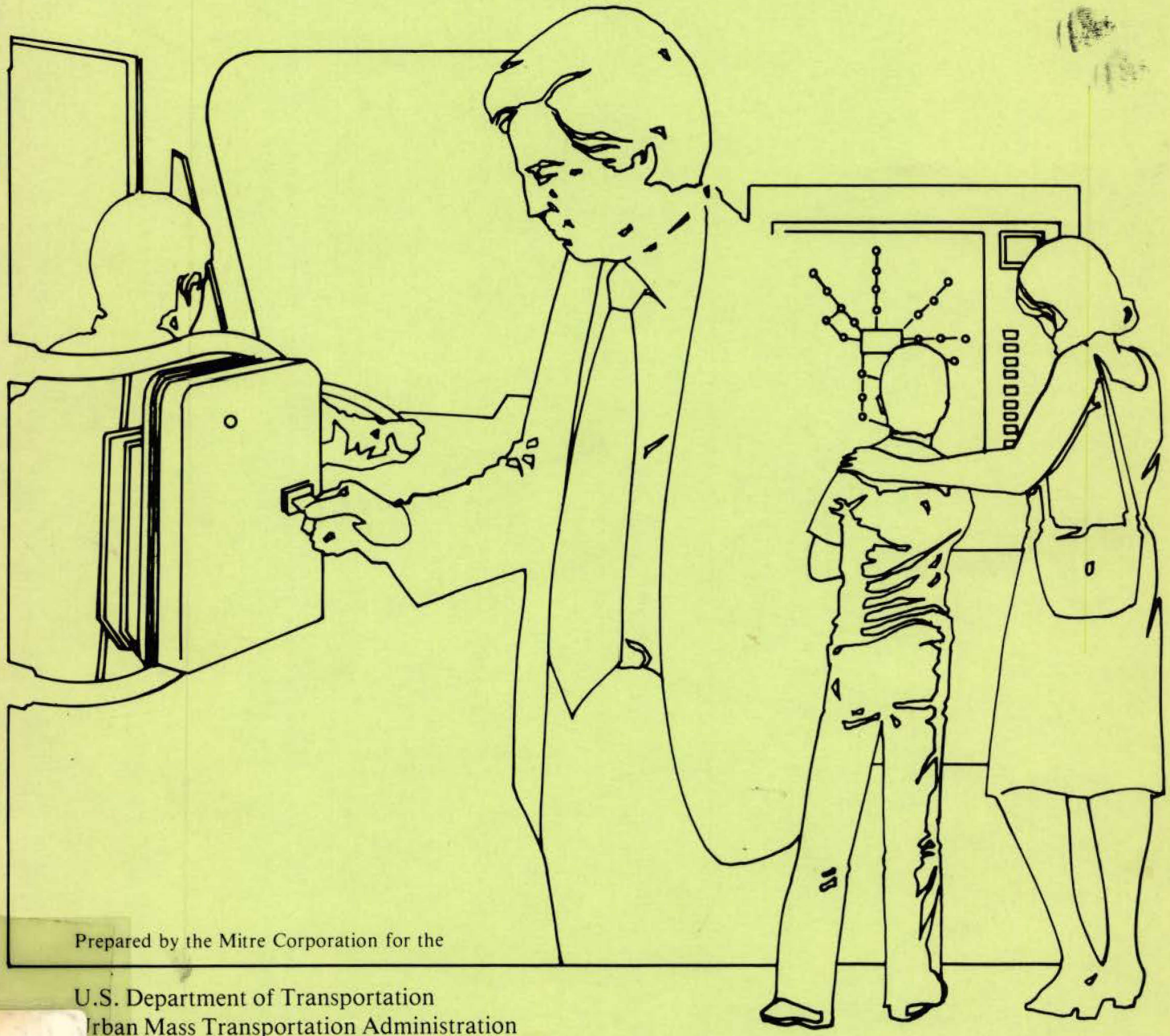
Self-Service Fare Collection

System Requirements



Prepared by the Mitre Corporation for the

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Washington, D.C. 20590

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16. Abstract

This document highlights and discusses the critical, non-hardware requirements for self-service fare collection and provides guidelines outlining the actions, procedures, policies and arrangements necessary to achieve a workable and efficient system. General requirements applicable across a range of specific system configurations are discussed in terms of the four major requirement areas identified--access, enforcement, information and support services. In addition, specific requirements associated with five variant SSFC system configurations are examined. These general and specific system requirements have been developed as a part of and, are intended to support, the on-going study and demonstration of self-service fare collection sponsored by the Office of Service and Methods Demonstration, Urban Mass Transportation Administration.

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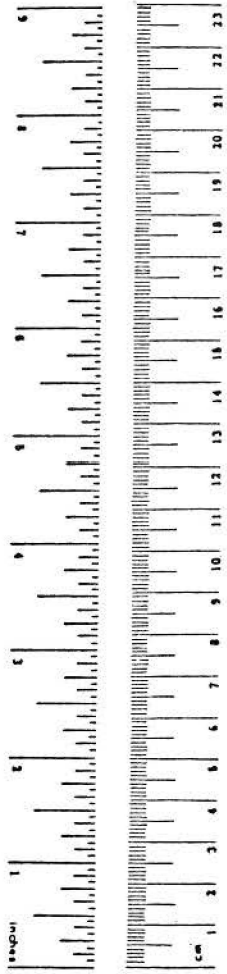
METRIC CONVERSION FACTORS

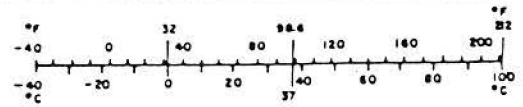
Approximate Conversions to Metric Measures

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



Approximate Conversions from Metric Measures

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



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1. INTRODUCTION

As part of its efforts to increase transit system productivity, the Office of Service and Methods Demonstration of the Urban Mass Transportation Administration is sponsoring several demonstrations of the self-service fare collection (SSFC) systems developed by European transit properties. These systems assign greater fare payment responsibility and autonomy to transit passengers and employ fare payment documents--tickets and passes--and special automated equipment to enable passengers to "serve" themselves.

As currently refined by European properties, such SSFC systems include a number of complex, interrelated functions:

- Information Dissemination
- Ticket and Pass Distribution
- Ticket Validation
- Ticket and Pass Inspection
- Equipment Maintenance
- Revenue Collection
- Data Collection
- Accounting and Audit Control

The functional diagram in Figure 1 suggests the nature and importance of the relationships among the various functional aspects of SSFC systems. The principal objectives of SSFC systems are the provision of greater passenger autonomy in fare payment activities and the minimization of vehicle driver involvement in fare collection enforcement. To achieve these objectives and to realize the benefits to be derived from the SSFC approach to fare collection, system designs must provide for the performance of the functions indicated, taking into account the inter-active nature of the various functions indicated.

Self-service fare collection systems take a variety of approaches to the achievement of these goals but have certain elements in common. The most visible common element is special equipment for dispensing and processing transit tickets. Observation and study of operational SSFC systems indicate, however, that other, less visible elements are equally critical for SSFC system effectiveness and workability. These include those elements which provide for:

a. unrestricted passenger access to transit service;

b. fare regulation enforcement based upon systematic spot checking;

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c. fulfillment of expanded information needs;

d. fare collection system services.

