Terminal will follow the procedures below.

(1) Verify that a spare cashbox is available in the vault pulling area.

(2) To pull a cashbox, pull the full cashbox from the bus and replace it with the empty cashbox. Once the full cashbox is emptied in the vault receiver, it then becomes the new spare cashbox. Do not apply too much force while inserting or removing cashboxes from fareboxes or revenue receivers.

(3) If a cashbox will not easily fit into the farebox obtain a second cashbox from the farebox maintenance room and try it in the farebox. If the spare cashbox works, tag the bad cashbox with a red tag and write the bus number, farebox number and time on the tag. Place the tagged cashbox where it will be picked up by the counting room truck. If the second spare cashbox will not go into the farebox, lock the farebox door and notify the farebox maintenance manager.

(4) If a cashbox will not easily fit into the revenue receiver, obtain a second spare cashbox and try it in the receiver. If the second spare cashbox will not fit properly into the receiver, try another cashbox, If it does not work, go to the back-up receiver unit.

(5) At the end of the peak pull-ins (6:00 P.M.) all spare cashboxes will be returned to the farebox repair room. No spare cashboxes will be left in the receivers overnight.

5. PROCEDURES FOR HANDLING MOBILE REVENUE BINS

(1) The money handler will obtain the revenue receiver door key from the counting room manager after loading the empty bin into the money truck at the counting room dock and leaving to go to the Gilbert Terminal box house.

(2) After arrival at the box house, the money handler will unlock the lower receiver bin doors, remove the full bin and replace it with the empty mobile bin that was picked up at the counting room. After the empty bin is placed in the receiver, the money handler will lock the receiver and move the full receiver bins onto the money truck for the return trip to the counting room.

6. KEY CONTROL

The following assignments of farebox and revenue receiver keys have been made.

Key Function	Number Supplied by GFI	DDOT Key Assignments
Fareboxes		
Access to top of farebox for maintenance	12	3 - Gilbert Superintendents 6 - Service Inspectors 2 - Gilbert Boxhouse farebox maintenance 1 - Security
Unlock bill transport inside farebox	3	1 - Gilbert Boxhouse farebox maintenance 1 - Warren Ave. Locksmith 1 - Security
Portable electronic probe to access cashbox	2	1 - Gilbert Boxhouse TSW 1 - Warren Ave. Locksmith
Revenue Receivers		
Open front doors of receiver vault to access mobile bin	3	1 - Moneyhandlers 1 - Counting room spare 1 - Security
Open emergency trapdoor of vault receiver	2	1 - Counting Room Manager 1 - Security
Open shutter plates of mobile bin to release coins and bills (same key is used for coins and bills)	3	1 - Counting Room 1 - Warren Ave. Locksmith 1 - Security

