SCRTD METRO RAIL PROJECT
Preliminary Engineering

FARE COLLECTION TECHNOLOGY ASSESSMENT

WBS 13 CAE11

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September 1982

ABSTRACT

This report is the first in a series to be prepared for the Metro Rail Fare Collection Subsystem Study. In accordance with WBS 13 CAE11, its purpose is to document information critical to the development of alternative concepts for further analysis and evaluation. The report encompasses local conditions pertinent to fare collection, and fare collection methods on other existing and planned systems. Fare collection systems are examined both conceptually and as applied by other transit agencies. Strengths and weaknesses, as experienced by specific properties, are detailed as well.

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CHAPTER 1
INTRODUCTION

1.1 SCOPE OF THE STUDY

The purpose of this Metro Rail Fare Collection Subsystem Study is to assist the Metro Rail Project staff in establishing fare policies and fare collection methods for the Metro Rail System. The analysis will be conducted in three related WBS elements. First, WBS 13 CAE11 involves a review of policies and methods of fare collection on other rail transit systems, as well as an assessment of pertinent local conditions. Second, WBS 14 CAE11 will entail the development and analysis of alternative fare policy and collection concepts corresponding to the local requirements of the Metro Rail System. Preliminary operational and design criteria for the preferred alternative will be prepared for incorporation into the Milestone 8 Report. Following public comment, the Board will approve the recommended alternative and the operational and design criteria will be finalized. The criteria will guide the Subsystems consultant in the preparation of preliminary designs, specifications and drawings. Third, WBS 16 CAE11 will involve review of these documents to evaluate completeness and compliance with the criteria.

Analysis of fare policy and collection alternatives will focus on projected 1995 ridership conditions with the initial 18.6 mile line in operation, but will consider - - in conceptualizing the alternative systems - - the need to expand as the Metro Rail ridership grows and the system reaches ultimate capacity and extension.

1.2 SCOPE OF THE REPORT

This report is the first in a series to be prepared for the Metro Rail Fare Collection Subsystem Study. In accordance with WBS 13 CAE11, its purpose is to document information critical to the development of alternative concepts for further analysis and evaluation. The report describes pertinent local conditions related to fare collection, as well as methods on other, existing and planned rail transit systems.

Examination of local conditions germane to fare collection on Metro Rail includes a discussion of the overall system, the current operating plan and the existing SCRTD bus fare structure (the subject of "Evaluation of the SCRTD Fare Structure," WBS 14 DAJ submitted by Booz, Allen as part of the SCRTD Metro Rail project). SCRTD's bus fare structure will significantly influence the fare structure that is developed for Metro Rail and the fare collection system that is required to accommodate it.

The description of existing and planned fare collection systems includes comparisons of fare structures; passenger procedures; fare collection equipment; and personnel functions associated with the operation and maintenance of the system. An overview of the strengths and weaknesses of the systems concludes the discussion.

Subsequent reports will describe: (1) the alternative fare structures and fare collection methods recommended for analysis; (2) the results of the alternatives analysis and evaluation; and (3) operational and design criteria for the selected scheme. Following a review of the specifications documents prepared by the Subsystems consultant, a memorandum on degree of compliance will be prepared.

1.3 GENERAL SYSTEM DESCRIPTION AND OPERATING PLAN

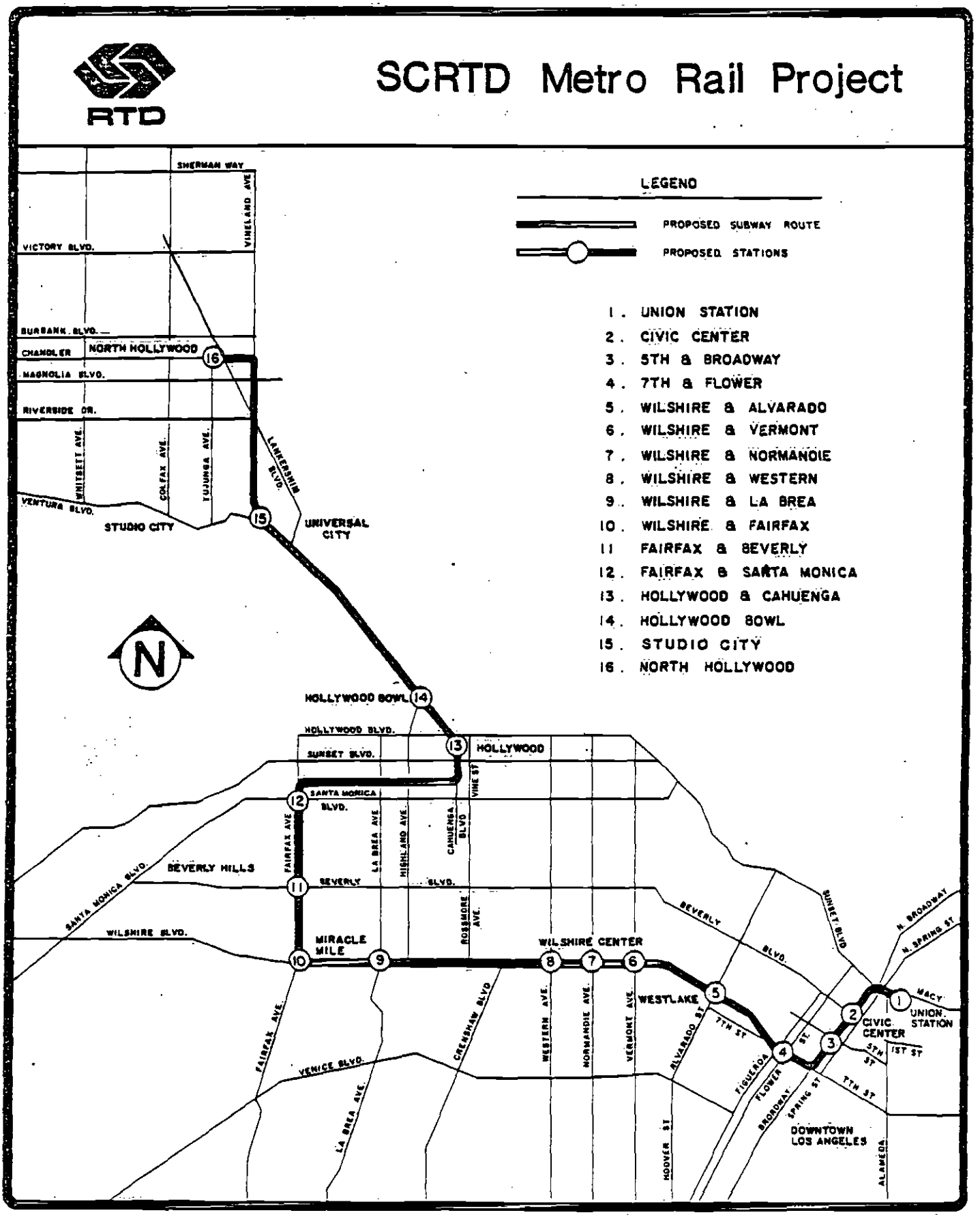
The initial Metro Rail system will be an 18.6-mile rail rapid transit line serving the downtown, Wilshire, Fairfax, Hollywood, West Hollywood and North Hollywood areas. As currently planned, the line will have 16 stations, with station spacings varying from 0.5 miles downtown to 2.7 miles through the Santa Monica Mountains. A schematic of the line is presented in Figure 1-1. Scheduled for commencement of operations in 1990, it is estimated that 309,000 riders will be using the system on a typical weekday in 1995.

Stations will be of subway construction (aerial construction of one station is currently being considered), with single or multiple entry and exit points to the street level. Escalators, stairs and elevators will connect these access points to fare collection areas and to the train platforms. Where feasible, center platforms located between the tracks will be used. All platforms will be level with the car floor.

As presently defined in the Milestone 1 Report, train service will be operated seven days per week, 20 hours per day, with hours between 5:30 A.M. and 1:30 A.M. Actual operating hours will be determined in the future. Nothing in the design of the system will preclude expansion to a 24-hour a day service.

To accommodate ridership levels projected for 1995 during the peak periods, six-car trains will be operated at 3 1/2 minute headways, and increase to 6 minutes as demand levels permit. A peak period vehicle load standard of 170 passengers per car has been established. Thus, a peak period train will be designed to carry a load of 1,020 passengers.

FIGURE 1-1
PROPOSED ROUTE AND STATIONS



During the midday period, six-car trains will be operated at regular 7 1/2 minute headways. In the evening, four-car trains will operate at 15-minute headways. An off-peak maximum vehicle load standard of 91 passengers per car has been established.

Table 1-1 summarizes service levels to be provided by time of day.

The system will be designed to permit an ultimate capacity of 30 six-car trains per hour, thus providing a capacity for carrying 30,600 patrons through the maximum load point in the peak hour. This ultimate capacity would permit a 72 percent increase in the number of riders anticipated in 1995.

Future rail line extensions are being considered in the design of the initial line so that future options are not precluded. These corridors are shown in Figure 1-2. The ultimate system under consideration consists of 150 route miles.

The initial 18.6-mile line will lie within the city limits of Los Angeles, with the exception of one station and a small segment of line in West Hollywood. Future extensions may enter other municipal jurisdictions in the county.

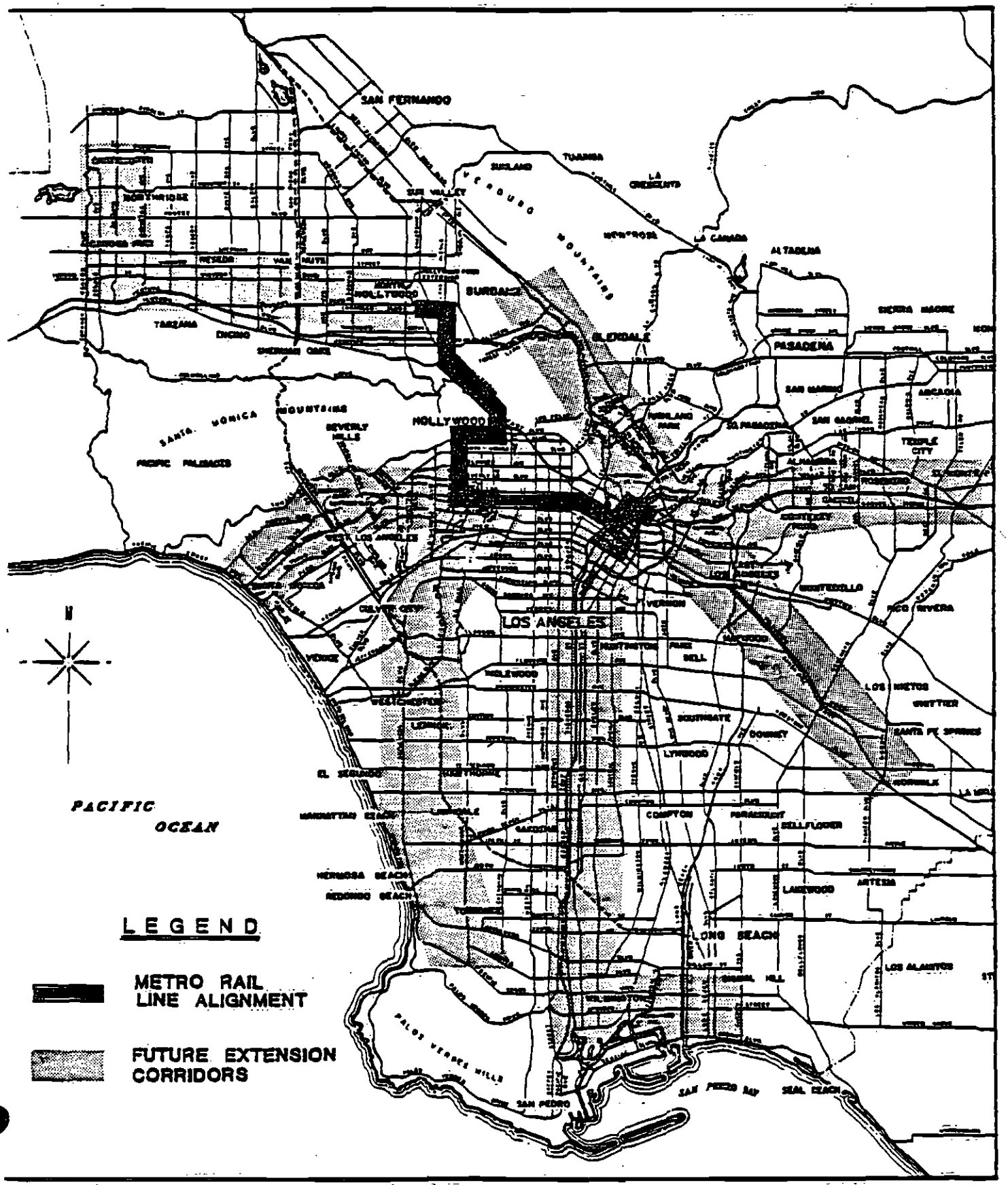
1.4 EXISTING FARE STRUCTURE

SCRTD's current fare structure consists of a flat, single-trip fare for local service, a transfer charge, and an express surcharge for bus lines utilizing the freeway system. Reduced

TABLE 1-1
PRELIMINARY SERVICE LEVELS

Period		Schedule Headway (minutes)	Consist (Cars)
Weekdays			
Early Morning	5:30 a.m. – 6:00 a.m.	15	6
	6:00 a.m. – 6:30 a.m.	7½	6
Peak Periods	6:30 a.m. – 9:00 a.m.	3½ – 6	6
	3:30 p.m. – 6:30 p.m.	3½ – 6	6
Midday	9:00 a.m. – 3:30 p.m.	7½	6
Evening	6:30 p.m. – 7:30 p.m.	7½	6
Night	7:30 p.m. – 1:30 a.m.	15	4
Saturdays			
Morning	5:30 a.m. – 7:30 a.m.	15	4
Day	7:30 a.m. – 7:30 p.m.	10	6
Night	7:30 p.m. – 1:30 a.m.	15	4
Sundays and Holidays			
All Day	5:30 a.m. – 1:30 a.m.	15	4

FIGURE 1-2
FUTURE CORRIDORS



fares are offered to select groups, including senior citizens, handicapped persons, students under the age of nineteen, and college and vocational students. In addition to the single trip fares, unlimited ride monthly passes are also available to both regular and reduced fare groups, with monthly stamps available for express service. There are five distinct distance steps in effect with this express service.

Currently, there are no fare differentials in effect for different times of the day and no time restrictions on the validity of a reduced fare. Fare levels, eligibility requirements, terms of use, and media are summarized for these fare categories in Table 1-2. The combination of having different fares by type of rider, type of service and number of rides (single vs. monthly) has resulted in a fare structure with a multitude of offerings. Altogether, the basic fare structure has 3 one-way fares, 2 transfer fares, 4 monthly pass fares, 2 single-trip express charge fare levels (of 5 steps each) and 2 monthly express charge fare levels (of 5 steps each).

Free travel is offered to a number of individuals. This currently includes employees of SCRTD and their dependents, District retirees, District Board members, selected local city and county government personnel, and blind individuals. Children under age 5 may also ride free provided at least one adult accompanies every five children. Except for the children, each of these groups uses either an RTD-issued pass or the individual's shield or uniform for identification.

Additional fare provisions exist for interagency travel. SCRTD has transfer agreements with 14 municipal carriers within the County of Los Angeles. Passes are not honored among them,

TABLE 1-2
PRESENT FARE STRUCTURE

Fare Type	Fare Level	Eligibility	Terms of Use	Media	Method of Purchase
1. ADULT					
a. Single Trip					
1) Basic	..... $0.85	. No restrictions	. all local service . additional fare required on express service . all times	. coins, tokens, tickets	. payment on boarding bus; tokens, tickets may be prepurchased at 300 RTD-designated outlets.
2) Transfer	. $0.15 each use . .	. No restrictions	. all local service, restricted by direction of travel & up to 1 hour for transfer . maximum 2 uses	. transfer coupon	. issued by 1st driver; additional $0.15 if not surrendered on boarding 2nd bus
3) Express Charge	$0.40 additional per 4-airmile increment on freeway, e.g., 2-6 miles: $0.40	. No restrictions	. added to base fare on express service . 5 distance steps	. coins, tokens, tickets	. payment on boarding bus
b. Multi-Trip					
1) Monthly Pass	.... $34.00	. No restrictions	. all local service . additional fare required on express service	. pass	. pre-purchase at 300 RTD-designated outlets
2) Monthly Express Charge	$12 per 4-airmile increment on freeway	. No restrictions	. added to monthly base fare on express service . five distance steps	. stamp affixed to monthly pass	. pre-purchase with monthly pass

TABLE 1-2
PRESENT FARE STRUCTURE
(Continued)

Fare Type	Fare Level	Eligibility	Terms of Use	Media	Method of Purchase
2. SENIOR CITIZEN/ HANDICAPPED					
a. Single Trip					
1) Basic	. . . . . $0.40	. age 62-65 = not employed full time . age 65+ = no restrictions . qualified transportation for handicapped (physical or developmental impairments)	. all local service . additional fare required on express service . all times	. coins, tokens, tickets	. acceptable ID must be presented on boarding . handicapped require RTD-Reduced Fare Card
2) Transfer	. $0.05 each use . .	. same as above	. same as full-fare transfer	. same as full-fare transfer coupon	. issued by 1st driver, additional $0.05 if not surrendered on boarding 2nd bus
3) Express Charge	$0.20 additional per 4-airmile increment on freeway	. same as above	. same as full-fare express charge terms	. coins, tokens, tickets	. payment on board bus

TABLE 1-2
PRESENT FARE STRUCTURE
(Continued)

Fare Type	Fare Level	Eligibility	Terms of Use	Media	Method of Purchase
2. SENIOR CITIZEN/ HANDICAPPED (continued)					
b. Multi-Trip					
1) Monthly Pass	..... $7.50	. same as above	. same as the adult monthly express stamp terms	1 sr. citizen base pass w/SC monthly stamp affixed 2 monthly reduced fare pass for handicapped	1 sr. citizen obtains base pass at ten (10) RTD centers, purchases monthly stamp at 300 outlets handicapped reduced fare ID card obtained through application to RTD ($1 fee), purchases monthly pass at 300 outlets
2) Monthly Express Charge	$6 additional per increment	. same as Single Trip/Basic	. same as the adult monthly express stamp terms	. reduced fare express stamp (showing no. of steps covered)	. pre-purchase at 300 RTD-designated outlets

TABLE 1-2
PRESENT FARE STRUCTURE
(Continued)

Fare Type	Fare Level	Eligibility	Terms of Use	Media	Method of Purchase
3. STUDENT (under 19)					
a. Single Trip					
1) Basic	..... $0.65	. full-time student under 19 w/RTD school ID card	. all local service . additional fare on express service . all times	. coins, tickets	. RTD school ID card presented on boarding; tickets may be prepurchased at 300 outlets; ID card requires application & photo at 300 outlets and renewable annually
2) Transfer	. $0.05 each use . .	. same as above	. same as full-fare transfer	. same as full-fare transfer	. issued by 1st driver, additional $0.05 if not surrendered on boarding 2nd bus
3) Express Charge	$0.20 additional per increment	. same as above	. same as full-fare express charge terms	. coins, tokens, tickets	. RTD school ID card presented on boarding
b. Multi-Trip					
1) Monthly Pass	.... $22.00	. same as above	. same as the adult montly pass terms	. student ID card (base pass) with monthly stamp affixed	. card application obtained from school; ID card & stamp purchased at 300 outlets

TABLE 1-2
PRESENT FARE STRUCTURE
(Continued)

Fare Type	Fare Level	Eligibility	Terms of Use	Media	Method of Purchase
3. STUDENT (under 19) (continued)					
b. Multi Trip					
2) Monthly Express Charge	$6 additional each increment	. same as above	. same as adult express pass terms	. discount express stamp	. express stamp purchased at 300 outlets
4. COLLEGE/ VOCATIONAL					
a. Single Trip					
Fares are same as adult — no discount					
b. Multi-Trip					
1) Monthly Pass	$26.00	. full-time student with 12 semester units or equivalent for minimum of 3 months	. all local service . additional fare on express service . all times	. base pass (photo ID) w/monthly pass stamp affixed	. base pass application from school; pass obtained at 10 RTD sales offices; monthly stamp purchased at 300 outlets, renewable annually
2) Monthly Express Charge	..... $6.00	. same as above	. same as the adult monthly express stamp terms	. discount express stamp affixed to base pass	. express stamps purchased at 300 outlets

however. The major municipal carriers are: Santa Monica Municipal Bus Lines, Culver City Municipal Bus Lines, Commerce Transit System, Montebello Municipal Bus Lines, Long Beach Public Transportation Company, and Gardena Municipal Bus Lines.