In most conventional fare collection systems, vehicle drivers control access and enforce fare payment through the fare collection process. They also serve as a major source of information about fares and routes. Minimizing driver involvement and reducing the amount of interaction with passengers requires that alternative arrangements be made for the performance of these functions. SSFC represents a systematic, integrated approach to the making of such arrangements and requires careful matching of equipment and non-hardware support elements to self-service objectives and procedures.

The purpose of this document is to highlight and discuss critical non-hardware system requirements for SSFC and to provide, for transit properties participating in SSFC demonstrations or interested in the SSFC concept, guidelines outlining the actions, procedures, policies and arrangements necessary to achieve an effective and workable self-service system. The delineation and discussion of SSFC system requirements focuses on what is necessary for the establishment and operation of such a system beyond a commitment to the implementation of the self-service concept and procurement of SSFC hardware. Section 2 discusses general SSFC system requirements applicable across a range of specific system configurations. Section 3 examines five variations of the general requirements for these alternative configurations and specific requirements generated by the configurations themselves. Section 4 reiterates key SSFC elements through a summary of key requirements and stresses the importance of total system design for effective demonstration and implementation of SSFC systems.

2. GENERAL REQUIREMENTS

Four requirement areas--access, enforcement, information and support--are particularly important for the effectiveness and workability of the SSFC approach to fare payment and collection. In order to develop and implement a SSFC system, transit properties must make changes and adjustments to their current practices and adopt new practices in these operational and support areas. None of these changes, adjustments or innovations can be made in a random or isolated fashion. Instead, provisions and arrangements in each requirement area must be designed to fit into and reinforce the provisions and arrangements in other requirement areas. The nature of the relationships among the various elements which make up SSFC systems are indicated in the functional diagram presented in Figure 1.

The system requirements generated by SSFC must also be related to the context of specific transit systems, i.e., fare structures, route configurations, system priorities and objectives, and the final SSFC system design product for any given transit system should reflect the nature, requirements and constraints of that system. While this document cannot specify the exact nature of the changes, adjustments or required innovations for particular transit systems or particular system configurations at specific sites, it does outline a framework of requirements for specific system design efforts and indicates the areas and directions in which change, adjustment and innovation must take place in order to develop a successful system. This will be accomplished through the identification and discussion of key requirements in the four major requirement areas and the tracing of a number of key relationships among requirements and requirement areas.

2.1 Access

A major distinguishing characteristic of SSFC systems is the provision of less restricted passenger access to transit service than that offered by conventional fare collection systems. Passengers board transit vehicles or enter boarding areas without being completely monitored or controlled by vehicle drivers, station attendants or automatic equipment. The purpose of such monitoring or control in conventional fare collections systems is, of course, to ensure the payment of fares by all passengers. The techniques evolved for SSFC enable transit systems to dispense with this monitoring of all passenger fare payment. In SSFC systems, passengers purchase fare payment documents--tickets or passes--which serve as proofs of payment throughout the transit journey. These documents provide a basis for transit system verification of proper fare payment through a program of

spot checking or random inspection. The fare payment documents are used to demonstrate payment to roving inspectors; this eliminates the need for passengers to pay a fare or present proof of payment to vehicle drivers. With this restriction removed, transit properties can make alternative arrangements for passenger fare payment and system fare collection. Fare payment documents can be made available for passenger purchase in a variety of forms and in a variety of locations. Once purchased, these documents allow passengers virtually unrestricted access to transit service and enable transit properties to use an alternative means of verifying fare payment. The use, therefore, of fare payment documents which permit both unrestricted passenger access and adequate fare enforcement is a key SSFC system requirement.

2.1.1 Fare Payment Documents

In order to fulfill this dual function, the fare payment documents provided by transit systems must have certain characteristics. They must:

a. be suitable for wide and varied distribution, e.g., for machine vending or for sale in various kinds of retail outlets,

b. be capable of bearing information necessary for the enforcement of fare regulations, i.e., value, notice of fare regulation requirements, necessary trip data, and, in the case of passes, passenger identity,

c. be readily inspectable, and

d. be resistant to counterfeiting, misinterpretation and/or alteration.

Fare payment documents used in SSFC systems take the form of tickets and passes since these media can be easily designed to fulfill the above requirements. Tickets can be made available in a variety of forms and values and can be distributed in a number of different ways. Passes, while not always suitable for machine vending, can be distributed or sold in a variety of ways and can be offered in a variety of values or for various time periods. Because both tickets and passes are flexible and adaptable media, transit systems can, and should, design fare payment documents tailored to the particular nature of individual fare structures and/or fare payment objectives.

2.1.2 Ticket Validation

Both tickets and passes are capable of bearing the information required for fare enforcement. The exact kind and amount of information required for effective fare enforcement, however, will vary according to the nature of particular fare structures and the type of payment document used. Because passes typically authorize unlimited transit use for specific time periods, the primary information requirement for enforcement is passenger identity and period of validity. While the value of a given ticket is usually imprinted on it at the time of purchase, specific information must be indicated at the time of use. This process of encoding or imprinting a ticket with usage information is called cancellation or validation. In flat fare systems, value and time and date of use would be sufficient information for enforcement. In systems with more complex fare structures, more specific trip data, i.e. trip origin, line or route number, must be added in order for the tickets to serve as proofs of payment for given trips. This information allows inspectors or checkers to verify proper fare payment. In addition, therefore, to providing suitable fare payment documents, transit systems must also provide a means by which the specific information necessary for fare enforcement can be added to tickets in order to establish their validity for a given trip. Fulfillment of this requirement is accomplished through the use of special cancellation or validation devices. The processing of tickets by this equipment results in a specific receipt for payment of a trip fare; this receipt can then be used as proof of payment for a given transit journey. Because of the significance of this receipt for SSFC system operation, it is necessary:

a. to make obtaining the receipt (processing the ticket) as convenient and foolproof as possible--validators must be visible and accessible so that passengers can have no plausible excuse for not validating a ticket;

b. to ensure that the receipt is wholly sufficient to tie the fare payment document to the trip, i.e., that it contain whatever information is necessary to identify where and when the ticket is valid so that misuse and misinterpretation are minimized;

c. to ensure that the information added to the ticket can be easily interpreted by inspectors so that fare verification can be performed accurately and quickly; and

d. to ensure that passengers can determine if their ticket has been properly validated so that they are not penalized for system error (e.g., a validator printing the wrong zone code or time and date information on the ticket).

2.2 Enforcement

SSFC systems are designed to provide virtually unrestricted passenger access to transit service and to ensure that there is adequate enforcement of fare payment regulations. The basis for fare regulation enforcement in SSFC systems is the spot-checking or random inspection of the fare payment receipts obtained by passengers prior to actual transit use and retained as proof of payment throughout the transit journey. For effective enforcement, however, transit systems must do more than simply provide fare payment documents and deploy inspectors throughout the transit system. An overall enforcement program which supports and reinforces the actual on-the-spot inspection process must be established. The goal of the fare enforcement process, as of most other enforcement processes, should be to encourage passenger compliance with regulations through employment of visible, creditable deterrents, i.e. penalties for non-compliance. To ensure that enforcement is effective, creditable, and equitable, transit systems must identify and assess the legal authority available to them for fare enforcement efforts, establish standards and policies for enforcement and penalization, and design a framework for the on-going administration of a comprehensive enforcement program.