APPENDIX B

SUMMARY OF INDIVIDUAL GFI FAREBOX AUDITS

EXHIBIT B-1. SUMMARY OF INDIVIDUAL FAREBOX AUDITS--COIN COUNTS

COACH NUMBER	AUDIT DATE	METERED COINS ($)	ACTUAL COINS ($)	DIFFERENCE ($)	% DIFFERENCE FROM ACTUAL COIN COUNT
1353	12-3-84	70.74	70.74	0	0.00%
	1-23-85	107.56	107.32	0.24	0.22%
1511	12-3-84	107.94	99.93	8.01	8.02%
	1-22-85	66.85	66.21	0.64	0.97%
1512	12-21-84	79.67	95.93	-16.26	-16.95%
	1-23-85	57.20	57.30	- 0.1	-0.17%
	1-24-85	37.25	37.75	- 0.5	-1.32%
	1-24-85	57.80	58.25	-0.45	-0.77%
	1-24-85	16.24	16.34	- 0.1	-0.61%
1516	12-10-84	101.12	100.78	0.34	0.34%
	12-25-84	23.49	0.00	23.49	
	1-10-85	31.39	33.64	-2.25	-6.69%
	1-21-85	89.83	89.99	-0.16	-0.18%
	1-22-85	32.69	32.54	0.15	0.46%
1517	12-31-84	47.36	47.37	- 0.01	-0.02%
	1-9-85	85.73	85.56	0.17	0.20%
	1-15-85	133.59	134.28	- 0.69	-0.51%
	1-21-85	17.60	17.60	0	0.00%
	1-22-85	20.24	27.14	- 6.9	-25.42%
	1-23-85	63.70	62.92	0.7763	1.23%
	1-23-85	26.22	25.77	0.45	1.75%
	1-24-85	39.10	38.95	0.15	0.39%
	5-17-85	139.40	60.54	78.86	130.26%
1518	12-3-84	45.18	53.59	- 8.41	-15.69%
	1-21-85	17.19	17.19	0	0.00%
	1-22-85	67.39	67.65	- 0.26	-0.38%
	1-22-85	104.86	102.50	2.36	2.30%
	1-24-85	53.74	53.79	- 0.05	-0.09%
1524	12-14-84	62.79	62.44	0.35	0.56%
	12-21-84	97.13	82.36	14.77	17.93%
	1-15-85	124.17	124.22	- 0.05	-0.04%
1525	12-10-84	84.58	84.88	- 0.3	-0.35%
	1-7-85	26.75	26.61	0.14	0.53%
	1-21-85	27.96	31.10	- 3.14	-10.10%
	1-22-85	17.44	16.44	1	6.08%
	1-23-85	93.67	95.01	- 1.34	-1.41%
	1-23-85	16.15	15.66	0.49	3.13%
	1-24-85	16.56	21.65	- 5.09	-23.51%
	1-24-85	28.10	28.30	- 0.2	-0.71%
	1-24-85	18.20	18.33	- 0.13	-0.71%
1529	1-22-85	26.80	26.76	0.04	0.15%
	1-23-85	115.91	121.80	- 5.89	-4.84%

EXHIBIT B-1. CONTINUED

COACH NUMBER	AUDIT DATE	METERED COINS ($)	ACTUAL COINS ($)	DIFFERENCE ($)	% DIFFERENCE FROM ACTUAL COIN COUNT
	1-24-85	56.61	57.29	-0.68	-1.19%
	1-24-85	83.45	85.99	-2.54	-2.95%
1535	12-27-85	19.93	23.87	-3.94	-16.51%
	1-17-85	93.79	93.92	-0.13	-0.14%
	1-21-85	82.14	81.28	0.86	1.06%
	1-21-85	10.06	10.16	- 0.1	-0.98%
	1-22-85	59.48	59.40	0.08	0.13%
	1-22-85	51.03	44.31	6.72	15.17%
	1-23-85	125.48	116.86	8.62	7.38%
1563	12-13-84	101.26	66.00	35.26	53.42%
	1-21-85	57.46	58.21	-0.75	-1.29%
	1-23-85	18.86	18.81	0.05	0.27%
	1-24-85	53.68	53.78	-0.1	-0.19%
	1-24-85	36.83	31.89	4.94	15.49%
1565	1-14-85	66.79	66.79	0	0.00%
	1-21-85	29.20	29.25	-0.05	-0.17%
	1-22-85	40.96	40.87	0.09	0.22%
	1-22-85	73.64	74.17	-0.53	-0.71%
	1-23-85	53.50	54.13	-0.63	-1.16%
1566	12-31-84	33.60	34.06	-0.46	-1.35%
	1-8-85	107.99	109.70	-1.71	-1.56%
1567	12-17-84	57.59	61.20	-3.61	-5.90%
	1-7-85	93.51	94.41	-0.9	-0.95%
1577	1-22-85	71.87	72.44	-0.57	-0.79%
	1-22-85	12.95	12.16	0.79	6.50%
	1-23-85	62.67	62.36	0.31	0.50%
	1-24-85	118.23	121.07	-2.84	-2.35%
1818	1-22-85	13.64	13.64	0	0.00%
	1-22-85	54.24	56.39	-2.15	-3.81%
	1-23-85	78.96	78.64	0.32	0.41%
	5-17-85	60.53	137.81	- 77.28	-56.08%
1820	12-18-84	74.37	73.98	0.39	0.53%
	1-21-85	89.82	89.19	0.63	0.71%
	1-22-85	39.58	38.84	0.74	1.91%
	1-22-85	63.72	63.86	-0.14	-0.22%
	1-23-85	30.19	38.19	- -8	-20.95%
	1-23-85	67.16	67.18	-0.02	-0.03%
	1-24-85	119.33	119.33	0	0.00%
1824	1-10-85	89.85	99.18	-9.33	-9.41%