SCRTD operates some service in neighboring counties with fares set in accordance with that county's policies. A monthly interagency pass is also sold for unlimited use on any SCRTD or Orange County Transit District route.

Miscellaneous fares currently in use include a series of tourist passes, purchasable by visitors to the LA area, that are good for an unlimited number of rides for a varying number of days.

CHAPTER 2
FARE COLLECTION OVERVIEW

There are several fare structure and fare collection concepts that may be considered for application to the Metro Rail system. This chapter presents an overview of these concepts and provides a brief introduction to the application of these concepts at selected transit agencies. The concepts and associated transit systems are listed in Table 2-1 (acronyms are defined in the glossary). Summaries of each fare collection system are presented in Tables 2-2 through 2-10 for easy reference and are discussed in more detail in the text.

2.1 FARE STRUCTURE CONCEPTS

There are two basic types of fare structure: the flat fare and the graduated fare. The flat fare structure establishes one basic fare for any ride on the transit system, regardless of trip length or location. A majority of transit systems in North America utilize the flat fare because of its administrative simplicity. Rail transit systems currently having a flat fare structure include those in Chicago, Edmonton and Atlanta.

In practice, the flat fare concept has been adapted to meet the specific needs of the transit system. Within the structure there may exist several special fare elements. A premium may be charged for certain services. Reduced fares

TABLE 2-1

FARE COLLECTION CONCEPTS

AND THEIR APPLICATION

Flat Fare	
Barrier	
Manual/Automatic	Chicago Transit Authority (CTA)
Fully Automatic	Metropolitan Atlanta Regional Transportation Authority (MARTA)
Barrier-Free	Edmonton Transit System (ETS)
Graduated Fare	
Barrier	
Manual/Automatic	Metropolitan Transit Administration (MTA) in Baltimore
Fully Automatic	Port Authority Transit Corp. (PATCO) in Philadelphia and New Jersey
	Bay Area Rapid Transit District (BART) in San Francisco Bay Area
	Washington Metropolitan Area Transportation Authority (WMATA)
Barrier-Free	Metropolitan Transit Development Board (MTDB) in San Diego
	Calgary Transit (CT)

TABLE 2-2

CTA/CHICAGO: ENTRY CONTROL FARE COLLECTION

I. Description
- ... Passengers utilize coin-accepting or agent-controlled fare gates to enter a rail station, paying with coin, token, transfer or pass. Fare gates free-wheel in the exit direction.

II. Fare Structure
- ... Flat fare structure.
- ... Nominal surcharge on one suburban line.
- ... Special fares for elderly, handicapped, students, children and employees.
- ... Transfers incur a nominal charge.

III. Passenger Procedures
- ... Origin Station
  - — enter fare control barrier by depositing correct fare in coins or token.
  - — pass by agents booth to pay fare with pass, transfer or discount.
- ... On-Board
  - — during weekends and nights, pay conductor proper fare (no entry control at stations).
- ... Destination Station
  - — exits are uncontrolled, pass through free-wheeling barriers.

IV. Equipment Requirements
- ... Coin-accepting fare gates, with transfer issuing machines.
- ... Agent-controlled gates.
- ... Transfer issuing machines.
- ... High exit turnstiles.

V. Personnel Functions
- ... Station Agent
  - — handle non-standard fare transactions.
  - — public relations function.
  - — report malfunctioning equipment.
- ... Equipment Technicians
  - — repair and maintain equipment.
- ... Foot Collectors
  - — pick up cash receipts from stations.

TABLE 2-3

MARTA/ATLANTA: ENTRY CONTROL FARE COLLECTION

I. Description

... Passengers insert coins, or magnetically encoded passes into fare gates to enter station; gates are free-wheeling on exit. Some stations are designed for barrier-free transfer between bus and rail. Stations are unmanned.

II. Fare Structure

... Flat fare structure.

... Special fares for elderly, handicapped and employees.

... Transfers are free.

III. Passenger Procedures

... Origin Station
- enter through gate by inserting correct change, machine-readable transfer or pass.

... Destination Station
- exits are made through free-wheeling gates.

IV. Equipment Requirements

... Coin- and ticket-accepting entry fare gates.

... Exit gates.

... Handicapped gates.

... Magnetic pass encoders.

... Passenger assistance telephones.

... Closed-circuit television.

V. Personnel Requirements

... Zone Center Operators
- assist passengers via telephone.
- monitor station activities.

... Equipment Technicians
- repair and maintain equipment.

... Equipment Servicers
- pick up receipts from fare gates.

... Central Control Personnel
- monitor equipment status.
- dispatch equipment technicians.

TABLE 2-4

ETS/EDMONTON TRANSIT: BARRIER-FREE FARE COLLECTION

I. Description

... Passengers must have valid proof-of-fare payment while on the rail system. Proof-of-payment may be prepurchased monthly pass, bus transfer, or ride coupon obtained from coin-accepting fare gates in the station. Proof-of-payment may be inspected; those patrons without valid proof are fined.

II. Fare Structure

... Flat fare structure.

... Special fares for elderly, students, children and employees.

... Transfers are free.

III. Passenger Procedures

... Origin Platform

— patrons with pass or bus transfer bypass entry fare gates.

— single-trip patrons deposit coins into fare gate which issues receipt as proof-of-payment.

... On-Board

— passenger must present proof-of-payment upon request by an Inspector.

... Destination Platform

— patron disembarks from any door and encounters no barriers.

IV. Equipment Requirements

... Ticket-issuing fare gate.

V. Personnel Requirements

... Ticket Inspectors

— randomly check passenger tickets.

— issue penalty fines for fare evasion.

— perform public relations function.

... Equipment Servicers

— restock turnstile.

— remove cash receipts.

... Equipment Technicians

— maintain and repair equipment.

TABLE 2-5

MTA/BALTIMORE: ENTRY/EXIT BARRIER FARE COLLECTION

I. Description
... Passengers enter and exit stations through ticket-reading fare gates. Agents at each station accept transfers and special fares on entry (issuing exit card) and collecting additional fares as required on exit.

II. Fare Structure
... Zone fare structure.
... Peak/base fare differential.
... Special fares for elderly, handicapped and students.
... Transfers are discounted.

III. Passenger Procedures
... Origin Station
- purchase stored-ride ticket from vendor.
- enter through fare gate which checks validity and encodes ticket with appropriate information.

... Destination Station
- exit through fare gate which checks validity and subtracts one trip from ticket.

IV. Equipment Requirements
... Ticket vendors.
... Ticket-reading fare gates.
... Handicapped gates (agent-controlled).
... Emergency gates.
... Agent-controlled gates.
... Bill changers.

V. Personnel Requirements
... Station Agents
- handle non-standard fare transactions.
- backup for equipment.
- public relations function.
- restock ticket vendors.

... Equipment Technicians
- repair and maintain equipment.

... Revenue Collectors
- pick up cash receipts.

TABLE 2-6

PATCO/PHILADELPHIA-NEW JERSEY: ENTRY/EXIT BARRIER FARE COLLECTION

I. Description

... Passengers purchase machine-readable tickets from vendors or station concessions and insert these tickets into fare gates to enter and exit the station. Stations are unmanned.

II. Fare Structure

... Zone fare structure, five zones segregate 14.2-mile line.

... Special fares for handicapped and elderly.

... Transfers discounted for SEPTA buses.

III. Passenger Procedures

... Origin Station
- purchase ticket from vendor or newsstand
- enter through fare control barrier which checks validity and encodes the ticket with appropriate information.

... Destination Station
- exit through fare control barrier which checks validity and subtracts a trip from the ticket.

IV. Equipment Requirements

... Ticket vendors.
... Change-makers.
... Ticket-reading gates.
... Central ticket encoders.
... Passenger assistance telephones.
... Closed-circuit television.

V. Personnel Requirements

... Equipment Servicers
- restock ticket vendors.
- pick up receipts (cash from vendor, tickets from gates).

... Equipment Technicians
- maintain and repair equipment.

... Central Control Personnel
- monitor station activities.
- dispatch technicians.
- assist patrons.
- collect additional fare, if necessary.

TABLE 2-7

BART/SAN FRANCISCO: ENTRY/EXIT BARRIER FARE COLLECTION

I. Description
... Passengers purchase stored-value, magnetically-encoded tickets from vendors and insert these tickets in fare gates to enter and exit the station. Station attendants provide passenger assistance. Fare gates deduct fare from value on ticket.

II. Fare Structure
... Distance-related fare structure.

... Special fares for elderly, handicapped, students and children.

... Transfers to local transit are free; new regional pass to be implemented.

III. Passenger Procedures
... Origin Station
— purchase stored-value ticket from vendor.
— enter through fare gate which checks validity of ticket and encodes it with appropriate information for exit.

... Destination Station
— exit through fare gate which checks validity of ticket and subtracts appropriate fare.
— increase value of farecard at Addfare machine if fare exceeds ticket value.

IV. Equipment Requirements
... Ticket vendors.

... Entry/exit fare gates.

... Addfare machines.

... Ticket readers.

... Ticket encoders.

... Transfer dispensers.

V. Personnel Requirements
... Station Attendants
— repair ticket and money jams.
— assist passenger interface with equipment.
— notify technicians of equipment problems.

... Equipment Servicers
— restock ticket vendors.
— pick up captured tickets from gates.
— pick up cash receipts from vendors.

... Equipment Technicians
— maintain and repair equipment.

TABLE 2-8

WMATA/WASHINGTON, D.C.: ENTRY/EXIT BARRIER FARE COLLECTION

I. Description
   ... Passengers purchase magnetically encoded tickets from vendors and insert these tickets into fare gates to enter and exit the station. System is fully automated, station attendants provide passenger assistance.

II. Fare Structure
   ... Distance-related fare structure in peak periods.
   ... Flat fare structure in base periods.
   ... Special fares for elderly, handicapped, students and children.
   ... Transfers free from rail to bus.

III. Passenger Procedures
   ... Origin Station
      — purchase stored-value farecard from vendor.
      — enter through fare gate which checks validity of ticket and encodes it with appropriate information for exit.
   ... Destination Station
      — exit through fare gate which checks validity and subtracts appropriate fare from value of ticket.
      — increase value of farecard at Addfare machine if override value of ticket.

IV. Equipment Requirements
   ... Farecard vendors.
   ... Entry/exit fare gates.
   ... Addfare machines.
   ... Transfer dispensers.
   ... Data acquisition and display system.
   ... High production encoding machine.
   ... Elevator access control system.
   ... Handheld verifiers.

V. Personnel Requirements
   ... Station Attendants
      — assist passenger interface with equipment.
      — clear ticket and money jams.
   ... Equipment Servicers
      — restock ticket vendors.
      — remove captured tickets from gates.
   ... Equipment Technicians
      — maintain and repair equipment.

TABLE 2-9

MTDB/SAN DIEGO: BARRIER-FREE FARE COLLECTION

I. Description
   ... Passengers carry valid proof-of-payment at all times while riding the system, and present it to ticket inspectors if so requested. Failure to do so results in heavy fine. Tickets are purchased or validated at the station at the start of the trip. Stations are unmanned.

II. Fare Structure
   ... Zone fare structure, 16-mile line segregated into two zones.

   ... Special fares for elderly, handicapped and children.

   ... Transfers, nominal charge or free.

III. Passenger Procedures
   ... Origin Station
      — purchase ticket from vendor, validate prepurchased ticket or prepurchased pass.
      — enter train with no physical obstruction.

   ... On-Board
      — present proof-of-purchase upon request by inspector.

   ... Destination Station
      — exit from any door without encountering barriers.

IV. Equipment Requirements
   ... Ticket vendors/validators.

   ... Bill changers.

V. Personnel Requirements
   ... Ticket Inspectors
      — randomly check passenger tickets.
      — issue penalty fines for fare evasion.
      — perform public relations function.

   ... Equipment Servicers
      — restock ticket vendors.
      — pick up cash from vendors.

   ... Equipment Technicians
      — maintain and repair equipment.

TABLE 2-10

CT/CALGARY TRANSIT: BARRIER-FREE FARE COLLECTION

I. Description
... Passengers carry valid proof-of-payment at all times while riding the system, and present it to ticket inspectors if so requested. Failure to do so results in heavy fine. Tickets are purchased or validated at the station at the start of the trip. Stations are unmanned.

II. Fare Structure
... Two-zone fare structure.
... Free transit service within the downtown area.
... Special fares for elderly, students, children and employees.
... Transfers incur a nominal charge.

III. Passenger Procedures
... Origin Station
— pass or transfer holders may go directly to the train.
— passengers purchase or validate tickets at vendors on platform prior to boarding.
... On-Board
— patron must present proof-of-payment to an inspector upon request or face fine.
... Destination Station
— exits are made through any door free of obstruction.

IV. Equipment Requirements
... Ticket vendor/validator.
... Transfer issuing machine.

V. Personnel Requirements
... Ticket Inspectors
— randomly inspect passenger tickets.
— issue fines for fare evasion.
— perform public relations function.
... Equipment Servicers
— restock ticket vendors.
— remove cash receipts from vendors.
... Equipment Technicians
— maintain and repair equipment.

may be offered to selected groups. Discounts may be instituted for off-peak travel.

While MARTA in Atlanta charges a flat fare for all bus and rail service, the CTA in Chicago collects a surcharge for travel on a rail express service that originates in the suburbs. The CTA is also proceeding with plans to institute a fare for all rail transit service that will be higher than the bus fare.

In Edmonton, the flat fare that is collected on a bus or rail line entitles a passenger to ride in any direction on any line or lines for a specified amount of time. Round-trip travel on a single fare is possible, provided the time limit is not exceeded.

A graduated fare structure relates fares to the origin and destination of each trip. There are two basic types of graduated fare structures: the zoned fare and the distance-based fare.

With a zoned fare structure, a transit service area or transit line is divided into subareas or segments. These zones may correspond to geometric patterns of arbitrary width or length or may correspond to geography, land use or political jurisdiction. On a rail line, one or more stations may lie within a zone. A separate fare can be established for travel between each pair of zones - - or within a single zone.

Rail transit systems that utilize a zoned fare structure include PATCO in Philadelphia, MTA in Baltimore (currently under construction), MTDB in San Diego and Calgary Transit. PATCO's 14.2-mile rail line is segmented into five fare

zones. The MTA 14-mile rail line will have four zones. MTDB and Calgary Transit each have a two-zone system for their light rail lines. Travel within the downtown zone is possible at a lower fare in San Diego and for free in Calgary; trips to or from the outer zone require a higher fare.

Distance-based fare structures generally entail pricing based on two cost components: (1) a fixed charge or base fare, and (2) an added charge that is a function of the distance traveled. Both BART in the San Francisco area and WMATA in Washington, D.C. utilize this fare structure. BART has a base fare for the first six route miles of travel and a distance charge for each additional mile. WMATA utilizes composite miles rather than route miles, averaging air miles and route miles between stations; a distance charge is added after the first three composite miles.

As with the flat fare structure, transit systems having a graduated fare may incorporate special fare elements into the structure. Whereas BART will charge the same fare throughout the day, WMATA employs its distance-based fares only during the peak period; during the off-peak periods, a flat fare is charged. The MTA will have a peak/off-peak fare differential on its rail system. And similar to the flat fare systems, those with graduated fares offer reduced fares to certain groups, including the elderly and handicapped.

A cross-tabulation of fare elements offered at these transit systems is presented in Table 2-11.

TABLE 2-11

CROSS TABULATION OF FARE ELEMENTS

Transit System	Regular Fares			Reduced Fares			Transfers		Differentials	
	Single Trip	Multi-Trip	Unlimited Pass	Single Trip	Multi-Trip	Unlimited Pass	Bus to Rail	Rail to Bus	Service	Time
Barrier: Entry										
CTA/Chicago	X	–	X	X	–	X	X	X	X	–
MARTA/Atlanta	X	–	X	X	–	X	X	X	–	–
Barrier: Entry/Exit										
MTA/Baltimore	X	X	X	X	X	X	X	X	–	X
PATCO/Philadelphia	X	X	–	–	X	–	–	X	–	–
BART/San Francisco	X	X	–	–	X	–	–	X	–	–
WMATA/Washington, D.C.	X	X	–	–	X	–	–	X	–	X
Barrier-Free										
CT/Calgary	X	X	X	X	X	X	X	X	–	–
ETS/Edmonton	X	–	X	–	–	X	X	X	–	–
MTDB/San Diego	X	X	X	X	X	X	X	X	–	–

2.2 FARE COLLECTION CONCEPTS

There are two basic types of fare collection methods: barrier and barrier-free.