A useful analogy for thinking about and planning for the kind of enforcement program required for SSFC systems is parking enforcement where somewhat similar conditions and methods are found. Parking control programs usually involve establishing defined parking regulations and areas, communicating to the public the intent to enforce regulations, monitoring parking regulation compliance, issuing citations (or towing cars) and enforcing payment of fines. Parking regulations are typically observed when drivers feel that there is a strong probability that their cars will be ticketed if they park illegally, when penalties are sufficient to warrant compliance, and when penalties are enforced. Effective parking control requires

consistent, concerted enforcement activity from a variety of sources, e.g. policy-makers, courts, enforcement personnel, and depends on the establishment of enforcement creditability. Similarly, fare enforcement requires consistent, concerted activity within a program framework which emphasizes the building and maintaining of the belief that fare regulation compliance will be required of all passengers.

2.2.1 Legal Authority

A critical first step in the development of a workable SSFC enforcement program for an individual transit system is identification of its legal authority to enforce fare payment and its specific authority to enforce fares by a system of random inspection. In general, a transit system must possess sufficient legal authority to:

a. require passengers to purchase and retain a ticket or pass,

b. require passengers to correctly identify themselves upon request,

c. require passengers to produce proof of payment upon the request of authorized personnel,

d. assess on-the-spot fines or issue citations, and

e. seek court enforcement of fare violation penalties.

Survey and review* of the existing legal authorities of U.S. transit systems has indicated that there is a wide range of authorities which might be useful for fare enforcement but that, because enforcement of this type is unconventional in U.S. terms, existing powers may have to be supplemented or new authorities obtained. If particular elements of the required authority are not available to a transit system, alternative strategies may have to be developed and adopted. For example, if passenger identification cannot be demanded, passes might be designed to include passenger photo I.D.'s. Or, if the assessment of on-the-spot fines is not within the power of a

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*Eiseman, Gloria G., "Self-Service Fare Collection--Volume IV: Legal and Labor Issues," MTR 79W0087-04, The MITRE Corporation, McLean, VA., August, 1979.

transit system, citations similar to those used for parking enforcement could be issued. The diversity of local legal environments makes generalization about available legal authorities extremely difficult. Transit systems wishing to adopt SSFC must carefully assess the particular nature and extent of authority available to them locally. Identified authorities should then be matched to the minimum general requirements outlined in order to determine whether or not a workable enforcement program is feasible and in what direction it should be shaped. In many ways, the establishment of sufficient legal authority is the necessary pre-condition for the defining of more specific operational procedures and enforcement policies as well as for development of the SSFC system as a whole.

2.2.2 Enforcement Policies

Once sufficient legal authority has been identified or obtained and its exact nature is known, transit systems must outline the policies which will govern the enforcement and penalization process. Policies must be developed which establish or define:

a. the standards for determining and proving fare regulation violation,

b. the violations subject to penalties and whether penalties will vary by type of violation or type of violator,

c. the type of penalty to be assessed, i.e., on-the-spot fines or citation,

d. the level of penalties to be assessed,

e. the means of administering reinforcing penalties, and

f. the contingency procedures to be used if disputes arise or a passenger cannot pay.

Transit systems may develop these policies along a number of different lines since within each element there are a number of alternatives. Table I shows how various operational European SSFC systems have gone about establishing penalties and levels of penalties.

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TABLE 1 - FARE ENFORCEMENT IN SELECTED EUROPEAN TRANSIT SYSTEMS

	Number Of Inspectors	Number Of Inspectors Per Million Annual Passenger Trips	Percent Of Ridership Inspected	Base Adult Fare ($)	Base Fine ($)	Ratio Of Base Fine To Base Fare	Reported Fraud Rate (%)	Inspection/Fining Characteristics
BERN	12	0.15	5.0	0.41	13.70	33.3	1	Uniformed inspectors operating alone. On-the-spot fines.
BRUSSELS	5-10[a]	0.02-0.05[b]	NA	0.67	16.67	25.0	5	Uniformed inspectors and other transit employees check fares. On-the-spot fines.
COLOGNE	85	0.51	1.4	0.75	10.00	13.3	3	Inspectors in pairs and plainclothes. On-the-spot fines.
GENEVA	12	0.17	2.5	0.68	27.40	40.0	1	Uniformed inspectors operating alone and in teams. On-the-spot fines not used.
The HAGUE	27	0.36	1.0	0.58	2.50	4.3	9.9	Uniformed inspectors operating in teams. On-the-spot fines.
MILAN	100	0.16	1.0	0.35	6.25	25.0	1.2[e]	Inspectors operating in teams of 2 or 3. On-the-spot fines.
MUNICH	123[c]	0.28	3.0	0.75	10.00[d]	13.3	1.4	Two-three times a month 100% inspection at a U-Bahn or S-Bahn station. On-the-spot fines

[a] Additionally, approximately 200 other transit employees may inspect tickets.

[b] With inspections from (a), this figure may be 1.00.

[c] Seven more inspectors are in training and five more are authorized.

[d] As of January 1, 1979, the fine was increased to $20.00.

[e] Milan officially reports 1.2 percent fare evasion based on inspections performed during off-peak periods on surface modes. Fare evasion including peak period and subway ridership is approximately 8 percent.

The defining of specific standards and penalties for violation is important to the enforcement process; transit systems must let passengers know what violations are subject to penalty, the standards by which violation will be determined, what kind of penalties will be assessed and what kind of follow-up activity can be expected if fare regulations are not complied with. Standards and penalties should be equitable and reasonable. No class of rider should be singled out and riders in general should not be required to make extraordinary efforts in order to comply with fare regulations. If certain types of tickets or validation activities are to be required, passengers must be readily able to fulfill these requirements. Penalties should be high enough to deter fare evasion and enforced regularly to retain their credibility. Penalties may also be differentiated--by category of rider (student, elderly, tourist), by number of previous offenses and by type of infractions (no ticket, insufficient fare paid). When developing these policies, however, transit systems should also consider the administrative requirements associated with the type or number of penalties established and their effect on program efficiency. In general, standards and policies should be designed to encourage compliance and defined in terms of the particular requirements and constraints of given transit systems. The policies developed will be used to guide sustained operation and public orientation as well as to provide a basis for the enforcement program. As system ground rules, they should be realistic, implementable and appropriate for their particular settings and riderships and to the nature and amount of fare evasion or fraud expected within given transit systems.

2.2.3 Inspection Process

While enforcement programs for SSFC systems are built around the critical inspection process, the actual procedures for inspection and enforcement are relatively uncomplicated. Specific details may vary according to the particular objectives and preferences of given transit systems, but minimum procedures must include:

a. request for passenger proof of payment documents,

b. inspection of documents and verification of proper fare payment,

c. identification of fare violations,

d. assessment of fines, or other penalties (or issuance of citation),

e. maintenance of appropriate inspection records, i.e., records of violator identity, types and locations of violations, fines paid or citations issued.