EXHIBIT B-1. CONTINUED

COACH NUMBER	AUDIT DATE	METERED COINS ($)	ACTUAL COINS ($)	DIFFERENCE ($)	% DIFFERENCE FROM ACTUAL COIN COUNT
	5-16-85	74.02	74.02	0	0.00%
1826	12-19-84	70.27	71.75	-1.48	-2.06%
	1-21-85	25.95	25.77	0.18	0.70%
	1-22-85	20.10	19.99	0.11	0.55%
	1-22-85	90.61	90.71	-0.1	-0.11%
	1-23-85	91.77	89.89	1.88	2.09%
	1-23-85	12.93	13.42	-0.49	-3.65%
	1-24-85	77.34	77.56	-0.22	-0.28%
	1-24-85	63.80	64.04	-0.24	-0.37%
	5-15-85	47.31	47.32	-0.01	-0.02%
1827	12-14-84	95.66	95.93	-0.27	-0.28%
	12-25-84	19.02	20.85	-1.83	-8.78%
	1-17-85	107.26	106.39	0.87	0.82%
	1-21-85	66.14	66.28	-0.14	-0.21%
	1-21-85	14.97	11.77	3.2	27.19%
	1-23-85	73.15	73.47	-0.32	-0.44%
	1-23-85	51.54	50.54	1	1.98%
	1-24-85	108.38	107.67	0.71	0.66%
	1-24-85	11.31	11.10	0.21	1.89%
	5-13-85	119.66	120.16	-0.5	-0.42%
1829	1-14-85	46.24	46.55	-0.31	-0.67%
	1-21-85	13.70	13.70	0	0.00%
	1-23-85	48.82	48.34	0.48	0.99%
	1-24-85	39.24	40.05	-0.81	-2.02%
	1-24-85	20.98	22.25	-1.27	-5.71%
1832	12-26-84	32.80	33.15	-0.35	-1.06%
	1-14-85	92.68	92.59	0.09	0.10%
1833	5-13-85	131.13	130.65	0.48	0.37%
1837	12-21-84	38.60	55.64	-17.04	-30.63%
	1-10-85	18.48	18.63	-0.15	-0.81%
	1-21-85	22.50	22.49	0.01	0.04%
	1-22-85	104.96	105.16	-0.2	-0.19%
	1-23-85	100.30	96.39	3.91	4.06%
	1-23-85	14.21	18.67	-4.46	-23.89%
	1-24-85	111.21	111.09	0.12	0.11%
1838	12-20-84	72.05	67.23	4.82	7.17%
	1-23-85	94.93	97.02	-2.09	-2.15%
	1-24-85	95.70	94.27	1.43	1.52%
	1-24-85	4.35	4.40	-0.05	-1.14%
1842	12-26-84	25.71	26.11	-0.4	-1.53%
	1-21-85	42.82	42.76	0.06	0.14%
	1-22-85	18.43	17.83	0.6	3.37%

EXHIBIT B-1. CONTINUED

COACH NUMBER	AUDIT DATE	METERED COINS ($)	ACTUAL COINS ($)	DIFFERENCE ($)	% DIFFERENCE FROM ACTUAL COIN COUNT
	1-22-85	109.82	108.48	1.34	1.24%
	1-23-85	102.98	102.63	0.35	0.34%
	1-23-85	17.21	17.38	-0.17	-0.98%
	1-24-85	109.18	109.17	0.01	0.01%
	1-24-85	24.57	24.11	0.46	1.91%
	5-14-85	73.61	73.53	0.08	0.11%
1846	1-18-85	111.68	110.07	1.61	1.46%
	1-24-85	18.84	18.66	0.18	0.96%
1849	12-17-84	117.91	118.58	-0.67	-0.57%
	5-14-85	71.13	69.58	1.55	2.23%
1865	1-18-85	124.68	134.35	-9.67	-7.20%
	1-21-85	89.00	88.73	0.27	0.30%
	1-22-85	35.70	36.20	-0.5	-1.38%
	1-23-85	110.53	111.44	-0.91	-0.82%
	1-23-85	21.92	21.92	0	.00%
	1-24-85	37.26	37.26	0	0.00%
	5-16-85	110.06	110.31	-0.25	-0.23%