2.2.1 Barrier Fare Collection

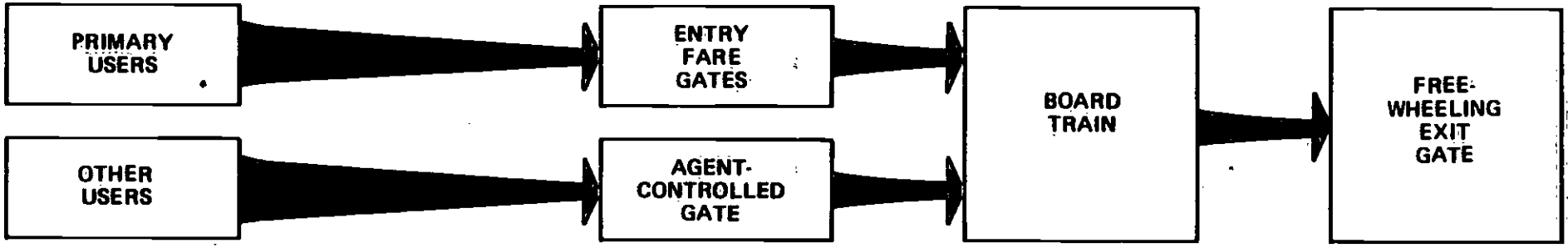
Barrier fare collection systems employ the use of a physical line of control, such as a bank of fare gates, to ensure that passengers pay the proper fare for their trip. This fare control line defines the "free" and "paid" areas of the transit system. To cross the control line, a patron must demonstrate the possession of valid proof of payment. This may entail inserting the fare into a fare gate or displaying or paying it to a station agent. Barrier fare collection may employ a manual or automatic means of collecting fares or may use a combination of the two.

A flat fare structure requires that the patron's fare be collected or examined only on entry, since the fare to be paid is independent of the destination. A graduated fare will, however, require that fares be examined both on entry and on exit since the fare will depend upon the specific origin and destination.

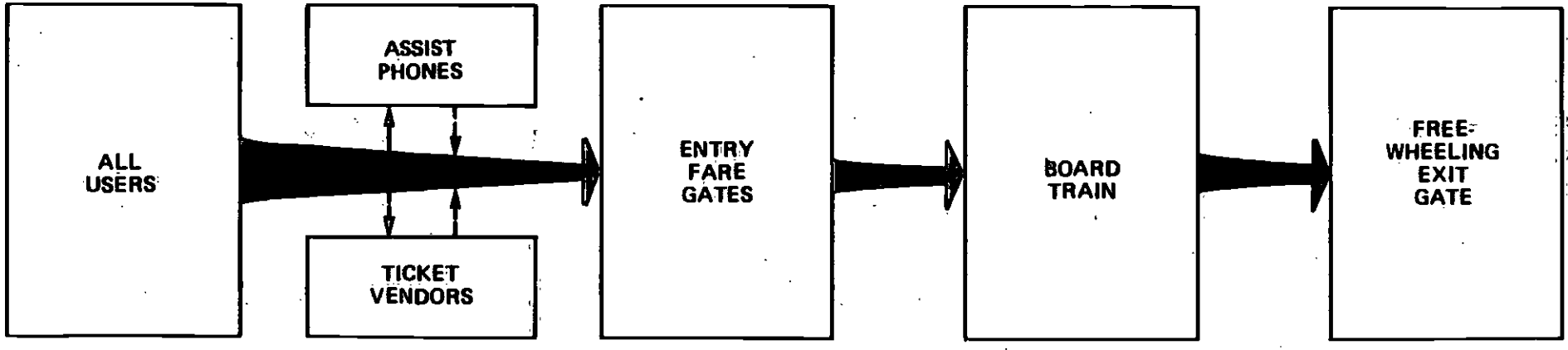
Entry Control - The barrier system utilized for the flat fare structure is referred to as an entry control system. Two variations of this concept are illustrated in Figure 2-1. Under a manual/automatic system, passenger-operated (automatic) fare gates will be available for use by the majority of patrons, who are traveling on the most commonly used fares. A station agent will be available - - in line with the fare gates - - to collect special fares that cannot be handled by

FIGURE 2-1
PASSENGER PROCEDURES FOR A BARRIER ENTRY CONTROL SYSTEM

MANUAL/AUTOMATIC:



FULLY AUTOMATIC:



the gates. The agent can also provide informational assistance to patrons. Exit from the station is unrestricted and generally entails crossing the fare control line through a fare gate that free-wheels in the exit direction.

Under a fully automatic system, all patrons will pass through a fare gate, which must then be capable of accommodating all valid media and fares that a passenger may have. If the fare gates do not accept coin, then ticket (or token) vendors must be provided to accommodate patrons making one-way trips. Patrons may generally obtain assistance from station attendants or by direct phone line from central operators.

The Chicago and Atlanta transit properties have entry control systems on their rail lines. Passenger procedures for each are shown in Figures 2-2 and 2-3. The CTA in Chicago utilizes a station agent to collect reduced fares, and transfers and to examine passes. The fare gates accept coin and tokens and can issue rail-to-bus transfers; they are currently experimenting with a system that can be installed in the fare gates to read magnetically-encoded passes.

In Atlanta, MARTA with unmanned stations has fare gates which accept coin, and magnetically-encoded bus-to-rail transfers, passes and permits. Passengers may obtain assistance by phone from zone center personnel.

Entry/Exit Control - The barrier system utilized for a graduated fare structure is referred to as an entry/exit control system. Two variations of this concept are illustrated in Figure 2-4. The manual/automatic concept is similar to

FIGURE 2-2
CTA SYSTEM PASSENGER ACTIVITIES

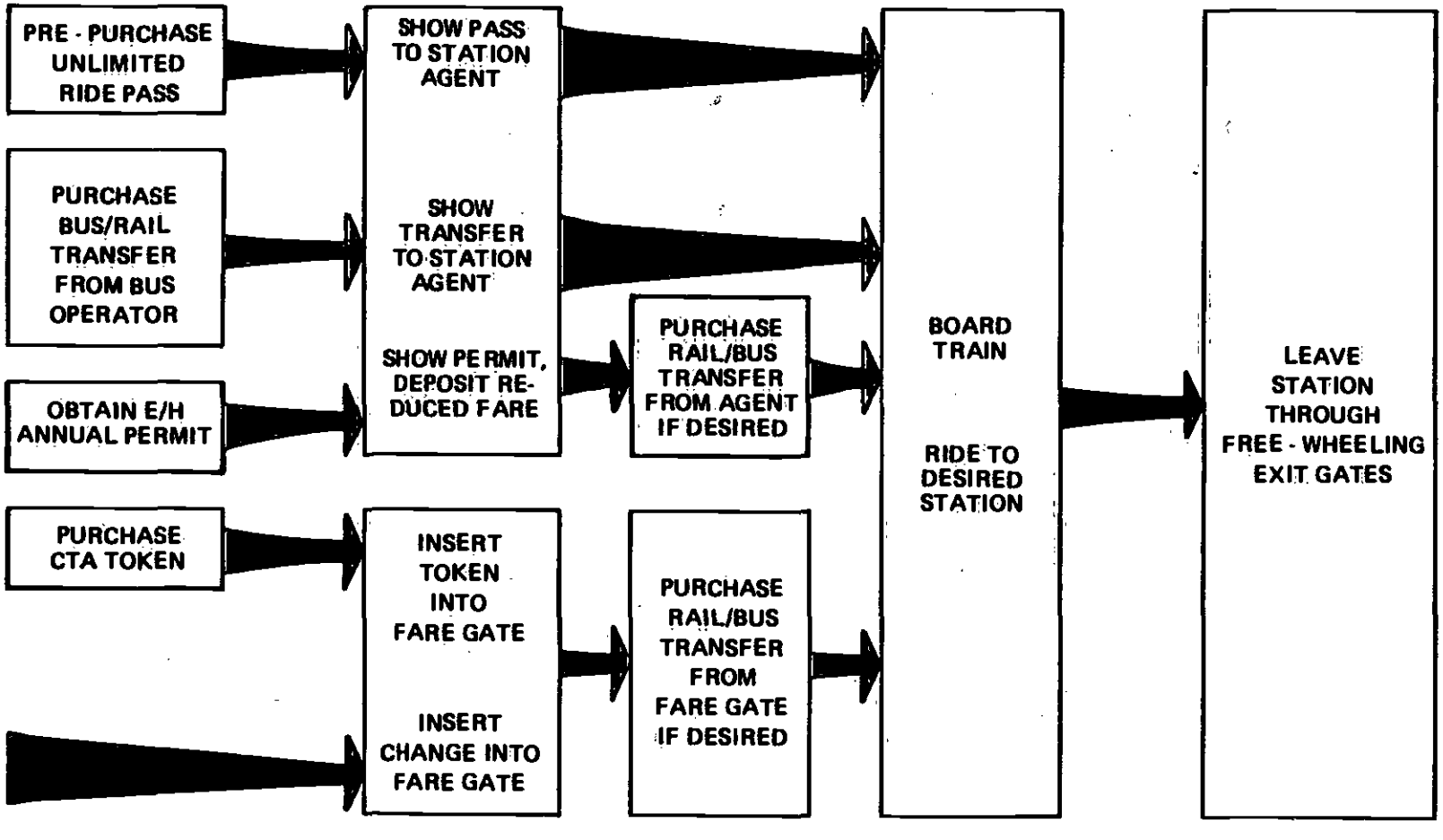


FIGURE 2-3
MARTA SYSTEM PASSENGER ACTIVITIES

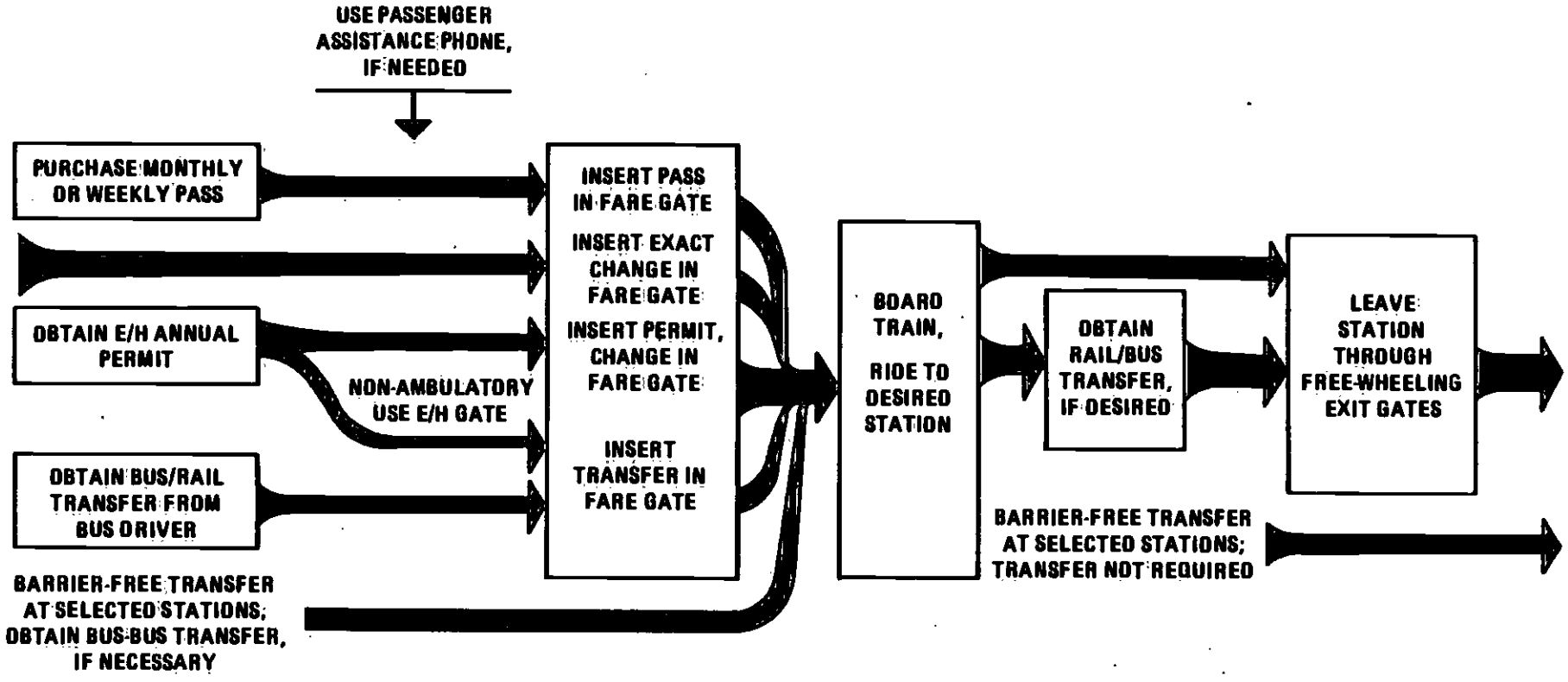
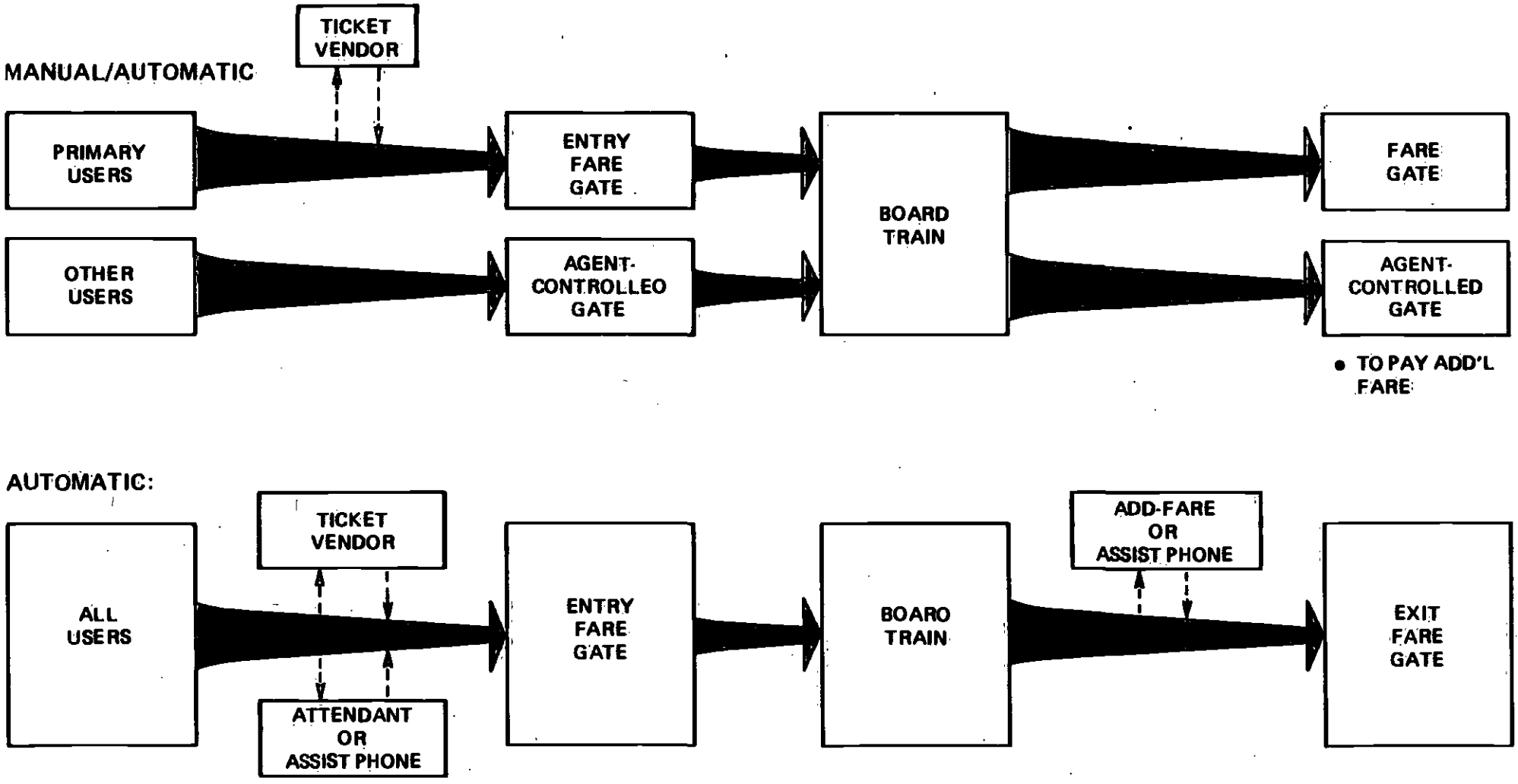


FIGURE 2-4
PASSENGER PROCEDURES FOR A BARRIER ENTRY/EXIT CONTROL SYSTEM

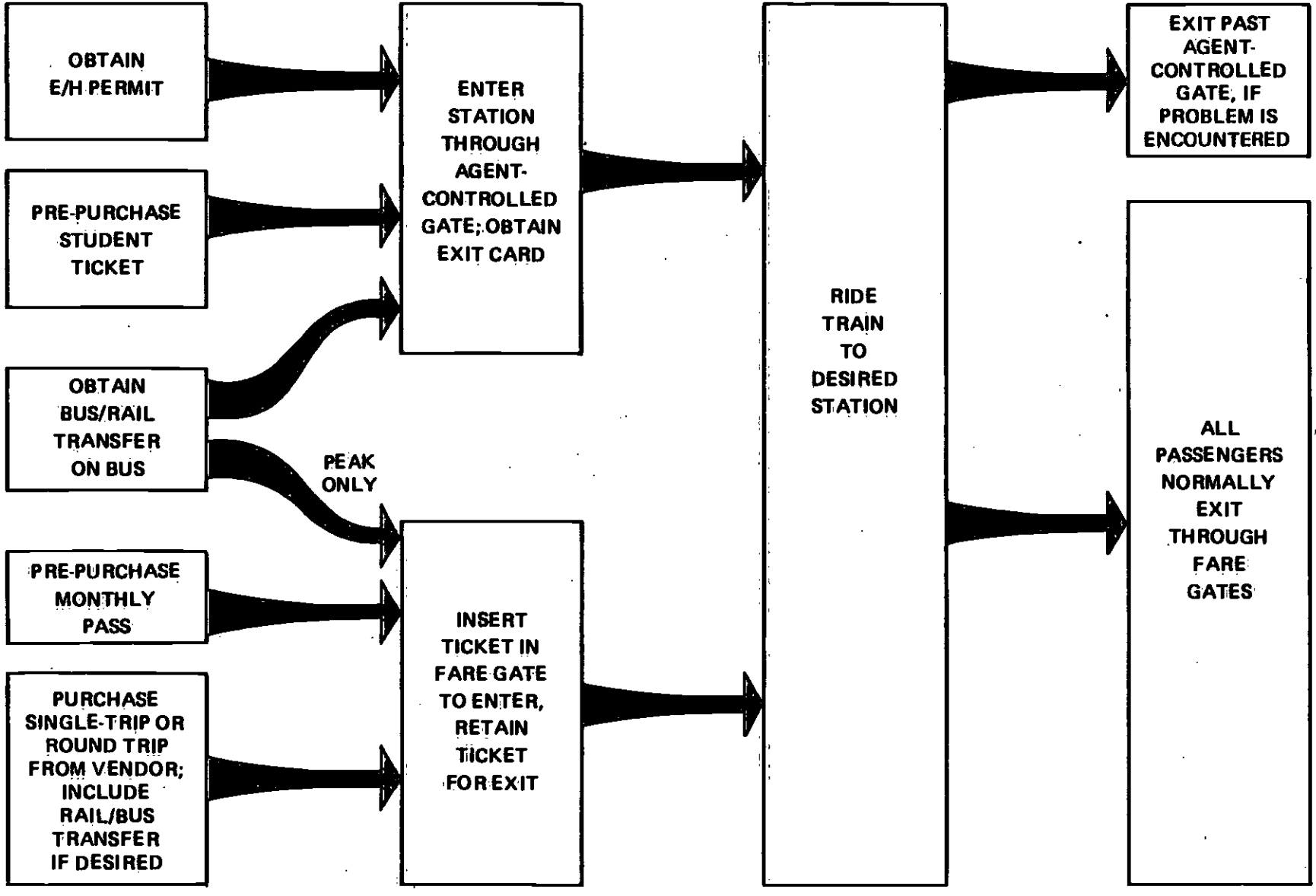


that for the entry control system, with the additional feature that the fare gates or agent must check for valid fare on exit as well as entry. When collecting fares on entry, the agent will give the patron a magnetically encoded zone ticket for exit. The function of the agent for exiting patrons will be to collect additional fare for overriding (when the patron's ticket is not valid for exiting at that station). This system is to be installed in Baltimore. Station agents will be utilized to permit system entry for patrons with reduced fares and certain bus-to-rail transfers; the agent will issue machine-readable exit tickets to these patrons. The station agent will also collect additional fare from passengers who wish to exit but have overridden the value of their ticket. Passenger procedures for the Baltimore system are presented in Figure 2-5.