These procedures should, however, be carried out within the context of an overall inspection strategy. Although the enforcement method used in SSFC systems is often referred to as random inspection, it is random only in the sense that it is based on probability and is not targeted toward either the entire passenger population or any identifiable individuals within that population. The premise of the enforcement method is that inspection of a defined sample of transit riders will uncover a given number of fare offenses and, more importantly, will establish the expectation that fare regulations will be enforced. The inspection process should be developed in terms of this goal of establishing in passengers' minds the expectation that fare regulation compliance will be monitored and enforced. This expectation is the result of establishment of enforcement creditability and may be directly influenced by the frequency and visibility of inspections and indirectly by passenger perceptions of inspection frequency and of the probability of being penalized for fare regulation infractions. There are a number of approaches which can be taken to the inspection process. Inspectors can operate singly or in teams; they can be uniformed or plain-clothed; inspection levels or rates can be high at certain periods and relatively low at other periods; inspection can also be targeted on certain routes or lines where fare evasion levels are high or can be diffused evenly throughout the entire system. The exact details of the inspection process should be formulated in terms of the particular conditions and enforcement objectives of specific transit systems.*

2.2.4 Administrative Framework

The inspection or checking of fare payment documents and the penalizing of fare regulation offenders should be performed as part of a larger, overall enforcement program. It is not sufficient to establish policies and deploy inspectors. A specific management framework for the planning and administration of the enforcement process is required if enforcement is to be

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*Examples and data obtained from study of operational enforcement programs which may be useful for the development of an inspection process may be found in the Legal and Labor Issues report cited previously.

effective, i.e. to minimize the level of fare evasion and fraud. Key tasks to be undertaken for a successful SSFC enforcement program include:

a. establishing an inspection process and deployment of inspectors in terms of an overall enforcement strategy,

b. collecting, monitoring and analyzing enforcement data, and

c. performing follow-up enforcement.

As indicated previously, the process of spot checking is not random in the sense that there is no method or plan involved. The rate of inspection and the specific locations and times at which inspections will be undertaken should be part of a deliberate, planned strategy for enforcement. In developing specific inspection levels and deployment plans, the particular fare enforcement problems of the transit system should be considered as well as the overall need to maintain a visible and creditable inspection presence.

In order to effectively deploy inspectors and carry out inspection procedures within the context of an overall enforcement strategy, various kinds of data relevant to the enforcement process must be collected, monitored and analyzed. Much of this data will be gathered by the roving inspectors and would include: types of offenses, time and location of offenses, offender identity and penalties assessed. The monitoring and analysis of this data will enable transit systems to identify patterns or trends in fare evasion and to respond appropriately. Inspection levels and inspector placement can be adjusted to meet changed conditions or new enforcement needs. The results of the data analysis should be constantly fed back into the inspection planning and administration process, and transit systems should emphasize flexibility and responsiveness in their approach to enforcement. Effective response to conditions encountered will be, in part, a product of the quality of the data and its analysis and the degree of attention paid to the results of the monitoring and analysis effort.

Although the primary focus of enforcement activity is the on-site inspector, this primary enforcement activity must be followed up in a systematic manner. Procedures for ensuring that deferred fines are paid and for seeking any necessary court enforcement of penalties must be developed. This kind of follow-up activity helps to establish and maintain the

credibility of the enforcement program and is particularly important if transit systems issue citations rather than assess on-the-spot fines. Specific arrangements should also be made for the handling of repeat or chronic fare violators and scofflaws.

2.3 Information

Although supplying passengers with various kinds of system usage information is an accepted part of transit systems' operational activities, the information needs presented by SSFC are more extensive and more critical to system operation. Passengers are assigned more responsibility for fare payment and will not, as a matter of course, be interacting with vehicle drivers or other information sources; penalties will be assessed for misuse of the system. The need for usage information in SSFC systems is also increased because this approach to fare payment and collection is new to American transit riders and differs significantly from traditional fare payment and collection practices. Transit systems adopting SSFC must, therefore, be prepared to meet these expanded information requirements. The operations expected of passengers in proposed SSFC systems must be examined and the information needed to carry out these procedures identified. Careful attention must also be directed to the dissemination of required information throughout a system. If the full benefits of self-service are to be realized, passengers should be able to use transit service without depending on vehicle drivers for basic usage information. When adopting a SSFC system, transit systems are, in effect, deciding not to use vehicle drivers to direct passenger fare payment and as the primary immediate source of usage information for passengers. Transit systems must, therefore, make adequate alternative arrangements for information provision. The making of these arrangements entails the development of a comprehensive information program so that the information provided throughout a system meets the various levels of rider needs, appropriately supports system operation, and reinforces rider awareness of the procedures associated with transit use. The primary reference point for the development of an information program should be the transit consumer and, in order to ensure the effectiveness of such a program, transit systems should:

a. elicit the support, input and assistance of transit consumer with attention paid to the needs of the transit disadvantaged,

b. link information dissemination activities to planning, marketing, public relations, and training activities,

c. develop strategies which take advantage of a variety of media and types of information aids,

d. arrange for the testing, monitoring and evaluating of proposed information aids, and

e. respond appropriately to consumer feedback.

In designing or developing an information program, three general kinds of information needs must be recognized and met if a SSFC system is to operate effectvely: notice of fare payment regulations, general system usage information, and specific system usage information.

2.3.1 Notice of Regulations

When adopting a SSFC system, transit systems are obligated to make passengers aware of the regulations governing the new fare payment system. This requirement is critical because of its legal implications; passengers might rightly object to being penalized for fare evasion if the required procedures and governing regulations are not clearly indicated throughout the system. Required information would include notice that:

a. fare payment documents must be purchased, validated (if necessary) and retained;

b. fare payment documents are subject to inspection;

c. specific penalties will be assessed for fare regulation violation; and

d. these penalties will be enforced through follow-up action if necessary.

Although such notification is particularly important during the introductory period, it should also be continuously provided to accomodate new riders and visitors and to reinforce enforcement efforts. To ensure adequate notification, information regarding regulations and required procedures should be provided through a variety of means, e.g. system orientation brochures, signs, transit schedules, tickets, and in a variety of

locations--particularly in those locations where passengers begin a transit journey, such as transit stations and bus stops.

2.3.2 General System Usage

Two kinds of general system usage information should be provided to passengers. They should be able to gain an understanding of both the overall operation of the SSFC system and the individual actions necessary to use transit service properly. An understanding of the overall operation should provide a meaningful context for the required individual actions. It may, for example, seem more reasonable to be required to retain a transit ticket if it is understood why such a document is required and the role it plays in facilitating self-service. The provision of this general overview type of information would be strongly linked to initial system implementation efforts and to the marketing and public relations activities of transit properties. The more detailed general operational information concerning the actual procedures to be used for fare payment should be particularly prominent at transit service points, i.e. stations or stops. Passengers should have ready access to sufficient information to make them feel comfortable and confident about using transit; the needs of new riders, visitors, and occasional or inexperienced riders should be given considerable weight in the development of information aids for general system usage. If a rider who is totally unfamiliar with the operation of the fare collection system can successfully carry out the required procedures, the informational assistance provided can be considered to be effective. Although specific procedures will vary by specific SSFC configuration, basic system usage information should include:

- how fare payment documents are obtained
- where they can be obtained
- how they are to be used
- if and how they are to be validated
- where and when they are to be validated.