EXHIBIT B-2. SUMMARY OF INDIVIDUAL FAREBOX AUDITS--BILL COUNTS

COACH NUMBER	AUDIT DATE	METERED BILLS ($)	ACTUAL BILLS ($)	DIFFERENCE ($)	% DIFFERENCE FROM ACTUAL BILL COUNT
1353	12-3-84	170.00	157.00	13	8.28%
	1-23-85	319.00	320.00	- 1	-0.31%
1511	12-3-84	265.00	271.00	- 6	-2.21%
	1-22-85	182.00	185.00	- 3	-1.62%
1512	12-21-84	297.00	355.00	- 58	-16.34%
	1-23-85	182.00	177.00	5	2.82%
	1-24-85	150.00	126.00	24	19.05%
	1-24-85	185.00	161.00	24	14.91%
	1-24-85	92.00	93.00	- 1	-1.08%
1516	12-10-84	294.00	298.00	- 4	-1.34%
	12-25-84	63.00		63	
	1-10-85	125.00	138.00	- 13	-9.42%
	1-21-85	270.00	272.00	- 2	
	1-22-85	88.00	88.00	0	0.00%
1517	12-31-84	200.00	203.00	- 3	-1.48%
	1-9-85	256.00	257.00	- 1	-0.39%
	1-15-85	395.00	397.00	- 2	-0.50%
	1-21-85	62.00	62.00	0	0.00%
	1-22-85	40.00	40.00	0	0.00%
	1-23-85	175.00	179.00	- 4	-2.23%
	1-23-85	82.00	83.00	- 1	-1.20%
	1-24-85	142.00	140.00	2	1.43%
	5-17-85	372.00	371.00	1	0.27%
1518	12-3-84	182.00	186.00	-4	-2.15%
	1-21-85	71.00	73.00	-2	-2.74%
	1-22-85	218.00	219.00	-1	-0.46%
	1-22-85	208.00	210.00	-2	-0.95%
	1-24-85	122.00	127.00	-5	-3.94%
1524	12-14-84	191.00	194.00	-3	-1.55%
	12-21-84	299.00	305.00	-6	-1.97%
	1-15-85	297.00	297.00	0	0.00%
1525	12-10-84	220.00	231.00	- 11	-4.76%
	1-7-85	74.00	74.00	0	0.00%
	1-21-85	101.00	101.00	0	0.00%
	1-22-85	79.00	80.00	-1	-1.25%
	1-23-85	245.00	247.00	-2	-0.81%
	1-23-85	80.00	82.00	-2	-2.44%
	1-24-85	39.00	41.00	-2	-4.88%
	1-24-85	17.00	24.00	-7	-29.17%
	1-24-85	77.00	77.00	0	0.00%
1529	1-22-85	110.00	110.00	0	0.00%
	1-23-85	324.00	328.00	-4	-1.22%