The fully automatic entry/exit control system differs from the manual/automatic concept in that the fare gate must be capable of processing all passengers for entry and exit. As illustrated in Figure 2-4, a passenger must have a valid machine-readable ticket before entering the system, purchased either at a ticket vendor or prior to entering the station (pre-purchase). At the patron's destination, the same ticket must be inserted into an exit fare gate. The passenger is provided a means of paying additional fare if the ticket is not valid for exit at that station. Passenger assistance is generally available from a station attendant on some systems or by phone to a central control operator on others.

PATCO and WMATA have applied the barrier entry/exit control concept in very different ways. PATCO has a zone fare structure and sells tickets that are valid for a given number of rides between two zones; this is referred to as a stored-

FIGURE 2-5
MTA SYSTEM PASSENGER ACTIVITIES (PLANNED)



ride system. For a multi-trip ticket, a ride is deducted for each use until no rides remain. WMATA has a distance-based fare structure and sells tickets that have a monetary value; this is referred to as a stored-value system. Each time a ride is completed, the price of the trip is deducted from the previous value on the ticket.

PATCO utilizes the passenger-assistance phone to collect additional fare for overriding; the central control operator determines the amount to be paid and the passenger inserts the value in coin into the phone. WMATA does not involve human interaction; passenger-activated add fare machines determine the additional fare, accept the payment and re-encode the patron's ticket to permit exit.

Procedures for using PATCO (Philadelphia-New Jersey) and WMATA (Washington, D.C. area) are illustrated in Figures 2-6 and 2-7. The procedures for using BART (San Francisco Bay Area) which are very similar to those for WMATA are illustrated in Figure 2-8.

2.2.2 Barrier-Free Fare Collection

Barrier-free fare collection does not use a physical line of control in each station to collect or examine each passenger's fare. Instead, transit personnel circulate throughout the transit system to examine a passenger's proof of payment.

As shown in Figure 2-9, regardless of the type of fare structure, a passenger purchases the proper ticket prior to boarding the train and retains the ticket as proof of payment while on the system. If requested, the patron must show the

FIGURE 2-6
PATCO SYSTEM PASSENGER ACTIVITIES

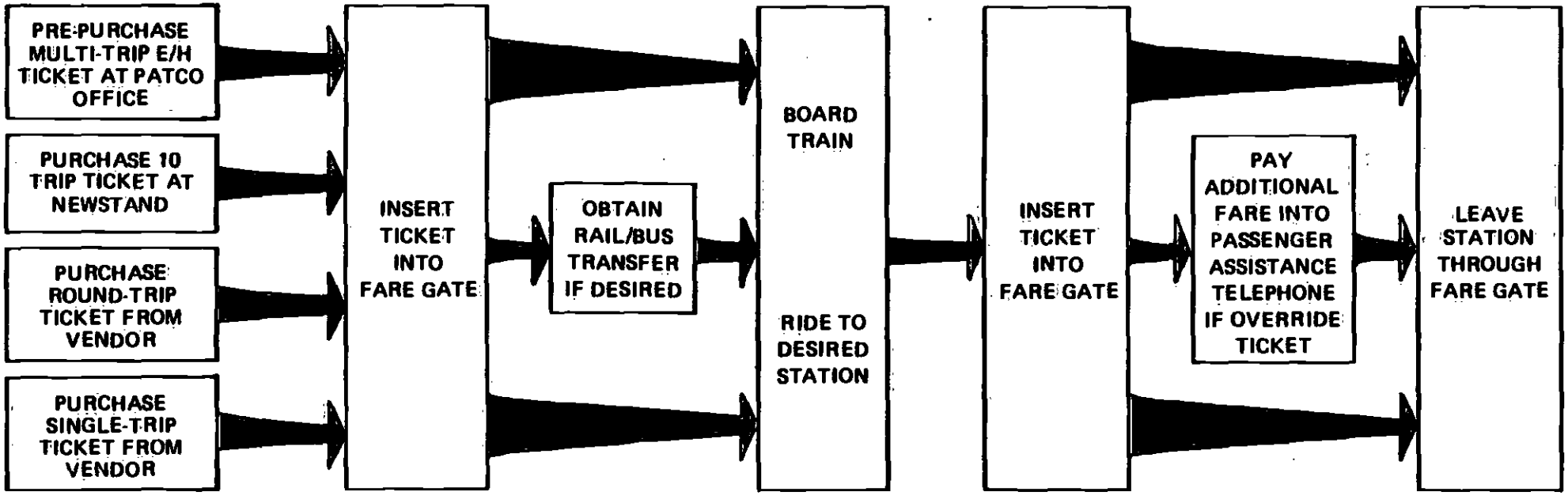
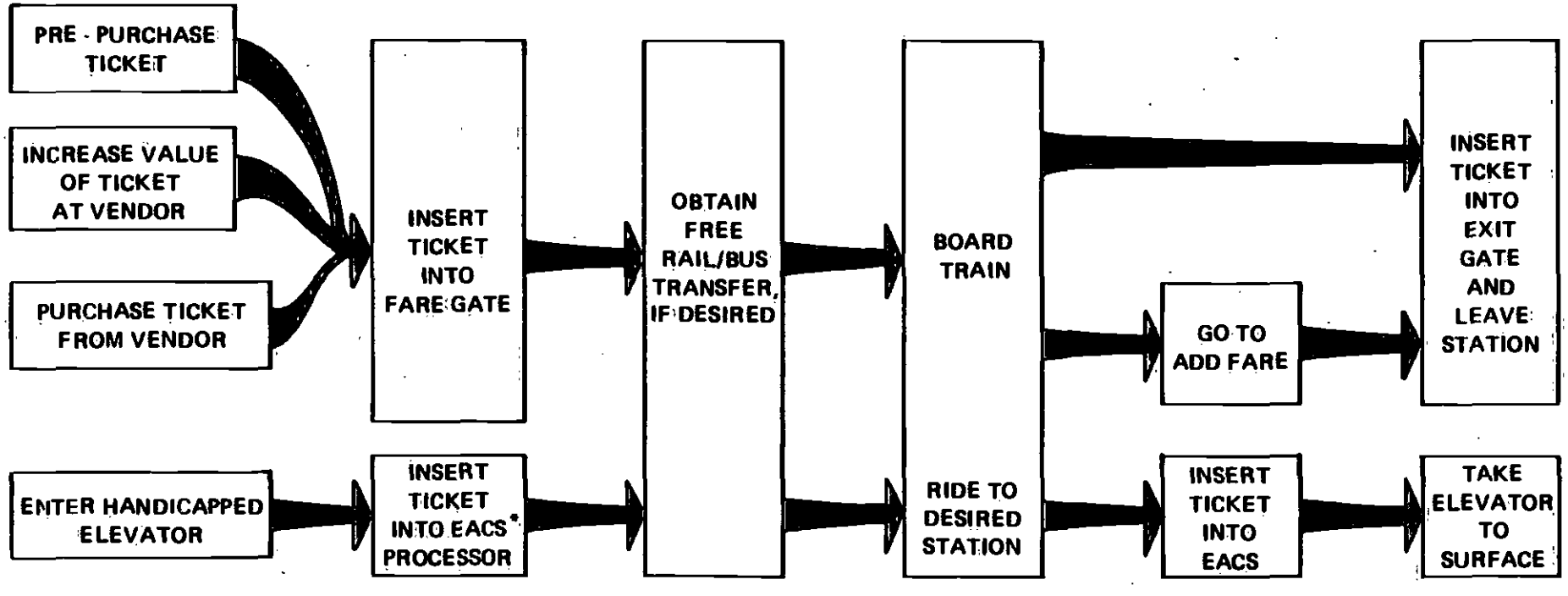


FIGURE 2-7
WMATA SYSTEM PASSENGER ACTIVITIES



* Elevator Access Control System

FIGURE 2-8
BART SYSTEM PASSENGER ACTIVITIES

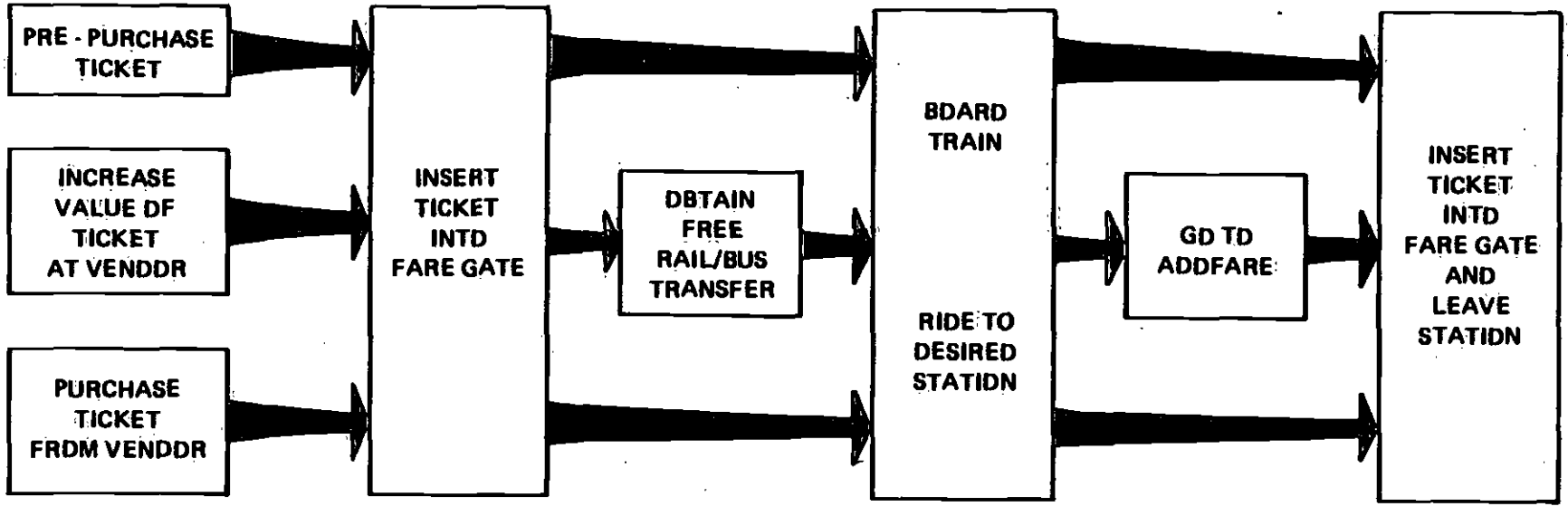
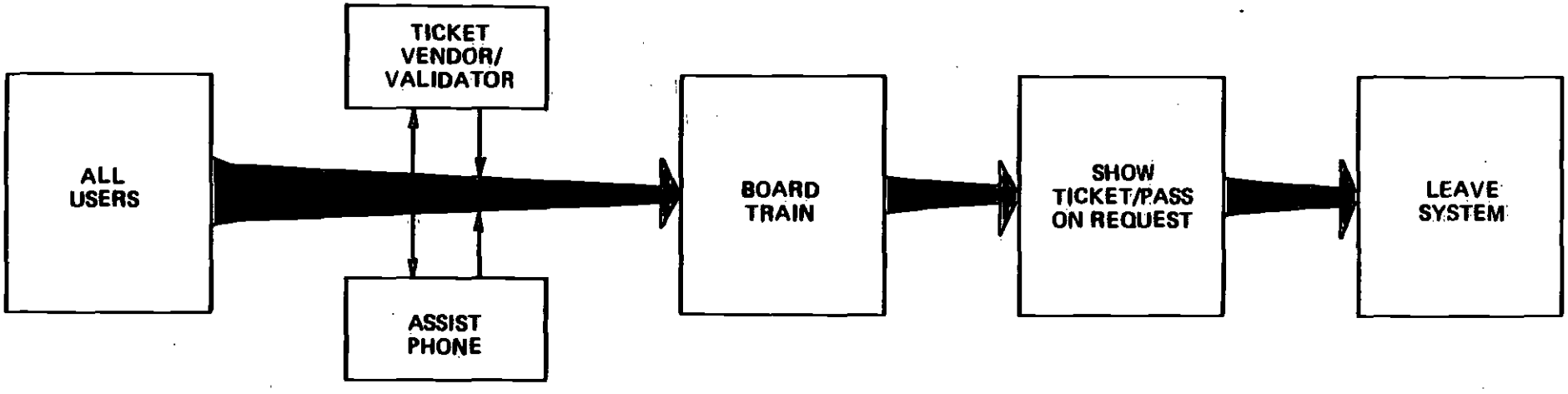


FIGURE 2-9
PASSENGER PROCEDURES FOR A BARRIER-FREE SYSTEM



proof of payment to the ticket inspector. Passengers without valid proof of payment may be required to pay either a "super-fare" or a fine that is substantially higher than the normal fare. The fine may be paid on-site in some cases, or through the court system. The fines levied on a patron can be made progressively higher for each successive infraction.

In general, only a small percentage of daily passengers will be approached on a given day. Because the probability of having one's proof of payment inspected is low, the "super-fare" or fine must be set at a level that is sufficient to deter widespread abuse and fare evasion.

The barrier-free concept is utilized on three North American light rail transit systems: San Diego, Calgary and Edmonton. Passenger procedures for each are presented in Figures 2-10, 2-11 and 2-12. As Table 2-12 shows, to date the reported fare evasion rates have been as low as or lower than those of systems in Europe.

Each of the three systems has a mechanism for collecting fines through the local judicial system. California legislation empowers the MTDB in San Diego to set fines for fare evasion and to utilize system or contracted personnel to enforce its fare evasion regulations. Due to the relative expediency in California, MTDB fines are collected through the criminal court system rather than the civil courts as in Edmonton and Calgary. The courts return 85 percent of the fine to MTDB.