2.3.3 Specific System Usage

Additional specific information is also required to support the on-going use of transit service in SSFC systems. Since passengers are expected to determine and pay their fares with little or no assistance from vehicle drivers or other attendants, the information necessary to do this must be widely available. The amount and kind of information will vary according to the nature of given fare structures, the types of fare payment documents used, and the kinds of services available. Transit

systems with complex fare structures and an array of available services will have more extensive and complex information requirements than those with relatively simple flat fare structures. Whatever the exact nature of this fare structure and services, passengers should be provided with the information necessary for them to:

a. accurately determine the proper fare for particular trips, and

b. select the most advantageous fare or fare payment option.

Except in flat fare systems, it will not be sufficient to simply post fare schedules. Passengers must be able to relate their specific trips to specific fare amounts in order to purchase sufficient and appropriate proofs of payment. This involves providing system maps which indicate major or common destinations as well as more specific street routings. It also involves providing full pricing information including any fare differentials in effect.

2.4 Support Services

In order for SSFC systems to operate in a smooth sustained manner, transit systems must make arrangements for providing both initial and on-going support services for the fare collection system. New personnel, i.e. inspectors, must be hired and trained; current personnel must be acquainted with new procedures. The fare payment flexibility made possible by SSFC will not act as an incentive for increased transit use if the tickets or passes necessary are not readily available, or if passengers are unaware of their existence. Vending and validating equipment cannot facilitate passenger self-service if it is not operating properly. General system requirements for SSFC include, therefore, providing for both administrative support--training, ticket/pass distribution, marketing/public relations and general administrative services and equipment support--maintenance, revenue collection and machine stocking.

2.4.1 Administrative Support

The general administrative support services required for conventional fare collection-- record keeping, accounting, data collection--will also be required for SSFC, but particular administrative procedures may have to be modified in order to meet SSFC requirements, e.g. controlling fare payment document sales. Some of the new administrative requirements under SSFC

have already been discussed in the enforcement section of this paper. Additional requirements are also presented by the expanded use of fare payment documents, the need to train inspection personnel and retrain and orient current personnel, and the need for and desirability of expanded or intensified marketing and public relations efforts.

2.4.1.1 Fare Payment Document Distribution

Since the purchase of fare payment documents by all or most passengers is a required element in all SSFC systems, provisions must be made for the distribution and sale of these documents. In many SSFC configurations, the primary method for making tickets available is machine vending. Even in SSFC systems that use vending machines extensively, however, arrangements are usually made for the sale of passes, which are often not suitable for machine-vending, through a network of retail outlets, i.e. banks, newstands, and small retail stores. Transit systems may also develop special transit property-operated sales points throughout the system. Such retail outlets typically offer a range of available tickets as well as passes and may be equipped with small ticket vending machines to facilitate the sale and control of ticket and pass stock. These kinds of arrangements present a number of administrative requirements. A network of such outlets may have to be developed which involves: arranging with individual firms or chains of firms to sell these documents at their facilities; setting up revenue collection, stocking and auditing procedures; and negotiating the payment of a commission on sales. Efforts should be made to locate such outlets widely and evenly throughout the transit system so that they are accessible and convenient and to ensure that potential transit riders know where they are located. These efforts must be made not just in response to isolated administration requirements but as part of an overall system requirement for a retainable proof of payment and are, therefore, a particularly significant aspect of SSFC systems development and implementation. The minimization of driver involvement in fare collection can only be accomplished if alternative fare payment points are widely and conveniently available.

2.4.1.2 Training

Although much of the operational activity associated with SSFC is carried out by passengers, there are also significant new and modified functions to be performed by transit system personnel. Preparations for implementing a SSFC system should, therefore, include provisions for training or retraining relevant operating personnel and for the general orientation of transit

system staff. Maintenance and revenue collection personnel, for example, will have to become familiar with new equipment and procedures. The major training requirements for SSFC implementation, however, involve the new enforcement staff and vehicle drivers since these employees will play the most active role in system operation and will be the primary points of passenger contact with the transit system. Their performance as transit system representatives will, to a considerable extent, influence both the effectiveness and the acceptance of the new approach to fare payment, collection and enforcement. Training should provide positive orientation and reinforcement for this role as well as specific operational skills and information.

For many transit properties the hiring and training of inspectors will be a new undertaking. Although many transit systems employ security guards or special transit police, their duties and activities are considerably different from those of inspectors in SSFC systems. In developing a training program for inspectors, therefore, transit properties should look closely at the functions and procedures to be carried out by inspectors and ensure that sufficient information, orientation, instruction and opportunity for skill development are provided. In general, inspectors will have to have detailed knowledge in three areas:

- fare structure and fare payment documents
- service networks--routes/stops
- enforcement policy and authority

Knowledge of the fare structure, payment documents and system network is necessary for the verification of proper fare payment. In order to ascertain whether or not a passenger has paid the proper fare, the inspector must be able to determine the proper fare based on his knowledge of the system and the information on the fare payment document receipt. In effect, the inspector computes the correct fare for the passenger's trip up to the point of inspection and checks to make sure that the ticket's value is sufficient. This activity requires computational skill and practice as well as an information base.

Inspectors must also be trained to carry out defined procedures and assess the stated penalties for fare violations. Careful training will help to ensure that consistent procedures and penalties are being applied throughout the system and will give inspectors confidence in their inspection and enforcement authorities. Training should give inspectors an overall understanding of enforcement policy and underlying legal authorities as well as the details of violation standards and penalties. They should be fully aware of how they may and may not conduct

the inspection process and what penalties to apply as well as what actions to take when confronted with disputes, controversies or emergency situations.

Another major training area for inspectors would be interaction with the public. Inspectors should be trained to deal with passengers who may be upset or angry because of inspection or penalty assessment. Training should include specific guidance for approaching passengers and requesting proof of payment as well as the most effective way of handling penalty assessment. The manner in which inspections are carried out is important for their effectiveness and for SSFC's acceptance by the public. The training process will play a significant role in shaping an inspector's attitude toward his/her duties and motivating him/her to conduct them in a positive way. Since the roving inspectors will be in direct contact with passengers, they are part of the public relations component of transit systems and can expect to be called upon for assistance by passengers. Inspectors should be encouraged throughout the training process to interact constructively and responsively with passengers and to view their work positively.

The training of vehicle drivers will provide an overall understanding of the new fare collection and enforcement process as well as specific training for their role in it. Since the role of the vehicle driver is altered significantly in SSFC systems, the training process should also be aimed at pointing out the driver benefits of the system and at securing support for the new approach. Drivers' roles will vary according to specific SSFC configurations, but drivers, like inspectors, will be a prime information and assistance resource for passengers. The retraining of vehicle drivers should prepare drivers to help passengers become accustomed to the new system as well as to carry out any residual fare collection and enforcement responsibilities. They will also have some role monitoring the performance of SSFC equipment, e.g. a point for passenger complaint that equipment is malfunctioning.

Other employees should also be exposed to the overall workings of the new SSFC system so that they can assist the riding public and support the development and implementation process which will affect many aspects of the transit system. With proper instruction and motivation, all transit property employees can participate in the information dissemination and marketing processes in an informal way.