EXHIBIT B-2. CONTINUED

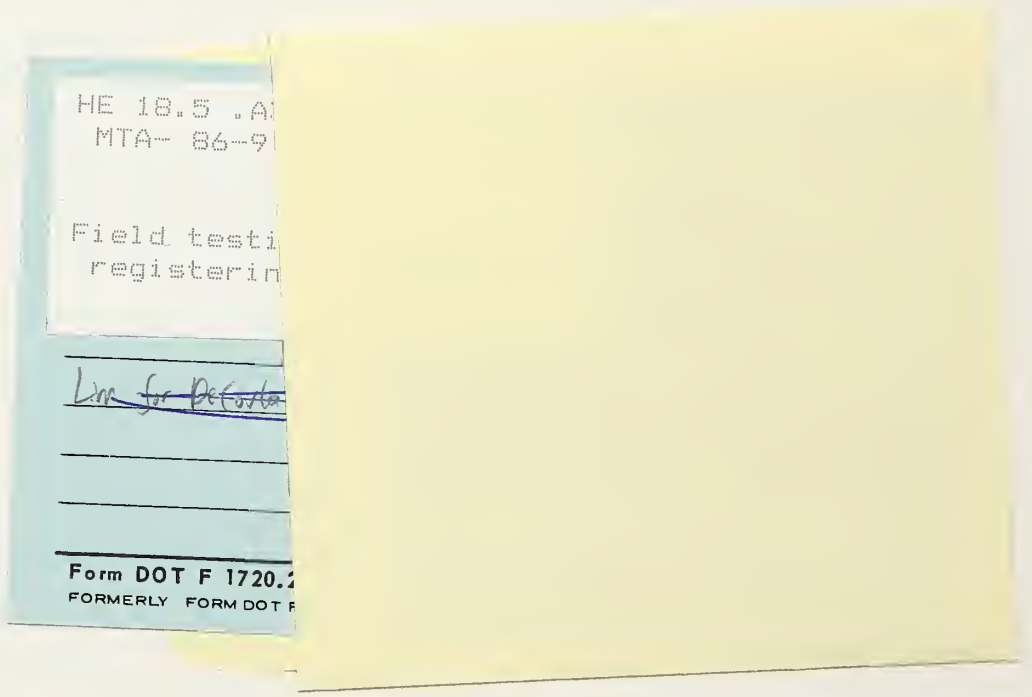
COACH NUMBER	AUDIT DATE	METERED BILLS ($)	ACTUAL BILLS ($)	DIFFERENCE ($)	% DIFFERENCE FROM ACTUAL BILL COUNT
	1-24-85	124.00	128.00	-4	-3.13%
	1-24-85	206.00	210.00	-4	-1.90%
1535	12-27-85	78.00	86.00	-8	-9.30%
	1-17-85	263.00	269.00	-6	-2.23%
	1-21-85	271.00	265.00	6	2.26%
	1-21-85	60.00	60.00	0	0.00%
	1-22-85	206.00	210.00	-4	-1.90%
	1-22-85	129.00	129.00	0	0.00%
	1-23-85	391.00	394.00	-3	-0.76%
1563	12-13-84	264.00	266.00	-2	-0.75%
	1-21-85	178.00	203.00	-25	-12.32%
	1-23-85	32.00	32.00	0	0.00%
	1-24-85	185.00	194.00	-9	-4.64%
	1-24-85	105.00	112.00	-7	-6.25%
1565	1-14-85	208.00	210.00	-2	-0.95%
	1-21-85	128.00	131.00	-3	-2.29%
	1-22-85	88.00	93.00	-5	-5.38%
	1-22-85	101.00	105.00	-4	-3.81%
	1-23-85	143.00	142.00	1	0.70%
1566	12-31-84	113.00	115.00	-2	-1.74%
	1-8-85	271.00	275.00	-4	-1.45%
1567	12-17-84	184.00	242.00	-58	-23.97%
	1-7-85	283.00	392.00	-109	-27.81%
1577	1-22-85	189.00	190.00	-1	-0.53%
	1-22-85	42.00	42.00	0	0.00%
	1-23-85	182.00	193.00	-11	-5.70%
	1-24-85	317.00	316.00	1	0.32%
1818	1-22-85	82.00	83.00	-1	-1.20%
	1-22-85	165.00	166.00	-1	-0.60%
	1-23-85	223.00	233.00	-10	-4.29%
	5-17-85	209.00	214.00	-5	-2.34%
1820	12-18-84	233.00	234.00	-1	-0.43%
	1-21-85	258.00	291.00	-33	-11.34%
	1-22-85	147.00	151.00	-4	-2.65%
	1-22-85	155.00	159.00	-4	-2.52%
	1-23-85	80.00	79.00	1	1.27%
	1-23-85	182.00	184.00	-2	-1.09%
	1-24-85	344.00	347.00	-3	-0.86%
1824	1-10-85	269.00	272.00	-3	-1.10%