FIGURE 2-10
MTDB SYSTEM PASSENGER ACTIVITIES

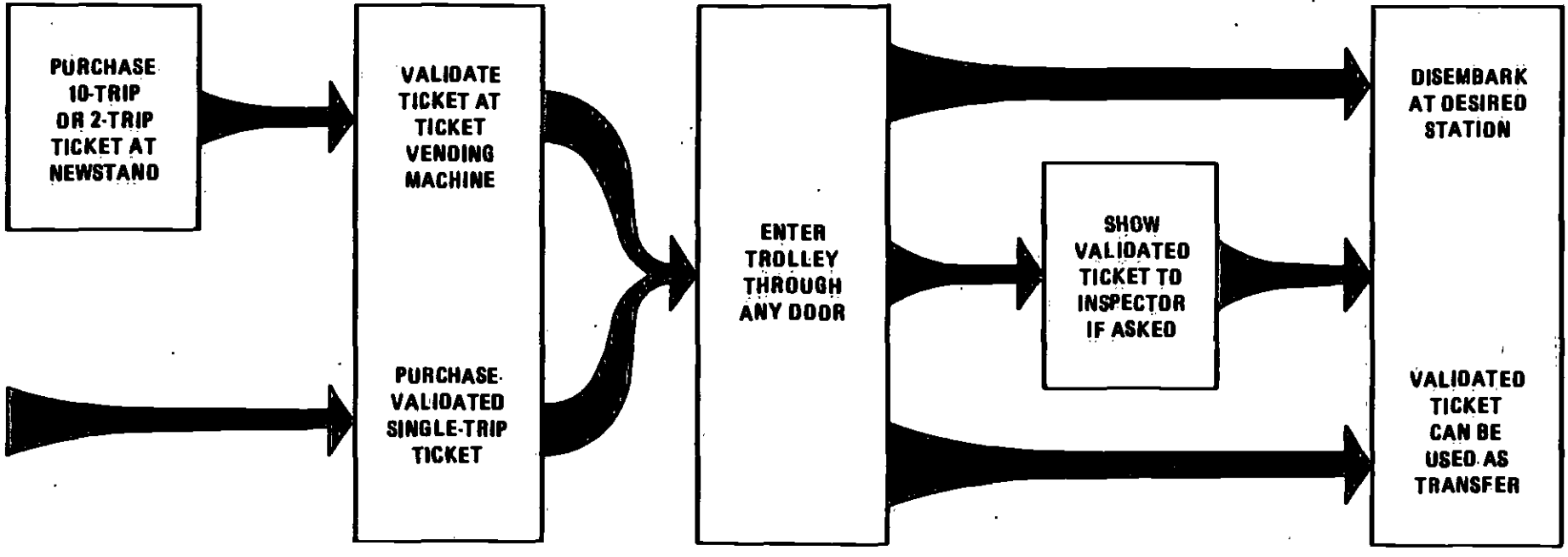


FIGURE 2-11
CT SYSTEM PASSENGER ACTIVITIES

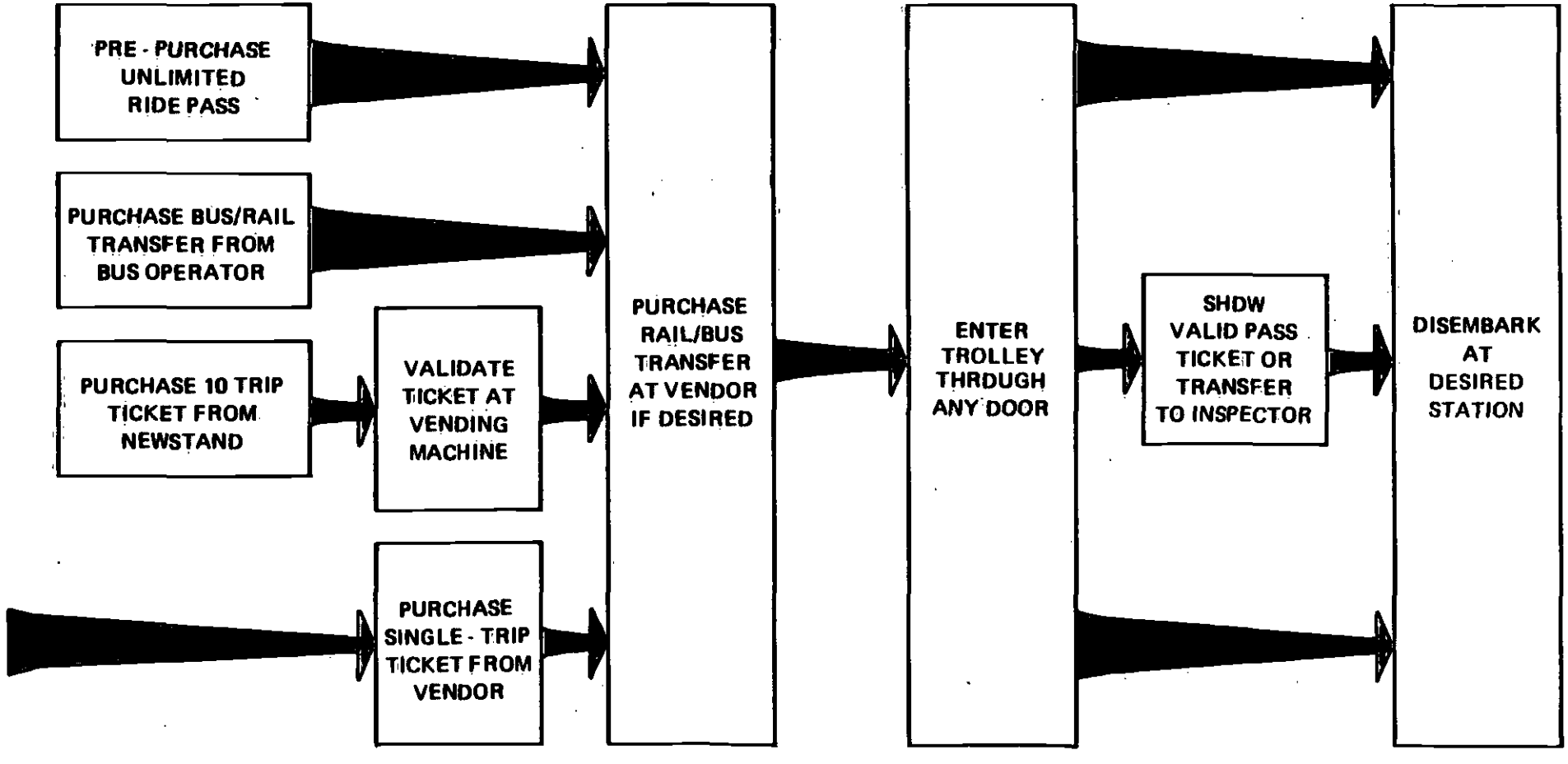


FIGURE 2-12
ETS SYSTEM PASSENGER ACTIVITIES

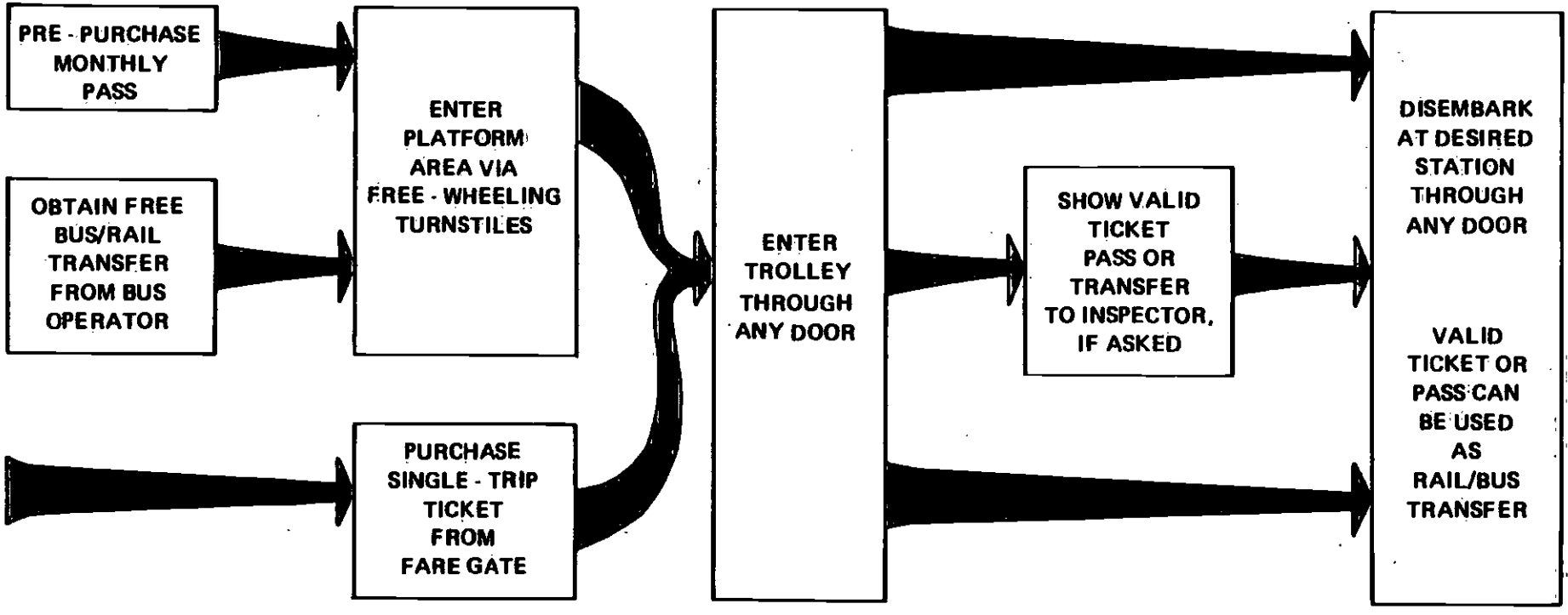


TABLE 2-12

SELF-SERVICE, BARRIER-FREE REPORTED FRAUD RATES

City	Annual Passenger Trips per Inspector	Reported Inspection Rate (%)	Reported Fraud Rate (%)
Berne, Switzerland	6,700,000	5.0%	1.0%
Cologne, Germany	2,000,000	1.4%	3.0%
Geneva, Switzerland	6,000,000	2.5%	0.8% – 1.1%
The Hague, Netherlands	2,800,000	1.0%	9.9%
Milan, Italy	6,100,000	1.0%	1.2% – 8.0%
Munich, Germany	3,300,000	3.0%	1.4%
Edmonton, Canada	680,000	5.0%	1.0%
Calgary, Canada	800,000	2.0%	1.0%
San Diego, USA	600,000	41.0%	0.3%

Source: *"Self-Service Fare Collection: Review and Summary," prepared by the MITRE Corporation for the Urban Mass Transportation Administration, August 1979; and telephone interviews with managers of Calgary Transit, Edmonton Transit System and the Metropolitan Transit Development Board of San Diego in May 1982.*

CHAPTER 3
FARE COLLECTION PROCEDURES

This chapter reviews and compares the various options that exist for collecting different types of fares. The fare elements examined include the single-trip fare, multi-trip fare, reduced fare, transfer and fare differentials.

3.1 SINGLE-TRIP FARE

The single-trip fare is the primary type of payment tendered on transit systems in North America. There are a variety of ways to collect this fare element, as shown in Table 3-1.

3.1.1 Barrier System - Flat Fare

On transit systems having a flat fare and barrier entry control, the patron paying a regular one-way fare will either insert payment media into a fare gate or drop it into a station agent's farebox. The automatic fare gate or station agent will ascertain that the correct fare has been tendered and release a locked turnstile to permit the patron to enter the paid area. Exit requires no action.

Fare media may include coins, tokens or tickets. Tokens or tickets must, of course, be purchased prior to their use. This may be done either off-premises or from vendors in the station.

TABLE 3-1

ACCOMMODATION OF REGULAR SINGLE TRIP FARE

Collection Concept	Transit System	Media	Purchase	Collection/Inspection
Flat Fare				
Barrier	CTA/Chicago	Token	Off-Site	Fare Gate; Agent
		Coin	.....	Fare Gate; Agent
	MARTA/Atlanta	Coin	.....	Fare Gate
Barrier-Free	ETS/Edmonton	Coin	.....	Fare Gate; Inspector
Graduated Fare				
Barrier	BART/San Francisco	Magnetic Ticket	Vendor	Fare Gate
	MTA/Baltimore	Magnetic Ticket	Vendor	Fare Gate
	PATCO/Phila.-N.J.	Magnetic Ticket	Vendor	Fare Gate
	WMATA/Wash.,D.C.	Magnetic Ticket	Vendor	Fare Gate
Barrier-Free	CT/Calgary	Ticket	Vendor	Inspector
	MTDB/San Diego	Ticket	Vendor	Inspector

Both CTA and MARTA collect single-trip fares in coins; CTA accepts tokens as well. The value of accepting tokens or tickets in lieu of coins is that less bulk is involved per transaction and many more transactions can be handled before the fare gate till must be emptied.

3.1.2 Barrier Systems - Graduated Fare

On transit systems having a graduated fare and barrier entry/exit control, the patron paying a regular one-way fare must purchase a ticket that is valid for the trip, insert the ticket in the fare gate to cross the fare control line into the paid area and retain the ticket during his or her trip for use on exit at the destination. The ticket is purchased from ticket vendors and will be encoded with machine readable data pertaining to the extent of its validity. A zoned fare system requires that the ticket be valid between the origin and destination zones of the trip. A distance-based fare system requires that the dollar-value of the ticket be at least equal to the fare of the trip.

If the value of the ticket is not sufficient for the trip, the exit fare gate at the patron's destination will reject the ticket without releasing the turnstile and direct the patron to the designated means of paying additional fare. On a manual/automatic system, such as in the Baltimore rail line under construction, the station agent will interpret the ticket code, determine its value, collect the additional fare and release the turnstile for the patron to exit.

On a fully automatic system, the patron may be either directed to a passenger-assistance phone or to an Addfare machine. The passenger-assistance phone on PATCO in the

Philadelphia area connects the patron to the central control operator. By directing the passenger to insert the ticket into a designated fare gate with diagnostic capability the operator can interpret the ticket encoding and determine the additional fare that must be tendered. The patron pays this amount into the phone, the operator verifies the amount and releases a fare gate for the patron to exit.

Addfare machines such as those used by WMATA and BART, obviate the need to communicate with central control personnel. The Addfare will calculate the balance necessary to exit at that station, display the amount and, upon receipt of the correct change, re-encode the ticket for exit.

3.1.3 Barrier-Free Systems - Flat or Graduated Fare

The procedure required to pay single-trip fare on a barrier-free system differs little between transit properties having a flat or graduated fare structure. The passenger must purchase a single-trip ticket from a ticket vendor prior to entering the station platform or train. The ticket is printed at the time of purchase, generally with the fare type, time, date and station. If the transit system has a graduated fare structure, the patron must be sure to purchase a ticket that is valid for the length of the trip. If the patron is challenged by a ticket inspector, the ticket must be presented and must be valid for that particular point, time and direction.

The light rail lines in Calgary, San Diego and Edmonton are each similar in the manner in which single-trip patrons are accommodated. Whereas Calgary and San Diego utilize stand-mounted ticket vendors at each station, single-trip patrons on the Edmonton light rail line are directed to

coin-accepting turnstiles that issue single-trip tickets. The turnstile, which free-wheels in each direction, doubles as a passenger-counter.

3.2 MULTIPLE-TRIP FARE

A multiple-trip fare element is included in the fare structure of most transit systems. Fare media include passes and multi-trip tickets. Passes permit an unlimited number of rides during a specified period of time (e.g., one month). Multi-trip tickets may have either a finite number of trips or a finite dollar value and have no expiration date.

Table 3-2 summarizes the fare media and means of purchase and verification of multi-trip fares at selected transit systems.

3.2.1 Barrier Systems - Flat Fare

On transit systems having a flat fare and barrier entry control, the patron using a pass will either insert the card into the fare gate or show it to the station agent. The automatic fare gate or station agent will ascertain that the pass is valid and release a locked turnstile to allow the patron access to the platform. Turnstiles are free-wheeling in the exit direction. Fully automatic systems require appropriate software to prevent the use of a pass by more than one patron at a time (passback).

Multi-trip tickets on flat fare systems will have a finite number of trips. Printed tickets are hand punched by a station agent. Machine-readable tickets are inserted in a

TABLE 3-2

ACCOMMODATION OF REGULAR MULTIPLE-TRIP FARE

Collection Method	Transit System	Media	Purchase	Collection/Inspection
Flat Fare				
Barrier: Entry	CTA/Chicago	Unlimited Ride Pass	Off-Site	Agent; Fare Gate
	MARTA/Atlanta	Unlimited Ride Pass	Off-Site	Fare Gate
Barrier-Free	ETS/Edmonton	Unlimited Ride Pass	Off-Site	Ticket Inspector
Graduated Fare				
Barrier: Entry/Exit	BART/San Francisco	Stored-Value Ticket	Vendor	Fare Gate
	MTA/Baltimore	Unlimited Ride Pass	Off-Site	Fare Gate; Agent
	PATCO/Phila.-N.J.	Stored-Ride Ticket	Newsstand	Fare Gate
	WMATA/Wash.,D.C.	Stored-Value Ticket	Vendor	Fare Gate
Barrier-Free	CT/Calgary	Unlimited Ride Pass	Off-Site	Ticket Inspector
		Multi-Ride Ticket	Off-Site	Ticket Inspector
	MTDB/San Diego	Unlimited Ride Pass	Off-Site	Ticket Inspector
		Muiti-Ride Ticket	Off-Site	Ticket Inspector

fare gate ticket transport which deducts one ride and releases the turnstile for entry.

Both the Chicago and Atlanta systems utilize the unlimited-ride pass. At MARTA in Atlanta, the pass is inserted into a ticket transport on the fare gate where it is read. CTA's pass in Chicago is currently printed on paper stock and is shown to the agent to gain entry.

3.2.2 Barrier Systems - Graduated Fare

On transit systems having a graduated fare and barrier entry/exit control, the patron using a multi-trip ticket inserts the ticket in the fare gate to enter the system and does the same to exit. On stored-ride systems, a ride is deducted from the ticket; systems having stored-value will deduct the price of the trip and print the remaining value on the ticket. If the cost of the trip exceeds the value of the ticket, the exit fare gate will reject the ticket until additional fare is paid to the Addfare (BART, WMATA), assistance phone (PATCO), or station agent (MTA).

A pass inserted in the fare gate is simply verified for use at the time, date and location. Fare gates require software to prevent "passback" of passes. Tickets are encoded with machine-readable data pertaining to the validity of the ticket for any ride.

Stored-value or stored-ride tickets may be purchased from vendors. Pre-encoded tickets may also be made available at outside sales outlets. Passes are sold off-site.

3.2.3 Barrier-Free Systems - Flat or Graduated Fare

The procedure required to pay a multiple-trip fare on a barrier-free system differs little between transit agencies subscribing to a flat or graduated fare structure. A patron holding an unlimited-ride pass simply enters and exits the train as desired. A passenger using a multiple-ride ticket must go to a ticket vendor, located near the station platform, and insert the ticket into the validation slot. The vendor cuts a portion of the ticket, and stamps the date, time and station on the remainder. On systems subscribing to a graduated fare structure, it is the patron's responsibility to purchase a ticket valid for the entire trip. If challenged by an inspector, the patron must present a valid pass or ticket, or face a substantial penalty.

Calgary, Edmonton and San Diego (MTDB) all offer an unlimited-ride pass; Calgary and San Diego (MTDB) provide multi-ride tickets as well. Passes and multiple-ride tickets must be purchased off-site.

3.3 REDUCED FARES

All transit agencies receiving federal operating or capital funds under Section 5 of the Urban Mass Transportation Act are mandated to provide, at minimum, half-priced fares for the elderly and handicapped in off-peak periods. Many transit agencies also incorporate elective discounts in their fare structures, some of which may be restricted to use during specific times of day.

As shown in Table 3-3, transit systems may offer reduced fares for single-trips, multiple-trip tickets and on unlimited

transfers are free to elderly, handicapped (with identification) and all express bus riders, while an upgrade is required for transfers from local and urban bus service.

The fare media and method of collecting bus-to-rail transfers at selected transit systems is presented in Table 3-6.

3.5 FARE DIFFERENTIALS

Fare differentials are generally related to time or type of service. Time-based differentials reflect transit cost structure by charging a greater fare in peak periods relative to off-peak periods. Differentials related to service type may involve charging a higher fare for rail service than for bus service or for a particular suburban or express route.

3.5.1 Flat Fare - Barrier Systems

An entry control system can collect time-based differentials at the fare gate or agent's booth. Automatic fare gates must be equipped with a clock and be programmed to accept the base fare in off-peak periods and a premium fare in peak periods. Service-based differentials are more difficult to collect in an entry control system. All fare gates at a suburban station can be programmed to incorporate a surcharge into the fare, as all patrons entering the system are utilizing suburban service. However, patrons entering an urban station and traveling to a suburban station do not incur the surcharge. Entry fare gates cannot discern the difference between urban and suburban riders at an urban station.

TABLE 3-6

ACCOMMODATION OF SINGLE-TRIP BUS-TO-RAIL TRANSFERS

Collection Method	Transit System	Media	Use
Flat Fare			
Barrier: Entry	CTA/Chicago	Paper Transfer	Agent
	MARTA/Atlanta	Magnetic Transfer	Fare Gate
Barrier-Free	ETS/Edmonton	Paper Transfer	Inspector
Graduated Fare			
Barrier: Entry/Exit	BART/San Francisco	No Transfer	.....
	MTA/Baltimore peak	Magnetic Transfer	Fare Gate
	off-peak	Paper Transfer	Agent
	PATCO/Phila.-N.J.	No Transfer	.....
	WMATA/Washington, D.C.	No Transfer	.....
Barrier-Free	CT/Calgary	Paper Transfer	Inspector
	MTDB/San Diego	Paper Transfer	Inspector

While neither of the flat fare systems discussed in this text subscribe to a time-base differential, CTA does have a surcharge on a particular express rail service that operates in the peak period. The fare surcharge is collected inbound only on board the train.