2.4.1.3 Marketing/Public Relations

Marketing and public relations efforts can play a highly significant role in SSFC system implementation and operation. In most cases, the information requirements associated with SSFC will be handled and met by marketing/public relations personnel during both system initiation and regular operation. In order to make current passengers and potential passengers aware of and receptive to the new fare collection methods, SSFC will have to be sold to the public. Transit properties can also take advantage of the marketing opportunities presented by a changeover to SSFC, e.g. implementation of discount or incentive fares, to encourage greater use of available transit service. Ideally, the introduction and operation of a SSFC system can be part of a larger effort to market transit services in general. Recognition of the importance and desirability of deliberate marketing activities on the part of transit systems is still a fairly recent phenomenon in the United States; increasing amounts of research and operational experience are, however, becoming available for use by transit systems wishing guidance and suggestions in this requirement area. Much of this information has been derived from study of European systems employing SSFC techniques; the consensus of those studying such systems appears to be that the marketing effort is significantly greater. Some portion of the benefits attributed to SSFC techniques may, in fact, be derived from concurrent marketing activities. European systems focus on serving the market for transit and, therefore, have a strong consumer orientation; SSFC is a part of this marketing philosophy. This fact suggests that the full benefits of SSFC may be best realized when such systems are implemented within the context of an overall consumer-oriented marketing strategy.

2.4.2 Equipment Support

The maintenance of any equipment to be used is an important element for successful SSFC operation. Transit properties should ensure that they have the resources--staff, space, equipment--to adequately maintain any required equipment. This capacity must include the ability to perform unscheduled maintenance as well as routine preventive maintenance. In SSFC systems using special fare collection equipment, both the passengers and the transit system itself are, to a great extent, dependent on this equipment. Prolonged malfunction of required SSFC equipment could lead to passenger inconvenience and/or service disruption. Ensuring smooth, uninterrupted SSFC operation entails the organization of a maintenance program which meets the particular requirements of specific SSFC configurations and equipments and

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usually involves the deployment of special field maintenance teams. The varying maintenance requirements of alternative SSFC configurations should be taken into account during the system development process and matched to transit properties' ability to provide an adequate level of maintenance support. Sophisticated SSFC equipment cannot contribute to the success of a SSFC system if it cannot be properly maintained.

Somewhat similar provisions must also be made for the collection of revenue from and the restocking of vending machines. While transit properties have established procedures for the collection of revenue from transit vehicles equipped for conventional fare collection, new procedures will have to be established for the revenue collection and restocking associated with SSFC equipment. Depending on usage, capacity and security considerations, revenue collecting equipment will have to be emptied at given intervals. If ticket vending machines are employed, arrangements will have to be made to keep them supplied with tickets. Failure to remove money and/or restock tickets may lead to equipment malfunction, service disruption, passenger inconvenience and/or revenue loss through theft. The revenue collection and restocking process may involve the use of special field teams to service scattered, off-vehicle equipment which would also set up new accounting and auditing requirements. As in the maintenance area, these requirements should be taken into account in system planning and design since they may require expansion of transit systems' current support capacities.

3. ALTERNATIVE SSFC CONFIGURATIONS AND ASSOCIATED SYSTEM REQUIREMENTS

The identification and discussion of general, non-hardware system requirements in Section 2 was based on a generalized SSFC system concept to highlight certain constituent elements of such systems and to provide insight into their nature and their relationships to each other and to the fare collection system as a whole. This section, through an examination of the non-hardware requirements associated with five alternative system configurations, outlines the implications of particular equipment configurations for these non-hardware requirements since the five systems vary principally in their use of special SSFC equipment. The purpose of this delineation is twofold. One, it describes, for the guidance of transit properties wishing to participate in SSFC demonstrations or to adopt the self-service approach to fare collection, specific requirements associated with five alternative configurations identified as suitable for demonstration and implementation in the United States. The requirements outlined in Section 2, while broadly applicable to all SSFC systems, are further specified, modified or refined in response to particular equipment utilization decisions. Two, delineation of more specific requirements associated with particular configurations also helps to demonstrate the kinds of effects varying equipment configurations have, in general, on SSFC system requirements. This should assist transit properties developing a SSFC system to put together systems which reflect their own properties, conditions and characteristics but do not conform to any one of the five configurations identified. It is important to recognize, for example, that if a SSFC system is almost completely automated, information dissemination requirements will be greater since there is a decrease in driver participation in fare collection and enforcement and, consequently, in interaction with passengers. If, on the other hand, a SSFC system is only partially automated and continues to rely to some degree on driver participation in fare collection and enforcement, the requirements for information sources other than the driver are not as great.

To a greater or lesser degree, the specific amount and location of SSFC equipment to be used affects each of the four requirement areas discussed in Section 2. In the discussion which follows, these effects are identified as system requirements specific to particular configurations. Since a range of configurations is presented, a range of effects is to be expected. Two of the configurations make extensive use of special SSFC equipment and their requirements, therefore, closely adhere to the general systems requirements outlined. A third configuration

uses a minimal amount of specific SSFC equipment; its specific system requirements are, therefore, farther removed from the general requirements. In order to avoid unnecessary repetition this section focuses on the requirements which are either intensified or made more significant for a particular configuration or which diverge from the general requirements.

3.1 Wayside Vending/Wayside Validation

The wayside vending and validation configuration is structured around extensive use of special SSFC vending and validating equipment. Both types of equipment would be located at all or most transit stops so that passengers can purchase and validate tickets before boarding the transit vehicle. This configuration can be characterized as a "full" self-service system; there is minimal fare payment and collection activity on-board the vehicle and, therefore, minimal driver involvement. In general, this configuration closely resembles the general SSFC model; specific requirements associated with it, therefore, closely resemble in intensified form the general system requirements.

3.1.1 Access

Since this configuration is based on extensive use of automated SSFC equipment, machine vendable tickets are required although both tickets and passes can also be made available at alternative sales points.

The wayside location of validation equipment also creates some specific requirements if tickets are to be made available on-board vehicles. Since there are no validators available aboard the vehicle, drivers would have to sell prevalidated tickets; these driver-validated tickets must, in zone or distance fare systems, bear sufficient information for inspector verification, e.g., trip origin. In systems with complex fares, the driver would have to be provided with a dispensing/validating machine to assist on-board sales.

3.1.2 Enforcement

Since the fare payment documents and means of validation necessary for enforcement of fare regulations are fully provided for in this configuration and readily accessible to passengers, the general requirements for enforcement outlined in Section 2.2 are sufficient for establishment of an adequate enforcement program.

3.1.3 Information

In addition to the general requirements outlined in Section 2.3, this configuration requires the provision of both general system usage information and specific trip/fare information at all or most stops since passengers will be expected to purchase and validate tickets prior to boarding the vehicle and, will not have access to a vehicle driver or attendant for assistance. Transit systems must, therefore, ensure that enough information to properly operate the vending and validating machines and obtain a proof of payment is available at all or most stops.

It is particularly important to indicate at all or most stops that validated tickets or passes are required for transit use since, in order to gain the advantages of this full self-service configuration, on-board sales should be minimized. If passengers are to be discouraged from obtaining tickets on-board, they must be given adequate warning that pre-purchase and validation are expected.

3.1.4 Administrative Support

An important additional administrative requirement is the specific design of an initial marketing/public relations effort for the introductory phase of SSFC implementation. This approach to fare payment is significantly different from conventional approaches and will require extensive educational and promotional activity to facilitate and encourage initial usage.