EXHIBIT B-2. CONTINUED

COACH NUMBER	AUDIT DATE	METERED BILLS ($)	ACTUAL BILLS ($)	DIFFERENCE ($)	% DIFFERENCE FROM ACTUAL BILL COUNT
	5-16-85	199.00	200.00	-1	-0.50%
1826	12-19-84	216.00	225.00	-9	-4.00%
	1-21-85	95.00	97.00	-2	-2.06%
	1-22-85	79.00	79.00	0	0.00%
	1-22-85	258.00	260.00	-2	-0.77%
	1-23-85	259.00	253.00	6	2.37%
	1-23-85	81.00	85.00	-4	-4.71%
	1-24-85	234.00	146.00	88	60.27%
	1-24-85	151.00	152.00	-1	-0.66%
	5-15-85	178.00	177.00	1	0.56%
1827	12-14-84	320.00	322.00	-2	-0.62%
	12-25-84	64.00	64.00	0	0.00%
	1-17-85	284.00	288.00	-4	-1.39%
	1-21-85	253.00	256.00	-3	-1.17%
	1-21-85	57.00	60.00	-3	-5.00%
	1-23-85	249.00	250.00	-1	-0.40%
	1-23-85	108.00	109.00	-1	-0.92%
	1-24-85	241.00	255.00	-14	-5.49%
	1-24-85	50.00	50.00	0	0.00%
	5-13-85	296.00	295.00	1	0.34%
1829	1-14-85	153.00	153.00	0	0.00%
	1-21-85	53.00	53.00	0	0.00%
	1-23-85	170.00	171.00	-1	-0.58%
	1-24-85	116.00	115.00	1	0.87%
	1-24-85	68.00	70.00	-2	-2.86%
1832	12-26-84	95.00	95.00	0	0.00%
	1-14-85	278.00	282.00	-4	-1.42%
1833	5-13-85	309.00	316.00	-7	-2.22%
1837	12-21-84	43.00	43.00	0	0.00%
	1-10-85	70.00	70.00	0	0.00%
	1-21-85	46.00	47.00	-1	-2.13%
	1-22-85	368.00	371.00	-3	-0.81%
	1-23-85	367.00	374.00	-7	-1.87%
	1-23-85	81.00	82.00	-1	-1.22%
	1-24-85	391.00	401.00	-10	-2.49%
1838	12-20-84	167.00	173.00	-6	-3.47%
	1-23-85	307.00	315.00	-8	-2.54%
	1-24-85	253.00	267.00	-14	-5.24%
	1-24-85	26.00	27.00	-1	-3.70%
1842	12-26-84	109.00	111.00	-2	-1.80%
	1-21-85	153.00	153.00	0	0.00%
	1-22-85	57.00	57.00	0	0.00%

EXHIBIT B-2. CONTINUED

COACH NUMBER	AUDIT DATE	METERED BILLS ($)	ACTUAL BILLS ($)	DIFFERENCE ($)	% DIFFERENCE FROM ACTUAL BILL COUNT
	1-22-85	340.00	347.00	- 7	-2.02%
	1-23-85	312.00	313.00	- 1	-0.32%
	1-23-85	82.00	83.00	- 1	-1.20%
	1-24-85	333.00	335.00	- 2	-0.60%
	1-24-85	90.00	92.00	- 2	-2.17%
	5-14-85	182.00	196.00	-14	-7.14%
1846	1-18-85	398.00	412.00	-14	-3.40%
	1-24-85	65.00	66.00	- 1	-1.52%
1849	12-17-84	391.00	392.00	- 1	-0.26%
	5-14-85	195.00	184.00	11	5.98%
1865	1-18-85	385.00	398.00	-13	-3.27%
	1-21-85	286.00	296.00	-10	-3.38%
	1-22-85	117.00	117.00	0	0.00%
	1-23-85	314.00	318.00	- 4	-1.26%
	1-23-85	107.00	106.00	1	0.94%
	1-24-85	175.00	179.00	- 4	-2.23%
	5-16-85	285.00	291.00	- 6	-2.06%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