3.5.2 Barrier Systems - Graduated Fares

Entry/exit fare gates can be programmed to automatically collect time-based differentials in the same manner as entry gates. The fare to be charged can be determined at either the time of entry or exit. Service-related differentials are generally incorporated into the graduated fare structure.

WMATA, PATCO and MTA all have or will have a time-based differential. WMATA charges a distance-based fare in the peak periods and a flat fare in the off-peak. PATCO currently employs an internal fare gate clock to restrict use of reduced fare tickets to off-peak periods. MTA plans to include a peak/base differential into its fare structure using similar equipment.

3.5.3 Barrier-Free Systems - Flat or Graduated Fare

The procedure required to pay a fare differential differs little between barrier-free systems subscribing to a flat or graduated fare structure. Ticket vendors must have the capability to dispense tickets priced at the appropriate fare levels. An internal clock mechanism can adjust the fare required for single-trip tickets. Otherwise, it will generally be the patron's responsibility to purchase the correct ticket.

None of the barrier-free systems included in this review utilize fare differentials.

CHAPTER 4
EQUIPMENT AND PERSONNEL

This chapter discusses the type of equipment and personnel generally required for each type of fare collection system. The features of the equipment and responsibilities of the personnel are described.

4.1 FARE COLLECTION EQUIPMENT

Equipment associated with the fare collection system will include that which is necessary for fare processing, media and revenue handling and system monitoring. The equipment and its features will depend upon the particular manner in which a fare collection concept is applied on a transit system. A detailed description of equipment on selected systems is presented in Appendix A.

4.1.1 Fare Processing Equipment

Fare processing equipment refers to that equipment which the patron must use in order to pay the proper fare. A general description of the type of equipment that can be utilized to collect fares is presented in this section.

Barrier System - A barrier entry control system that processes flat fares may have the following equipment:

- Automatic Fare Gate

  - Passenger-activated, permits entry to the "paid" area following insertion of proper fare

  - Free-wheels in the exit direction

  - Must accept all media on a fully automated system, and the predominant media on manual/automatic system

  - Media accepted may include coin, tokens or machine-readable tickets or passes.

- Agent-Controlled Fare Gate

  - On manual/automatic systems only, the agent releases the gate to permit entry to the "paid" area after verifying by visual inspection that the proper fare has been paid

  - May be locked or allowed to free-wheel in the exit direction.

- Ticket or Token Vendors

  - Required only on systems in which machine-readable tickets or tokens are a predominant media

  - Located in the station "free" area, accepts coin or in some cases dollar bills, and vends the ticket or token and in some cases, change

  - Tickets are machine-readable and may be either pre-encoded with pertinent data or encoded by vendor at time of sale. Data may include: fare type, date/time of purchase, location or vendor number, system security code.

- Transfer Dispenser
  - For rail-to-bus transfers, is located in the "paid" area
  - May accept coin or issue a free transfer
  - May be free standing or may be attached to fare gate and tied to fare payment
  - Prints station, time and date at time of issue.

- Handicapped Swing Gate
  - Activated by remote control by system personnel, or by a handicapped passenger with proper machine-readable identification, will swing open to permit entry or exit of a person in a wheelchair.

Fare processing equipment for selected entry control systems is presented in Table 4-1.

A barrier entry/exit control system that processes graduated fares will have equipment that is more complex than the entry control equipment, because of the need to verify fare validity on exit and to collect additional fare for overriding, as shown in Table 4-2. The mechanics and software of the equipment will also depend on the use of either a stored-ride system for zoned fares or a stored-value system for distance-based fares:

- Automatic Entry Fare Gate
  - Passenger-activated, permits entry to the "paid" area following insertion of a valid machine-readable ticket

TABLE 4-1

ENTRY CONTROL: FARE PROCESSING EQUIPMENT

Transit System	Equipment	Media	
		Accepted	Vended
CTA /Chicago	Fare Gate	Coin; Token (Magnetic Ticket)	Transfer
	Agent Gate	.....	.....
MARTA /Atlanta	Fare Gate	Coin; Magnetic Ticket	Transfer
	E/H Gate	Coin; Magnetic Ticket	Transfer
	Assistance Phone	Coin	.....

TABLE 4-2

ENTRY/EXIT CONTROL: FARE PROCESSING EQUIPMENT

Transit System	Equipment	Media	
		Accepted	Vended
MTA/Baltimore	Ticket Vendor	Coin	Magnetic Ticket
	Fare Gate	Magnetic Ticket	.....
	Agent Gate	.....	....
	E/H Gate	Magnetic Ticket	.....
	Transfer Dispenser	Coin	Transfer
PATCO/Phila.-N.J.	Ticket Vendor	Coin	Magnetic Ticket
	Fare Gate	Magnetic Ticket	.....
	E/H Gate	Magnetic Ticket	.....
	Transfer Dispenser	Coin	Transfer
	Assistance Phone	Coin	.....
BART/San Francisco and WMATA/ Washington,D.C.	Ticket Vendor	Coin, Bill, Magnetic Ticket	Magnetic Ticket
	Fare Gate	Magnetic Ticket	.....
	Transfer Dispenser	.....	Transfer
	AddFare	Coin, Magnetic Ticket	Magnetic Ticket

- For stored-ride system: verifies tat the ticket is valid for entry at that time and station; deducts one ride from single and multi-trip tickets

- For stored-value system: verifies that the ticket is valid for the transit system and has value; encodes the station of origin

- Is combined with an exit fare gate.

• Automatic Exit Fare Gate

- Passenger-activated, permits exit from the "paid" area following insertion of a valid machine-readable ticket

- For stored-ride system: verifies that the ticket is valid for exit at that station; captures expired tickets

- For stored-value system: verifies that the ticket is valid; deducts the trip fare from the value stored on the ticket; prints the remaining value on the ticket and captures tickets with no remaining value.

• Agent-Controlled Fare Gate

- On manual/automatic systems only, the agent releases the gate to permit a patron to enter or exit the "paid" area, after verifying by visual inspection the proper payment of fare

- For entering patrons, the agent may collect or verify any media on the system that is not machine-readable and issue a machine-readable exit ticket

- For exiting patrons, the agent may collect additional fare for overriding.

- Handicapped Swing Gate

  - Activated by remote control by system personnel, or by a handicapped passenger with proper machine-readable identification, will swing open to permit entry or exit of a person in a wheelchair.

- Ticket Vendors

  - Located in the station "free" area, accepts coin and in some cases dollar bills and vends a machine-readable ticket; may give change

  - For stored-ride system: patron selects ticket necessary for travel to destination; ticket may be pre-encoded or encoded at time of purchase

  - For stored-value system: patron selects desired value to be printed and encoded on ticket at time of purchase.

- Transfer Dispenser

  - For rail-to-bus transfers, is located in the "paid" area

  - May accept coin or issue a free transfer

  - Is free-standing

  - Prints station, time and date at time of issue.

- Fare Upgrade Machines
  (Addfare and passenger-assistance phones)

  - Permit additional fare to be paid if ticket is not valid for station exit

  - Located in station "paid" area

- Addfare machines are passenger-activated; they read a machine-readable ticket, determine the additional fare owed and upon receiving proper payment re-encode the ticket for exit

- Passenger-assistance phones permit the passenger to communicate with a central control operator. The operator determines the value of the ticket via diagnostics in a fare gate, verifies that the additional fare has been paid into the coin-registering passenger-assistance phone and releases a fare gate for patron exit.

Barrier-Free System - A barrier-free system requires the same equipment regardless of the fare structure.

- Ticket Vendor

  - Located in the designated "free" area of the station, accepts coin and in some cases dollar bills and vends a printed ticket; may give change

  - The ticket will be printed at time of purchase with fare type, location, date and time.

- Ticket Validator

  - Located in the designated free area and generally combined with the ticket vendor, validates a multi-trip ticket for use on that trip

  - The multi-trip ticket is printed with location, date and time.

Fare processing equipment and media for selected barrier-free systems is presented in Table 4-3.

TABLE 4-3

BARRIER-FREE: FARE PROCESSING EQUIPMENT

Transit System	Equipment	Media	
		Accepted	Vended
CT/Calgary	Ticket Vendor	Coin	Ticket
	Ticket Validator	Multi-Trip Ticket	.....
ETS/Edmonton	Fare Gate	Coin	Receipt
MTDB/San Diego	Ticket Vendor	Coin	Ticket
	Ticket Validator	Multi-Trip Ticket	.....

4.1.2 System Monitoring Equipment

Fully automated fare collection systems require a means of monitoring equipment performance and controlling equipment operation. This may be the responsibility of the central control operator or of the station attendant.

System monitoring personnel will generally sit at a console that provides visual messages of equipment status (e.g., in-service, out of service, door open) and permits a limited degree of control over equipment operation (e.g., take out of service, put in service, release gate for one entry or exit, free-wheel turnstiles in emergency). At least one fare gate per bank of gates will permit the personnel to interpret a ticket's code to diagnose a problem and to ignore part or all of the encoding so the patron can use the ticket.

In addition to the equipment monitoring console, operators at central control will also be provided a means of observing and communicating with patrons who are using the fare collection equipment. Equipment will include closed-circuit television, passenger-assistance phones and a public address system.

4.1.3 Media and Revenue Handling Equipment

Each type of fare collection system requires some means of processing revenue. Special equipment is also required for processing certain media.

Processing of revenue may be done in-house or contracted out to the bank in which it is deposited. In general, a coin counter is utilized to tally up coin revenue. Dollar bills are generally hand sorted and counted.

Media processing requirements will depend on the system. Pre-encoded tickets, transfers or passes require a high speed ticket encoder to efficiently prepare the quantity of tickets that are regularly used.

Tokens may generally be sorted, counted and in some cases rolled by the same equipment that counts coins. Tickets are generally printed by an outside contractor.

4.2 SYSTEM PERSONNEL REQUIREMENTS

An important aspect of fare collection is the personnel requirements for system operation. Labor costs comprise a significant portion of total fare collection costs for most transit systems. The degree of automation influences the type of personnel required, as shown in Table 4-4. Fare collection personnel can be grouped into five functional categories: station personnel, on-board personnel, maintenance personnel, revenue collection prsonnel and central control personnel.

4.2.1 Station Personnel

Station personnel are utilized on some systems having barrier fare collection. They can be functionally classified as agents or attendants.

Station agents are directly involved in the collection of fares on manual/automatic systems. Their primary function is to handle special fares and transfers not accommodated by machines. Agents also assist passengers experiencing difficulty with the equipment.

TABLE 4-4

FARE COLLECTION STAFFING REQUIREMENTS

	Manual/Automatic Barrier		Fully Automated Barrier				Barrier-Free		
Transit System:	CTA	MTA	MARTA	PATCO	BART	WMATA	CT	ETS	MTDB
Station Personnel									
. Station Agents	X	X	–	–	–	–	–	–	–
. Station Attendants	–	–	X	–	X	X	–	–	–
On-Board Personnel									
. Conductors	X	–	–	–	–	–	–	–	–
. Operators	X	–	–	–	–	–	–	–	–
Ticket Inspectors									
. Inspectors	–	–	–	–	–	–	X	X	X
Central Control									
. Patron Assistance	–	–	X	X	–	–	–	–	–
. System Status	–	–	X	X	X	X	–	X	X
Maintenance									
. Technicians	X	X	X	X	X	X	X	X	X
Revenue Processing									
. Revenue Collection	X	X	X	X	X	X	X	X	X
. Revenue Counting	X	X	X	X	X	X	X	X	X

At the CTA and MTA, station agents supplement automatic fare collection by handling all non-standard transactions. PATCO does not utilize station agents but uses part-time personnel to supplement ticket vendors at major stations during the a.m. peak period.

Station attendants are sometimes employed on fully automated barrier systems. They are not responsible for actual fare collection, but instead provide assistance to passengers experiencing problems in utilizing automatic fare collection equipment. Station attendants often have some light maintenance responsibilities as well. Attendants man all stations at BART and WMATA and make all soft repairs (e.g., ticket or money jams). Additional responsibilities include putting all fare collection equipment into service, setting all reversible aisles into the predetermined entry/exit pattern to obtain optimal flow for the initial operating period, and auditing all machine registers for use by financial and security offices at its high volume rail terminals. Station attendants are not essential to system operations, but contribute to patron security and convenience.

4.2.2. On-Board Personnel

The CTA utilizes conductors to collect fares on-board during nights and weekends when trains consist of only two cars. This measure has proven more cost-efficient than having manned stations (i.e., station agents) during these particular periods. Conductors also issue transfers upon receipt of the appropriate fare. Operators of one-car trains also perform a fare collection function on the CTA. In this case, only the doors near the operator are used for boarding. Passengers deposit the proper fare in a registering box adjacent to the operator.

4.2.3 Ticket Inspectors

Ticket inspectors are a critical element of barrier-free fare collection. The inspectors are charged with enforcing fare payment policies through organized random checks or patrons for proof of payment. Inspectors circulate vehicles between and at stations examining patron tickets, passes, and receipts of fare payment. Passengers not having proof of payment in their possession are issued fines for fare evasion. Inspectors also perform a passenger assistance function and provide public relations for the transit system.

4.2.4 Central Control Personnel

Central control personnel are used on many transit systems to monitor overall system operations and via a closed-circuit television system to provide remote surveillance of stations for reasons of safety and security.

These personnel will be responsible for monitoring fare collection operations on systems where stations are unmanned and automated. Duties may include:

- Monitoring and controlling equipment status;
- Monitoring fare collection system use;
- Providing passenger assistance by PABX phone; and
- Ensuring the safety and security of passengers using the fare collection system.

Central control personnel can generally remove equipment from service if a problem occurs and are responsible for summoning maintenance technicians. On some barrier systems, if a patron encounters problems entering or exiting the system, the

operator can diagnose the problem and command the fare gate to permit entry or exit. Responsibilities may also extend to actual collection of additional fare for overriding a ticket, via a coin-registering passenger-assistance phone.

Central control personnel at BART, WMATA, PATCO and MARTA monitor system status. In addition PATCO and MARTA personnel can assist patrons experiencing difficulty, utilizing equipment diagnostics and system override controls.

The barrier-free systems in San Diego and Edmonton utilize central control personnel to monitor fare collection operations via CCTV.

4.2.5 Equipment Maintenance Technicians

Maintenance technicians are required to service, maintain, and repair all automatic fare collection equipment. The number of maintenance personnel required at a given system is directly related to the type, amount and reliability of fare collection equipment and use. At some transit systems (e.g., BART, WMATA, MARTA), maintenance technicians only visit stations when notified of a failure. At other systems (e.g., PATCO), maintenance technicians can be directed to a failure by central control, but will also roam segments of the line and check all equipment for proper operation. At BART and WMATA, technicians only handle hard failures, while MARTA and PATCO technicians repair hard and soft failures.

4.2.5 Revenue Collection and Processing Personnel

Most systems require three general personnel functions for revenue handling: revenue collection from stations,

revenue processing at a central counting facility, and delivery of revenue to banks. Revenue collectors, sometimes called revenue agents or foot collectors, are responsible for collecting all rail revenues from stations and parking lots. This usually entails removing a full cash box from fare collection equipment and replacing it with an empty cash box. At some systems (e.g., PATCO, MTA), the revenue collectors are also required to replenish the ticket stock and change in fare equipment. Revenue collectors transport the fare revenue from the station to the central counting facility via an armored truck (e.g., CTA) or a revenue train (e.g., WMATA).

Revenue processing personnel are generally responsible for manually processing mixed $1 or $5 bills and operating currency counting machines. Tokens are separated from coins and returned to the cashier. Tickets are destroyed or retained for additional use. Revenue processing personnel prepare currency for deposit, and revenue delivery personnel transfer the money to the bank.

CHAPTER 5
SYSTEM PERFORMANCE AND REQUIREMENTS

For each concept and its equipment, there are associated costs. Capital costs increase with the level of equipment complexity. (They are also sensitive to contractual terms for their manufacture, the size of the contract, and economic conditions in the industry.) Operating costs will be influenced primarily by the number of personnel needed to operate the system and to maintain the equipment. In some instances, attempts to control operating costs through use of automated equipment has resulted in higher maintenance costs. Reliability of equipment is an important issue in this regard, as it determines the number of maintenance personnel needed to achieve the necessary equipment availability goals.

This chapter discusses the experiences of selected transit systems in the areas of equipment performance and capital and operating costs.

5.1 EQUIPMENT RELIABILITY

Reliability is a measure of the probability that equipment will fail to function properly either over time, distance or a number of cycles. As fare collection equipment is most sensitive to the number of transactions that are performed, the most common measure of reliability is the mean cycles (or transactions) between failures - MCBF. Transit systems will differ in the definition of a failure. A failure may be

recorded if any function is lost, or if only a critical function is lost; the type of repair and personnel performing it may also determine whether a failure is reported.

Table 5-1 shows MCBF levels for equipment on selected systems. The numbers reflect all maintenance actions undertaken by either maintenance technicians or by station attendants. Factors which influence reliability levels include:

- The complexity of the equipment;
- The quality of design and manufacture;
- The quality of scheduled maintenance and repairs;
- The intensity of use (time-related failures have a greater effect on reliability with lightly-used equipment); and
- The age of the equipment.

The table shows a sensitivity of reliability to equipment complexity. In Philadelphia, PATCO uses plastic tickets and does not print on them; thus, its fare gates are not plagued by jams due to ticket wear or the failure of a print mechanism. Fare gates on BART (San Francisco) and WMATA (Washington, D.C.) print on paper tickets that are often used several times before they are discarded; this contributes to the relatively low reliability of these units. WMATA has embarked on a multi-million dollar retrofit program that will, among other things, improve ticket transport operation; the program is also expected to improve electronic reliability.