3.1.5 Equipment Support

The extensive use of automated fare collection equipment in this configuration involves concomittant maintenance requirements. Equipment will be located at numerous, scattered sites, and adequate maintenance arrangements will require the formation of mobile field teams capable of on-site servicing of equipment. This is particularly crucial for the performance of unscheduled equipment maintenance. Maintenance requirements are increased by the strong probability that a high proportion of the equipment will be located in unprotected wayside locations, leaving them exposed to adverse environmental conditions and the threat of vandalism.

Revenue and ticket stocking requirements are similar to the maintenance requirements. Revenue must be collected and tickets restocked at numerous scattered locations, and service and support arrangements will require mobile collection and stocking units.

3.2 Wayside Vending/On-Board Validation

The major difference between this configuration and the all wayside mode previously discussed is the location of validation equipment on-board transit vehicles. Like the all wayside configuration, it is a full self-service system since passengers have no need to interact with vehicle drivers and extensive access to automated vending and validating equipment. The specific requirements for this configuration are, for the most part, virtually identical to those for the all wayside configuration except in the maintenance area and, to a lesser degree, the enforcement area.

3.2.1 Access

Since, like the all wayside configuration, this configuration is based on extensive use of automated SSFC equipment, machine vendable tickets are required although tickets and passes can also be made available at alternative sales points. Because validators are located on-board the vehicle, drivers can, if desired, sell tickets which passengers validate themselves. This eliminates the requirement in the all wayside configuration for the issuance of pre-validated tickets.

In systems using zone or distance fares, some arrangement must be made to reset the validation equipment as the vehicle travels from zone to zone so that the correct zone of origin can be indicated on the validated ticket.

3.2.2 Enforcement

Although, in general, the enforcement requirements outlined in Section 2.2 apply to this configuration, the location of validating equipment on-board the transit vehicles has some effect on the enforcement process--particularly in systems with zone or distance based fares. Passengers may be tempted to defer validation until an inspector is spotted or until another zone has been entered (which would reduce the price of the trip). There are several ways to discourage this practice and efforts should be made to do so--particularly during the period of initial operation. The use of plain-clothed inspectors to monitor ticket validation and establishment of failure to validate upon boarding as a fare regulation infraction are possible tactics. Another might be to arrange via radio communication to have on-board validators disabled or shut off immediately prior to an inspector boarding the vehicle. Whatever the tactics used, the goal must be to establish the creditability of fare regulation enforcement in order to discourage passenger attempts to beat the system.

3.2.3 Information

Like the all wayside configuration, this configuration requires the provision of both general system usage information and specific trip/fare information at all or most stops since passengers will be expected to purchase tickets before boarding the vehicle and will not have access to a vehicle driver for assistance. Transit systems must, therefore, ensure that enough information is available for passengers to properly operate the vending machines and obtain a proper fare payment document at all or most stops. It should also be made clear to boarding passengers that they must validate these pre-purchased tickets at the time of boarding in order to comply with the fare payment regulations.

3.2.4 Administrative Support

Administrative support requirements are the same as those for wayside vending/wayside validation since the primary difference between the two configurations is the placement of validation equipment.

3.2.5 Equipment Support

While the revenue collection and ticket stocking requirements for this configuration are the same as for the all wayside configuration, the equipment maintenance requirements are significantly different. The vending equipment will require, as indicated previously, the formation of mobile field teams for the performance of both preventive and unscheduled maintenance. The validating equipment, because of its placement on-board the vehicle, can be maintained as vehicle equipment. Preventive and scheduled maintenance can, therefore, be performed along with regular vehicle maintenance activities. Unscheduled maintenance needs, however, present a more difficult problem. Validator break-down or malfunction could potentially affect vehicle operation since it is a major component of the fare collection system. To avoid the possibility of service disruption and/or vehicle down time, specific arrangements must be made for unscheduled maintenance, en route validator replacement, and validator redundancy on each transit vehicle.

3.3 Selected Location Vending/On-Board Validation

This configuration differs from the wayside vending configuration in terms of the amount of vending equipment used and, therefore, the extent of automated ticket issuance capability throughout the system. Automated ticket vending machines would be located

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selectively, e.g., in high usage areas or at major transfer points. No defined number of machines would be called for and vending equipment could be placed in protected, secure areas. This configuration is essentially a less-automated, full self-service system and can be implemented incrementally be gradual addition of more vending equipment.

3.3.1 Access

As in the wayside vending configurations, machine vendable tickets are required; these tickets must also be made available at alternative sales points where passes can also be sold. If gradual implementation is a transit system objective, an alternative ticket sales point could be the vehicle driver. This would, however, constrain the variety of fare payment options which could be made available; validation, however, could still be performed by passengers. This SSFC system could also operate with minimal driver sales if suitable alternative ticket sale arrangements were made.

3.3.2 Enforcement

This configuration's enforcement requirements would be the same as those for the wayside vending/on-board validation configuration since the primary difference between the two configurations is the amount of vending equipment used.

3.3.3 Information

General system usage information is the major information requirement for this configuration along with, of course, the general requirement for notification of fare regulations. Since machine ticket vending capability is limited, the amount of information required for the operation of automated ticket machines is less than those required by the totally automated configurations. Operating and specific fare/trip information must be available at vending machine locations, but is not required at all or most stops. The amount and kind of information to be made available regarding specific fares or specific trips or fare payment options are, to some extent, dependent on the level of driver involvement desired. If driver involvement were to be minimized, passengers would have to be provided with sufficient information at all ticket-purchase locations; if tickets are to be obtained from the driver, passengers should be provided with sufficient prior information to be able to deposit the correct fare and receive a receipt or ticket in exchange. If so desired, drivers could continue to act as primary source of information regarding specific fares for specific trips.

3.3.4 Administrative Support

The major administrative requirement for this configuration is the development of alternative ticket and pass distribution points. Since there is only a limited provision for automated vending, systemwide ticket availability can only be accomplished through driver sales, which are disadvantageous from an efficiency standpoint, or through a network of retail ticket and pass outlets. Unlike the wayside vending configuration, the selected location vending configuration requires a supplementary ticket sales network if the benefits offered by SSFC are to be realized through minimization of driver involvement.

The configuration also presents some specific marketing and public relations requirements. The most visible effect of its implementation will be the general system use of tickets rather than payment of cash fares aboard vehicles. Special efforts will have to be made to promote ticket pre-purchase and to make riders aware of ticket sales locations--both automated and non-automated--since riders may not encounter the vending machines as they cannot help but do in the wayside vending configurations. Since the change to SSFC may be less noticeable in this configuration, passengers may tend to continue to rely on drivers as the primary point for fare payment. It is incumbent upon the marketing segment of the transit system to ensure that riders and potential riders know about the various ticket pre-purchase options available.

If extensive driver sale of tickets is envisioned, driver training should also include instruction in ticket sales and the operation of any ticket issuing equipment to be used. Training will also have to be provided for those selling tickets in retail outlets. Passengers will be using these agents as information resources regarding fares and payment options, and the sellers will have certain record-keeping and accounting functions to perform. They may also be using small-scale automated ticket issuing devices which would necessitate instruction in their operation.

3.3.5 Equipment Support

While the maintenance requirements associated with the use of automated vending and validating equipment would be less extensive for this configuration, specific maintenance arrangements must be made for the on-board validators, for the limited number of vending machines to be used and, possibly, for the

ticket issuing equipment to be used by retail outlets and/or drivers. As in the wayside vending configurations, the potential scattering of vending equipment throughout a transit system requires a capacity for both preventive and unscheduled field maintenance. Since the vending and issuing equipment can be located in protected, secure areas, however, the amount of unscheduled maintenance should be less than in the wayside vending configurations. The on-board validators would present the same maintenance requirements discussed in connection with the wayside vending/on-board validation configuration.