The rail systems in Chicago and Atlanta trace the majority of the problems with their fare gates to the

TABLE 5-1

EQUIPMENT RELIABILITY

		Fare Gates		Ticket Vendors		Miscellaneous		
Concept	Transit System	Mfg.	Reliability (MCBF)	Mfg.	Reliability (MCBF)	Type	Mfg.	Reliability (MCBF)
Barrier: Entry Control	CTA/Chicago	Duncan	2,500	–	–	–	–	–
	MARTA/Atlanta	Cubic	1,740	–	–	–	–	–
Barrier: Entry/Exit Control	PATCO/Phila.-N.J.	Cubic	5,910	Adv. Data	310	Bill Changer	Nick-O-Loc	1,190
	WMATA/ Washington, D.C.	Cubic	1,250	Cubic	100	Add Fare	Cubic	75
	BART/San Francisco	Cubic	1,135	Cubic	140	Add Fare	Cubic	225
Barrier-Free	MTDB/San Diego	–	–	Autelca	3,000	–	–	–

MCBF = Mean Cycles between Transactions

Source: Jet Propulsion Laboratory, Overview of Rail Transit Fare Collection, prepared for UMTA, August 1980; San Diego Metropolitan Transit Development Board, 1982.

microelectronics, coin acceptor and transfer dispenser. Each system is modifying the fare gate to reduce the likelihood that an electronic problem will cause the unit to go out of service. MARTA has also modified its transfer dispensing system. Edmonton Transit, dissatisfied with the low reliability of its CTA-type fare gates, is planning to replace them with post-mounted ticket vendors.

The ticket vendors on the barrier systems are far less reliable than on the barrier-free system at MTDB in San Diego. WMATA and BART vendors, which are the most sophisticated, are plagued with problems of bill and coin acceptance, and ticket transport. WMATA is planning an overhaul of its ticket vendors and currently has two pilot projects underway: one to improve bill acceptance, the other to improve ticket vending.

Although simple in concept, the PATCO vendor has not been able to operate reliably in an environment of continual use. The primary cause of failures is ticket jams. Under a grant from UMTA, PATCO has designed its own ticket vendor, which it is preparing to test.

The ticket vendor at MTDB accepts exact change and prints a ticket from fan-fold stock. Its primary cause of failure is paper jams.

5.2 EQUIPMENT COST

Capital costs of equipment depend primarily on their complexity. They can also be influenced by contractual terms, the size of the contract and economic conditions in the industry.

Purchase costs of equipment for selected systems are shown in Table 5-2. Despite the difference in the year of purchase, the costs show how they will vary with complexity. This is all the more evident in Table 5-3. This table presents rough estimates of equipment costs in 1980 dollars, which have been based on analyses of price quotations in response to different bids.

Systems such as BART and WMATA require the most costly equipment. System complexity also requires more kinds of equipment (i.e., fare gates, ticket vendors, Addfare units, WMATA's Data Acquisition and Display System). Simpler systems such as CTA, MARTA and PATCO require fewer types of equipment that are also less costly.

5.3 OPERATING AND MAINTENANCE COSTS

The annual cost of fare collection is composed of the cost of personnel needed to operate and maintain the system (shown in Table 5-4), of spare parts and consumables - - including media - - and by the power that is required for the equipment to operate. The major cost is associated with personnel.

Analysis of total annual costs for fare collection, presented in Table 5-5, does not provide a discernible pattern when examined on a per-passenger basis. One would expect the transit systems with unmanned stations to have the lowest costs. Ridership peaking levels and fixed station-related costs are believed to be affecting the results.

TABLE 5-2
COMPARISON OF EQUIPMENT COSTS

	Fare Gates		Ticket Vendors		Miscellaneous		
	Year Purchased	Unit Cost	Year Purchased	Unit Cost	Type	Year Purchased	Unit Cost
Barrier: Entry							
CTA/ Chicago	1978	$ 6,000					
MARTA/ Atlanta	1977	14,000	—	—	—	—	—
Barrier: Entry/Exit							
BART/San Francisco	1974	$43,000	1974	$33,500	AddFare	1974	$31,500
MTA/ Baltimore	1981	N.A.	1981	N.A.			
PATCO/ Phila.-N.J.	1976	10,000	1968	3,000	Aid Phone	1969	150
WMATA/ Washington, D.C.	1981	33,000	1981	49,000	AddFare	1981	42,000
Barrier-Free							
MTDB/San Diego	—	—	1981	35,000 *	—	—	—

N.A. Not Available

** Includes installation*

TABLE 5-3

ESTIMATED FARE COLLECTION EQUIPMENT CAPITAL COSTS

	Cost
Gates	
Mechanical Turnstile	
Token Accepting	$ 2,000
Coin Accepting - 1 or 2 identical coins with safebox	3,500
Electrical Turnstile	
Accepts no coins or tokens, unlocked from station attendant booth	3,200
Coin operated single slot, with safebox, time of day clock, microprocessor	8,000
Above, plus issues paper transfer from fanfold (accordion fold)	11,000
Above, plus reads magnetically encoded cards	14,000
Similar to above, another manufacturer	21,000
Ticket transport type for stored value farecard	27,000
Farecard Vendors	
Prints, encodes, and dispenses magnetic farecard; accepts bills, coins, returns change	29,000
Dispenses one value, pre-encoded farecard; accepts bills, no change	14,000
Dispenses one value, pre-encoded farecard from fanfold feed; accepts bills	2,000
Addfare	
Upgrades value-stored value, magnetically encoded card	27,000
Data Acquisition and Display System (per station)	14,000
High Speed Farecard Encoders	29,000
Bulletproof Agent Booth	40,000
Changemaker, or Token Vendor	2,000
Pass Readers — used as add on to gate	1,500 — 5,000
Transfer Dispensers — machine readable punched holes	3,000

Source: *Jet Propulsion Laboratory*, Overview of Rail Transit Fare Collection, *prepared for U.S. Urban Mass Transportation Administration, August 1, 1980.*

TABLE 5-4

COMPARISON OF PERSONNEL REQUIREMENTS

	Total Personnel per 1,000 Weekday Passengers	Total Personnel per Station	Station Personnel	Ticket Inspectors	Maintenance Technicians	Central Control[a]	Revenue/Media Personnel
Barrier: Entry							
CTA (Chicago)	0.8	3.9	626	—	26	—	41[b]
MARTA (Atlanta)	0.7	3.3	14	—	11	14	17
Barrier: Entry/Exit							
BART (San Francisco)	1.6	8.0	180	—	42	—	50
MTA (Baltimore) *(est.)*	0.7	8.4	72	—	13	—	16
PATCO (Phila.-N.J.)	1.0	3.2	10[c]	—	11	7	13
WMATA (Washington, D.C.)	1.2	8.4	244[d]	—	68	—	49
Barrier-Free							
MTDB (San Diego)	1.1[d]	0.5[d]	—	6	3[d]	—[d]	4

(a) Central control personnel are included only if their primary function is related to fare collection and passenger assistance.

(b) Does not include bank employees who process one-half of the revenue.

(c) Supervisors who roam the system.

(d) Personnel have multiple responsibilities which include fare collection.

TABLE 5-5

COMPARISON OF OPERATING COSTS

Concept/System	Annual Operating Cost	Operating Cost per Passenger	Operating Cost per Station
Barrier: Entry			
CTA /Chicago	N.A.	N.A.	N.A
MARTA /Atlanta	$1,945,000	$0.085	$114,000
Barrier: Entry/Exit			
BART /San Francisco	$11,900,000	$0.233	$350,000
MTA /Baltimore	2,712,000 *(est.)*	0.058	226,000
PATCO /Phila.-N.J.	1,100,000	0.086	85,000
WMATA /Washington, D.C.	13,750,000	0.155	320,000
Barrier-Free			
MTDB /San Diego	$409,000	$0.117	$ 23,000

N.A. Not Available

When examined on a per-station basis, the comparative costs are more in line with what would be expected. MTA, BART and WMATA - - each of which have both sophisticated equipment and a station agent or attendant at each station - - have significantly higher unit costs than the other systems. MTDB, the barrier-free system, has the lowest.

CHAPTER 6
CONCLUSIONS

This report has examined existing fare policy and fare collection concepts and their application and variations on selected systems. Its purpose has been to provide a basis for developing and analyzing fare collection alternatives for the Metro Rail system.

The fare policy concepts included flat and graduated fare structures, the latter of two types - - zoned or distance-based. Specific fare elements were identified, namely the single-trip fare, multi-trip fare, reduced fares, intermodal transfer and fare differentials (peak/off-peak and rail fare premium). Fare collection concepts examined included barrier and barrier-free systems. Barrier systems can be fully-automatic or a combination of manual and automatic operation.

A flat fare structure would require an entry-control system, allowing free exit. A graduated fare structure would require entry and exit control, with examination and validation of fare payment at both the origin and destination stations to ensure proper payment of fare.

Alternative means of processing passengers of different fare categories were identified.

For each system, the reliability of equipment and costs of operation were compared.

Based on the information that has been compiled and presented in this report, alternative fare collection systems for Metro Rail will be identified.

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GLOSSARY

GLOSSARY

ACRONYMS FOR TRANSIT SYSTEMS

Acronym	Transit System
BART	Bay Area Rapid Transit (San Francisco/Oakland, CA)
CT	Calgary Transit (Calgary, Canada)
CTA	Chicago Transit Authority (Chicago, IL)
ETS	Edmonton Transit System (Edmonton, Canada)
MARTA	Metropolitan Atlanta Rapid Transit Authority (Atlanta, GA)
MBTA	Massachusetts Bay Transportation Authority (Boston, MA)
MDCTA	Metropolitan Dade County Transportation Administration (Miami, FL)
MTA	Mass Transit Administration (Baltimore, MD)
MTDB	Metropolitan Transit Development Board (San Diego, CA)
MUCTC	Montreal Urban Community Transit Commission (Montreal, Canada)
NYCTA	New York City Transit Authority (New York, NY)
PATCO	Port Authority Transit Corporation (Philadelphia, PA/New Jersey)
SCRTD	Southern California Rapid Transit District (Los Angeles, CA)
SEPTA	Southeastern Pennsylvania Transportation Authority (Philadelphia, PA)
TRI-MET	Tri-County Metropolitan Transportation District of Oregon (Portland, OR
WMATA	Washington Metropolitan Area Transit Authority (Washington, DC)

APPENDIX A

DESCRIPTION OF SYSTEM EQUIPMENT OPERATION

APPENDIX A

DESCRIPTION OF SYSTEM EQUIPMENT OPERATION

This appendix describes, in detail, the operational aspects of fare collection equipment for the following transit agencies:

- BART (San Francisco);
- CT (Calgary);
- CTA (Chicago);
- ETS (Edmonton);
- MARTA (Atlanta);
- MTA (Baltimore);
- MTDB (San Diego);
- PATCO (Philadelphia); and
- WMATA (Washington, D.C.).

A summary list of fare collection equipment manufacturers follows this discussion.

BART/San Francisco - BART utilizes a fully-automated entry and exit control system to collect the graduated (distance-related) fare. BART incorporates ticket vending machines, bi-parting fare gates, addfare machines, ticket encoders, and agent ticket readers into the fare collection system. Each of these components is discussed below.

- Ticket Vending Machine - The BART vendor is used to purchase a new ticket or increase the value of a used ticket. The vendor accepts one- and five-dollar bills, nickels, dimes and quarters and gives change. In operation, a patron inserts his money and enters the desired value of the ticket by push buttons. The value is displayed digitally. The card is automatically encoded and printed with value. All monies are held in escrow until the ticket is issued. The vendor is encased in a vault-like cabinet for security.

- Fare Gates - Barriers are formed with gates which have pneumatically-operated bi-parting leaves, one on each of the gates that form the aisle. In operation, the passenger inserts his ticket into the fare gate and the ticket is read to determine validity for entry. The ticket is then magnetically encoded with the time, station of entry and a security code. As the passenger removes the ticket, the barrier opens. On exiting the system, the patron inserts the ticket into the exit gate where the magnetic code is read. The gate computes the fare, subtracts the proper amount and encodes the remaining value on the card. If no value remains, the ticket is captured.

- Addfare - Addfare is used to upgrade underpaid tickets to allow exit from the "paid" area of the station. The unit reads, checks the validity of the ticket, and calculates the additional funds required. After deposit of funds, the card is re-encoded for one-exit use. The unit also serves as a change maker.

- Ticket Encoder - The BART ticket encoder provides for high speed encoding of tickets for distribution through off-site outlets. Tickets can be encoded with any value, including special passes for students, employees, the elderly and handicapped.

- Agent Ticket Reader - The agent's reader is used by station attendants to display the data encoded on the ticket. This equipment is used to resolve disputed tickets.

- Data Acquisition Reader (DAR) - Monitors fare collection equipment and records cumulative transaction and fiscal data from each fare machine.

Calgary Transit - Calgary Transit employs a self-service, barrier-free fare collection system to collect the flat fare.

This is a proof-of-payment system where patrons are required to have in their possession a validated ticket, transfer or pass while riding the rail system. This system requires only one type of machinery to collect and validate fare payment. These devices are detailed below.

- Ticket Vendor/Validator - This machine has the capability of issuing single-ride tickets, validating multi-ride tickets and issuing transfers. The vendor accepts only coins, and provides no change. Upon fare payment a receipt is issued printed with the date and time. This receipt acts as a validated ticket for riding the system. If a transfer is desired, payment of a nominal fee is required in addition to the fare. Upon payment, a transfer is issued printed with the date and time for validation.

CTA/Chicago - The CTA utilizes a combination of automated fare collection equipment and manual assistance to collect its flat fare. The barrier system controls entry into the system; exits are free-wheeling. Equipment requirements include:

- Coin-Operated Fare Gate - The fare gate accepts any combination of pennies, nickels, dimes, quarters or half dollar or token in a single slot which add up to the total fare. The amount accumulated is displayed on a readout as each coin is deposited until the fare is met, at which time a bell sounds and the turnstile unlocks for the admission of one passenger. The turnstile will accept overpayment, but will not make change. If a passenger requires a transfer, he pays the nominal charge, in addition to the fare, and a transfer is issued by the transfer dispenser, which is attached to the gate console. The fare gate has one register to record passengers entering and another to record transfers sold. The turnstiles are locked until payment of fare in the entry direction, and are free-wheeling in the exit direction.

- Agent-Controlled Fare Gate - The agent-controlled fare gate admits a passenger to the paid area of a station upon registration of the fare by the agent. Like a coin-operated fare gate, this one is locked until fare payment is received. The control console provides registers for twelve classes of fare and for a count of the total entering traffic. The turnstile is fitted to permit free exit from the paid area. In operation, the patron drops the fare into an inspection plate. The agent verifies that proper fare has been paid and records the fare by pressing the appropriate button on the control console. This button releases the turnstile permitting entry.

- Exit Fare Gate - The exit fare gate is used to permit movement of passengers in one direction only, while preventing entry in the other direction. The barrier of the fare gate is a tripod turnstile.

- Revolving Gate - The revolving gate is a full height gate used to permit passage in the exit direction only, in areas where floor-to-ceiling control is required.

- Transfer Issuing Machine - The transfer issuing machine prepares and issues, a transfer imprinted with the prescribed design, time, date and a serial number. The machine is connected to the coin-operated fare gate. When the proper fare is deposited into the fare gate, a transfer is issued. The transfer is printed on a continuous roll of blank stock.

- Swipe Pass Reader - The CTA is currently testing a swipe pass reader at some fare gates. This device reads a magnetically-encoded strip on the back of a CTA-issued pass. The reader has no moving parts. The patron guides the pass past the magnetic-read heads on the reader, in place of the transport mechanism. The card never leaves the patron's hand, thus thwarting possible card or ticket jams. The pass contains a

security code on a special high-density magnetic tape that is difficult to duplicate. The system has a passback feature to prevent double usage of the same pass at a row of fare gates within a specified time period.

Edmonton Transit - The Edmonton Transit System is a self-service, barrier-free carrier utilizing a flat fare. It uses passes, transfers and fare gate-issued tickets as proof of fare payment. The ETS has very low equipment-related costs, only requiring a bank of fare gates at the station platform. Each of these is described below.

- Fare Gate - The fare gate acts as a vendor of single-trip tickets and as a passenger counter. Upon insertion of correct fare in coins (no change is provided) the machine issues a paper receipt of fare payment. The receipt is imprinted with the date and time, and is valid as a rail-to-bus transfer. The fare gate does not control passenger movement; it is free-wheeling in both directions.

MARTA/Atlanta - MARTA utilizes an entry control barrier system to collect the flat fare for service provision. The stations are fully automated and do not require manning, although station attendants provide passenger assistance at high-volume terminals. A typical set or array of gates at a mezzanine consists of one handicapped gate, two entry gates, one exit gate and one dummy console. The fare collection system also includes magnetic ticket encoders, a closed circuit television system, passenger assistance telephones and a public address system. Each of these elements is addressed below.

- Entry Fare Gate - The entry gate consists of a single slot coin acceptor, cash vaults, machine logic, ticket transport, transfer dispenser, passenger displays, tripod barrier mechanism, and a data registration and auditing unit. The coin acceptor can accept tokens, nickels, dimes and quarters. The ticket transport includes read and write heads and a ticket capture gate. The ticket transport also reads magnetically encoded bus-to-rail transfers.

  The turnstile barrier is locked until the appropriate fare is inserted and accepted by the logic system; processing time of the fare payment is less than one second. Once fare payment is accepted, an "ENTER" message on the top of the gate is lit. Simultaneously, the turnstile barrier is unlocked to permit the entry of one patron. The gate also dispenses a free transfer when the appropriate button is pressed at the end of a transaction. The entry gate is free-wheeling in the exit direction.

- Handicapped Swing Gate - The handicapped swing gate operates in the same manner as the entry gate, with two exceptions. This fare gate incorporates a hinged gate-type barrier and a display system that can be used to determine the validity of a farecard that was not accepted by the standard entry fare gate. Once inserted, the farecard will pop up through the ticket return slot and one of five messages will be displayed as follows:

  - Passback;
  - Time Expired;
  - Not Readable;
  - Damaged Card; or
  - Enter.

  If "ENTER" is lighted, the gate is unlocked and permits entry. The on-scene diagnostics assist the patron and MARTA Zone Center personnel in monitoring and resolving patron AFC problems.

- Exit Gate - The exit gate has no fare-accepting capability and cannot issue transfers. It is locked in the entry direction and free-wheels in the exit direction.

- Dummy Console - The dummy console serves two primary purposes: (1) it houses a master clock to control and supplys the precise time to each fare gate; and (2) it channels and restricts passengers in an orderly manner at one end of the bank of fare gates.

- Ticket Encoder - The MARTA high production encoding machines are used to magnetically and visually encode large numbers of pre-printed tickets. Tickets are encoded daily for use as bus-to-rail transfers. Special tickets are encoded for promotions, reduced fare for handicapped and senior citizens, and employee passes.

- Monitoring Equipment - MARTA utilizes a closed-circuit television system to monitor activities at each station mezzanine from zone center control offices. This visual monitoring system is supplemented with well-marked passenger assistance telephones. Control is further enhanced by a public address system at each mezzanine. MARTA monitors equipment and systems operations from a central control office. Equipment failures are electronically monitored and maintenance technicians are dispatched from this facility as necessary.

MTA/Baltimore - The MTA in Baltimore plans to use entry and exit control to ensure payment of its multi-zone fare. Fare collection equipment will have to accommodate a peak/base differential in the fare structure. MTA will complement automatic fare collection with manual assistance for special fares. Equipment requirements include ticket vending machines, entry/exit fare gates, bill changers, agent-controlled fare

gates, fareboxes and elderly/handicapped gates. Each of these is discussed below.

- Ticket Vending Machines (TVM's) - Located in the station mezzanine, this machine will vend single and round-trip tickets to all zones and permit the patron to purchase a ticket with or without transfer privilege. Patrons (other than students and elderly/handicapped patrons) entering a rail station without a pre-purchased ticket or a monthly pass deposits fare in the TVM (in coins) and is issued an entry/exit ticket and change.

- Fare Gates - Located in the station mezzanine, the fare gate will control entry and exit to and from the train boarding area of station. The gates will allow passage through the aisle which they control only after a valid ticket has been inserted into the ticket slot on the console. On exit, a single-trip ticket purchased with transfer privilege will be returned to the patron with the date and time printed on it.

- Bill Changers (BC) - Located in the mezzanines alongside TVM's, patrons entering a station who do not have fare in change can obtain change for a one or five dollar bill for use in purchasing a ticket. BC will give change in the form of a one dollar coin or a token (optional).

- Agent-Controlled Fare Gate - Located directly adjacent to the Station Agent's booth, this mechanism is a fare gate console without ticket reading capability. This gate is remotely controlled by the Agent from within the booth and is used to admit patrons whose fare is manually collected.

- Fareboxes (FB) - Located alongside the station agent's booth, the FB's will be located in both the free and paid area side of the booth. FB's will be similar in function to FB's used in MTA bus operations. Their usage will be for manual collection of payments, students' tickets and tokens.

- Elderly/Handicapped Gate - Located in the mezzanine in the gate array, this is a swing type gate that controls entry (exit) to (from) the train boarding area of stations. E/H gates are controlled by the station agent and will be used by wheelchair patrons and others who may be unable to enter through an aisle controlled by a turnstile.

MTDB/San Diego - MTDB utilizes a self-service, barrier-free system to collect its zone fare. MTDB's fully automated fare collection system consists of only two types of machines, a ticket vendor/validator and a change-maker. The system is simple, relatively inexpensive and has proven quite reliable. The equipment function is described below.

- Ticket Vendor/Validator - This machine, located on every station platform, has the capability of providing a single-ride cash fare ticket and validating a multi-ride ticket. The vendor accepts nickels, dimes, quarters, half-dollars and Susan B. Anthony dollars; no change is provided. A single-ride ticket is dispensed upon deposit of the required coin fare and indicates: type of tariff, date, time, station number and a security code. The multi-ride ticket is validated with similar information. Upon inserting the ticket into the proper slot, the machine prints the information and cuts off a portion of the ticket. No transfer dispenser is required because the trolley ticket serves as a valid transfer. The vendor has the capacity to collect and issue tickets for up to six different tariffs.

- Change-Maker - Located at selected stations, the change-maker accepts dollar bills or coins and makes change, so that the passenger can deposit exact fare into the ticket vendor.

PATCO/Philadelphia - PATCO utilizes a fully-automated entry/exit control system to collect its zone fare. All stations are remotely monitored and controlled from a central control room. The fare collection system is composed of automatic gates, ticket vendors, transfer dispensers, bill changers, ticket encoder, central tower control unit, passenger assistance telephones and a closed-circuit television system. Each of these elements is detailed below.

- Fare Gates - Fare gates control access to and exit from the PATCO system. The gates read the magnetically encoded ticket, check for validity, time of passage and rides remaining. Exit gates subtract a trip and encode the ticket for the appropriate number of remaining rides. A visual display on the gate shows the patron the number of trips remaining; if no rides remain, the ticket is captured. Gates report operational status and can be controlled from a central control office. Three basic types of gates are used: entry, exit and bi-directional.

- Ticket Vendors - Vendors dispense one and two-trip tickets which correspond to zone fares. All vendors accept coins, some accept and verify bills. Most provide change when appropriate. All tickets are pre-encoded.

- Transfer Dispenser - This machine vends pre-printed transfers to the SEPTA bus system. Transfers are round trip and sold at a discount.

- Bill Changers - Commercial bill changers are available at all stations. These machines accept and verify one-dollar bills and provide change in the form of three quarters, two dimes and one nickel.

- Ticket Encoder - The PATCO ticket encoder allows rapid encoding of tickets for distribution by ticket vendors.

- Central Tower Control and Display Unit - This unit permits the Central Control Supervisor direct communication with the passenger to analyze and correct difficulties. It can remotely control entry and exit gates as well as read and analyze disputed tickets; each unit has capacity to control 20 separate stations.

- Passenger Assistance Telephones - These telephones are toll-free and are placed in each station to help passengers experiencing difficulty with the fare collection system. The telephones accept coins when additional fare is required.

- Closed-Circuit Television - A closed-circuit television system is used to monitor all station activities.

WMATA/Washington, D.C. - WMATA utilizes an automatic entry and exit barrier control system to collect fares, although station agents are maintained at each mezzanine. The WAMTA system is an updated version of BART's fare collection system. The fare card vendors, fare gates, addfare machines, ticket encoders and ticket readers function in exactly the same manner as does the respective BART equipment. For this reason, these system components are not discussed here. However, additional WMATA equipment requirements, including the data acquisition system, and elevator access control system, are discussed below.

- Data Acquisition and Display System (DADS) - The DADS monitors and controls the status of all AFC machines. The unit contains controls to activate or alter the mode of operation of gate, vendors or addfares within each mezzanine. Each DADS has an internal printer for audit data.

Elevator Access Control System (EACS) - At stations where the E/H elevators bypass the fare control line, use of the elevators is controlled by the EACS. Patrons may summon the elevator from the surface, and ride it down to the platform level.

On exiting the elevator the patron inserts his ticket into the EACS processor located immediately outside the elevator door. The processor reads the ticket and magnetically encodes the time and station of entry.

On exiting the system, the ticket is inserted into the EACS, read and checked for validity and remaining value. The processor calculates the fare, subtracts the appropriate amount and prints the remaining value on the ticket. If no value remains, the card is captured. The EACS then summons the elevator to return the patron to the surface.

TABLE A-1
EQUIPMENT MANUFACTURERS

Transit System/City	Manufacturer	Equipment Category
BART/San Francisco	International Business Machines	Ticket Vendor Fare Gate Addfare Money Changer Ticket Reader
	Cubic Western Data	Ticket Vendor Fare Gate Addfare Data Acquisition Reader
CT/Calgary	Xamax	Ticket Vendor/Validator Ticket Printer
CTA/Chicago	Duncan	Fare Gate Revolving Gate Transfer Dispenser
ETS/Edmonton	Duncan	Fare Gate Transfer Validator
MARTA/Atlanta	Cubic Western Data	Fare Gate Handicapped Gate Ticket Encoder
MTDB/San Diego	Autelca	Ticket Vendor/Validator
PATCO/Philadelphia	Cubic Western Data	Fare Gate Ticket Encoder
	Advanced Data Systems Cincinnati Time Nick-O-Loc	Ticket Vendor Transfer Dispenser Bill Changer
WMATA/ Washington, DC	Cubic Western Data	Fare Gate Ticket Vendor Addfare Data Acquisition & Display Ticket Reader Ticket Encoder

TABLE 3-3

REDUCED FARE ELEMENTS
OFFERED AT RAIL TRANSIT SYSTEMS

Collection Method	Transit System	Single-Trip	Multi-Trip	Pass
Flat Fare				
Barrier: Entry	CTA/Chicago	X	–	X
	MARTA/Atlanta	X	–	X
Barrier-Free	ETS/Edmonton	–	–	X
Graduated Fare				
Barrier: Entry/Exit	BART/San Francisco	–	X	–
	MTA/Baltimore	X	X	X
	PATCO/Phila.-N.J.	–	X	–
	WMATA/Wash., D.C.	–	X	–
Barrier-Free	CT/Calgary	–	X	X
	MTDB/San Diego	X	X	X

ride passes. Passes and multi-trip tickets must generally be purchased off-site. On those systems where they are offered, reduced single-trip fares require presentation of an ID card, which must be obtained beforehand.

3.3.1 Barrier Systems - Flat Fare

The procedure for using a reduced fare pass or multi-ride ticket is similar to that for the full fare passes or tickets. The media is generally printed in a manner that makes them easily distinguishable from full fare media. With manual/automatic systems, the reduced fare patron with a pass or multi-trip or generally directed to the station agent to enable the transit property to control potential abuse of reduced fares. Transit systems with unmanned stations must occasionally police the stations to control this potential for abuse.

A single-trip reduced fare can be handled by issuing permits or identification cards, at a central office, to be used in fare payment. A patron inserts the machine-readable permit and coins into a fare gate, or shows the permit to the agent and pays him the reduced fare. A time-clock in the fare gates can restrict use of reduced fare media to off-peak periods.

In Chicago, the patron entitled to a reduced fare uses the agent-controlled gate. Multiple-trip fares are handled by a reduced pass; single-trip fares require a permit, which is issued annually. In Atlanta, both single- and multiple-trip fare media are accepted at fare gates. The patron must insert the pass, or permit and coins, into the fare gate to gain access to the platform. Both the permit and pass are returned to the patron.

3.3.2 Barrier Systems - Graduated Fare

On transit systems having a graduated fare and barrier entry/exit control, the patron paying a reduced fare will either insert payment media into a fare gate or pay the station agent. In operation, a patron using a multiple-trip ticket inserts it into the ticket transport where it is read and encoded with the date, time, and station of entry. On exit, the ticket is inserted into the fare gate where the magnetic encoding is read to ascertain whether or not the ticket is valid for exit. If determined valid, one trip is deducted at stored-ride systems and the appropriate value is deducted at stored-value systems. If the cost of the trip exceeds the value of the ticket, the fare gate will reject the ticket and direct the patron to the Addfare or assistance phone.

A single-trip reduced fare can be handled at manual/automatic systems. A patron shows the agent the permit and deposits the reduced fare into the agent's farebox to gain entry. After verifying the fare, the agent issues a magnetically-encoded ticket for use in exiting the system. To exit, the patron inserts the ticket into the ticket transport of the fare gate where it is read, verified and captured.

BART in San Francisco and WMATA in Washington, D.C. offer regular multiple-ride tickets which are sold at a discount to elderly and handicapped patrons off-site. The fare collection equipment at these systems does not distinguish the difference between reduced and full fare tickets.

PATCO in the Philadelphia area sells reduced multiple-ride tickets off-site, and restricts use to off-peak periods only. The fare gate, which is equipped with a clock, reads

the magnetically-encoded data to determine if a reduced fare is valid for a specific trip. If accepted, the gate is opened and the ticket returned. During peak periods, a full fare ticket is required to enter through the fare gate.

MTA in Baltimore, plans to utilize a manual/automatic system to collect both single- and multiple-trip fares as discussed above.

3.3.3 Barrier-Free Systems - Flat or Graduated Fare

The procedure required to pay a reduced fare on a barrier-free system differs little between transit agencies subscribing to a flat or graduated fare structure. A patron using an unlimited-ride pass enters and exits the train as desired, no validation process is necessary. A multiple-ride ticket user must validate one trip at the vendor prior to entering the system. Upon insertion of the ticket, the validator cuts and prints the date, time and station on the ticket. A patron wanting a single-trip ticket purchases one from the vendor at a reduced fare. The single-trip rider must carry a reduced fare permit in addition to the ticket as valid proof of payment. Upon request, patrons must show a valid pass, multi-trip ticket, or a permit and reduced fare ticket to an inspector, or face a substantial penalty.

Calgary, Edmonton and San Diego all offer reduced unlimited-ride passes; CT and MTDB provide reduced single- and multiple-trip tickets as well.

Fare media, means of purchase and verification of reduced fare elements for selected transit systems is presented in Table 3-4.

TABLE 3-4

ACCOMMODATION OF REDUCED FARES

Collection Method	Transit System	Media	Purchase	Use/Inspection
Flat Fare				
Barrier: Entry	CTA/Chicago	Pass	Off-Site	Agent; Fare Gate
		Permit/Coin	.....	Agent
	MARTA/Atlanta	Pass	Off-Site	Fare Gate
		Permit/Coin	.....	Fare Gate
Barrier-Free	ETS/Edmonton	Pass	Off-Site	Inspector
Graduated Fare				
Barrier: Entry/Exit	BART/San Francisco	Stored-Value Ticket	Off-Site	Fare Gate
	MTA/Baltimore	Pass	Off-Site	Fare Gate; Agent
		Permit/Coin	.....	Agent
	PATCO/Phila.-N.J.	Multi-Trip Ticket	Off-Site	Fare Gate
	WMATA/Wash., D.C.	Stored-Value Ticket	Off-Site	Fare Gate
Barrier-Free	CT/Calgary	Pass	Off-Site	Inspector
		Multi-Trip Ticket	Off-Site	Vendor; Inspector
	MTDB/San Diego	Pass	Off-Site	Inspector
		Multi-Trip Ticket	Off-Site	Vendor; Inspector

3.4 TRANSFERS

In most cities with rail transit, a bus system provides complementary service. Transfers provide an important tool in realizing integration of bus and rail service. However, there are substantial differences among transit properties regarding transfer policy. There are four basic pricing alternatives: free fare, nominal charge, discounted fare and full fare (no transfer), as shown in Table 3-5.

3.4.1 Barrier Systems - Flat Fare

On transit systems subscribing to a flat fare and barrier entry control, the rail-to-bus transfer may be vended by a transfer dispenser in the station paid area or dispensed at the fare gate linking the transfer to fare payment at the fare gate prevents its abuse. Upon acceptance of a patron's fare, and transfer charge where applicable, the transfer button on the fare gate is lit. If pressed, a rail-to-bus transfer is dispensed on the paid side of the gate.

At manned stations, rail-to-bus transfers can be purchased from the station agent.

Administering a bus-to-rail transfer can be more difficult. At manned systems, bus operators validate paper transfers on-board which are used to gain entry at the station agent's booth. Fully automated systems, however, require machine-readable transfer tickets which are distributed by the bus driver. These tickets may be encoded on the bus or pre-encoded for distribution to the buses.

TABLE 3-5
TRANSFER POLICY

Transit System/City	Transfers	
	Rail to Bus	Bus to Rail
BART/San Francisco	Free	Full Fare
CT/Calgary	Nominal Charge	Nominal Charge
CTA/Chicago	Nominal Charge	Nominal Charge
ETS/Edmonton	Free	Free
MARTA /Atlanta	Free	Free
MBTA/Boston	Full Fare	Full Fare
MDCTA/Miami	Free	Free
MTA /Baltimore	Nominal Charge	Discounted
MTDB/San Diego	Free	Nominal Charge
MUCTC/Montreal	Free	Free
NYCTA /New York	Full Fare	Full Fare
PATCO/Phila.-N.J.	Discounted	Full Fare
WMATA/Wash., D.C.	Discounted	Full Fare

Pre-encoding obviates the need for bus-mounted encoding equipment. However, it limits the number of different transfers (e.g., time and station-related transfers) a system can use, which is necessary to control the level of administrative complexity. The bus operators must be kept in adequate supply of properly encoded transfers. The process becomes more difficult to administer with the institution of a graduated fare structure.

A simple method for accommodating transfers, both bus-to-rail and rail-to-bus, is through a free-body transfer. This type of transfer must be accommodated during the station design phase. In operation, buses drive directly to the paid area of the station, where passengers interface between bus and rail without encountering barriers. This technique works particularly well with a flat fare and free transfers, although transfer charges for boarding and alighting patrons can be collected by the operator. The concept requires a dedicated staging area for the buses that is isolated from walk-in traffic.

CTA accommodates a bus-to-rail transfer with paper tickets which are collected by the station agent. Transfers contain time periods by 15-minute blocks, and are validated on an "as needed" basis. MARTA uses pre-encoded tickets to accommodate automated bus-to-rail transfers, and has experienced logistics problems. At several major stations, MARTA has implemented free-body transfers with substantial success.

3.4.2 Barrier Systems - Graduated Fare

On rail transit systems with a graduated fare structure, rail-to-bus transfers are generally provided by free-standing transfer dispensers in the paid area of the station. Upon entering the paid area, a patron can procure a rail-to-bus transfer from the transfer dispenser. The transfer is generally not valid at the station of issuance to prevent abuse.

BART, WMATA and PATCO offer rail-to-bus transfers in this manner. The BART transfer allows a free subsequent ride on AC Transit in Oakland or Muni in San Francisco.

WMATA provides a free rail-to-bus transfer which permits a discount on the subsequent bus trip. The bus system subscribes to a graduated fare structure. PATCO in Philadelphia also provides a rail-to-bus transfer to the SEPTA bus system. Round-trip transfers are sold at a discount in the paid area of stations. Transfers from PATCO are also accepted on New Jersey Transit buses.

Single-trip bus-to-rail transfers are not accommodated by BART, WMATA or PATCO. WMATA, however, does offer a two-week, unlimited-ride bus pass that is also a stored-value ticket for use on the rail system. Software modifications will soon limit the rail use of this ticket to the specified two-week period.

BART currently accepts the magnetically-encoded Muni "Fast-Pass" for use between two stations in San Francisco. The three major operators in the Bay Area - - BART, Muni and AC Transit in Oakland - - are preparing to implement a regional pass to be good on all three systems.

MTA in Baltimore plans to incorporate both rail-to-bus and bus-to-rail transfers into its fare structure. The rail-to-bus transfer will be sold for a nominal charge in the paid area of stations. Bus-to-rail transfers will offer a discount on regular zone fares. The transfers are expected to be printed on paper stock and collected by the station agent in off-peak periods. Upon receipt of the transfer, the agent will sell a magnetically-encoded ticket to the patron at a discount for use in exiting the system. Peak-period bus-to-rail transfers will be pre-encoded for use at automatic fare gates.

3.4.3 Barrier-Free Systems - Flat or Graduated Fare

A barrier-free system can effectively accommodate rail-to-bus and bus-to-rail transfers. The validated rail ticket serves as a transfer to the bus system for a specified time period in systems offering free transfers. Rail-to-bus transfers are dispensed from the ticket vendor at systems charging for transfers. In operation, the patron must show a validated rail ticket, and transfer receipt where applicable, to the bus operator to transfer. Bus-to-rail transfers are generally printed on paper stock and distributed by the bus operator. Some systems may require that a transfer upgrade be paid at the vendor for the subsequent rail ride. Upon request by an inspector, the patron must present a valid transfer, and upgrade receipt where applicable, or face a substantial penalty.

ETS offers free rail-to-bus and bus-to-rail transfers, valid for one hour, free-of-charge. CT has a nominal surcharge for all transfers, payable to vending machines or bus operators. MTDB offers free rail-to-bus transfers; bus-to-rail