Similar requirements would be presented for revenue collection and ticket restocking. While there would be fewer automated ticket vending machines in the system, revenue would have to be collected from the limited number of machines and arrangements made for the collection of revenue from ticket and pass retail outlets. The vending machine ticket stock would have to be replenished and ticket and pass stock supplied to the retail outlets.

3.4 Driver Monitored On-Board Validation

This SSFC configuration makes use of only one of the two basic types of SSFC equipment--the automated validation devices. Passengers cannot obtain fare payment documents from vending machines; pre-purchased tickets and passes are available only through retail outlets. A single validator would be located on-board the vehicle near the driver and all passengers would board via the driver door in order to buy a single trip ticket, validate a pre-purchased ticket, or present a pass. This configuration constitutes a partial SSFC system; certain SSFC features--passenger validation of their tickets and enforcement of zone and differential fares by inspectors--are employed, but unrestricted access is not provided. In flat fare systems, it is really a prepayment configuration. Because of the nature of this configuration, there are a number of variations in the general requirement areas discussed in Section 2.

3.4.1 Access

Since no automated vending equipment is used in this configuration, there is no requirement for machine vendable tickets, but tickets suitable for use in the validation equipment must be used. Tickets and passes would be available through retail outlets, but single trip tickets would also be sold by vehicle drivers. Regardless of the type

of fare document used, all passengers would be required to pass by the driver: passholders would show a pass; ticket holders would validate tickets. The driver would be responsible for monitoring the use of the validator by ticket holders as well as for selling single trip tickets and ensuring that all passengers have some kind of fare payment document. Since validation of tickets is required and there is only one on the vehicle, provisions must be made for speedy replacement of a malfunctioning validator or a suitable back-up method of validating tickets in an emergency so that service is not disrupted.

3.4.2 Enforcement

This configuration requires some modification of the SSFC enforcement process outlined in Section 2.2. Driver monitoring of the use of the validators and checking for fare payment documents is a partial form of fare enforcement. This activity on the part of the driver ensures that base fare payment is made. In flat fare structures, this could constitute sufficient enforcement of single trip fares. In zone based fare structures, passengers will compute the proper fare themselves, deposit cash into a conventional fare box, and receive the single trip ticket requested. The driver is not expected to verify the correctness of the stated fare. This activity will be performed by roving inspectors who, in zone or distance based systems, will verify sufficient payment and ticket and pass validity. Even though automated validators are used, the use of inspectors will ensure that the proper fare document has been validated, e.g. not an old ticket or a counterfeit.

3.4.3 Information

This configuration has essentially the same information provision requirements as the selected location/on-board validation configuration except that no machine operation information is required. In zone or distance based systems, specific fare/trip information must be available at stops so that passengers can compute their own fares.

3.4.4 Administrative Support

The administrative requirements for this configuration are the same as those for the selected location vending/on-board validation configuration since both require ticket and pass sales outlets in order to offer widespread self-service.

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3.4.5 Equipment Support

The equipment support requirements for this configuration are considerably less than those for the previously discussed configurations. The only SSFC equipment to be serviced is the single on-board validator and, possibly, a ticket issuing device to be used by the driver. Since these are located on-board the vehicle, preventive maintenance can be performed during regular vehicle maintenance. Special arrangements, however, are required for unscheduled maintenance of the single validator. Maintenance units must be prepared to repair or replace these devices quickly so that any vehicle down time which could result is minimized.

3.5 Minimal Hardware

This configuration incorporates certain SSFC features but uses none of the special equipment associated with automated SSFC systems. As a partial SSFC system, it introduces the SSFC concept to a transit system without requiring investment in special equipment. Fare payment documents are required of all passengers. Certain passengers--those using passes--are provided with unrestricted access to the transit vehicle; enforcement personnel verify possession and proper use of payment documents. In the minimal hardware configuration, however, drivers continue to be involved in the fare collection process although their enforcement duties are substantially reduced. The amount of driver participation in fare collection and the potential for the streamlining of passenger boarding would be determined by the proportion of pass usage. Because this fare collection system is relatively simple and does not involve special SSFC equipment, specific system requirements are also minimal.

3.5.1 Access

In order to use transit service, passengers must obtain a fare payment document. In this configuration, only driver-issued single trip receipts and passes are to be used, however, since there is no provision for a means of validating multi-trip or pre-purchased single trip tickets. Passes could be made available in a number of ways, e.g. at sales outlets, by mail. The single trip receipts, however, are only available through the vehicle driver; there are no provisions for alternative sales of single trip tickets. The only requirement for these receipts and passes is that they bear the information needed for inspection. In flat fare systems, the receipts would only have to indicate time and date of issuance. In systems using

using zone or differential fares, the receipts would have to indicate time, date, trip origin, line or route number, and amount paid. In this situation, drivers would need a ticket issuing device to facilitate the receipt preparation process. There are no additional or special requirements for passes beyond the normal indication of passenger identity and period of validity. As indicated previously, pass holders would not be required to present the pass to the driver, but all other passengers would be required to obtain a fare payment receipt from the driver.

3.5.2 Enforcement

The general requirements outlined in Section 2.2 would apply to this configuration since passengers are required to possess a proof of payment and there is no provision for driver inspection of passes.

3.5.3 Information

Because this configuration continues to place considerable reliance on vehicle drivers for fare collection, the need for additional or alternative information provision is significantly decreased. Passengers will still have to be notified of the requirement to obtain and retain a proof of payment document in the form of a single trip receipt or pass, but specific system usage information regarding fares for specific trips is not necessary. Extensive provision of general system usage information is also not required since, for the most part, the passenger will follow procedures similar to those currently used for fare collection in most transit systems.

3.5.4 Administrative Support

There are no particular administrative requirements associated with this configuration beyond those generally outlined in Section 2. It should be noted, however, that this configuration is structured around the use of passes to gain SSFC benefits. To enhance the self-service characteristics of this configuration passes must be widely and conveniently available, and their use should be encouraged and promoted. The distribution and marketing of passes are, therefore, important elements for the success of this configuration.

If drivers are to use ticket issuing devices, instruction in their use should be provided for training programs.

3.5.5 Equipment Support

The only equipment which might require support would be ticket issuing devices used by drivers. These devices could be maintained and stocked as part of normal vehicle servicing processes. Revenue would be collected in the traditional manner.

4. SUMMARY OF KEY REQUIREMENTS

Table II summarizes key non-hardware requirements for the development and implementation of self-service fare collection systems; transit properties wishing to use the self-service approach to fare collection must make arrangements fulfilling these key requirements in order to achieve successful, workable systems. Although special SSFC equipment plays a central role in the development and implementation of SSFC systems as is recognized in Section 3, this outlining and discussion of system requirements has focused almost exclusively on non-hardware considerations. The purpose of this exclusive focus is to highlight and emphasize requirements which may be over-shadowed by equipment considerations and, therefore, overlooked in system development. The summary of key requirements presented in Table II is intended, therefore, to serve as a general checklist for system planning and design efforts and ensure consideration of these critical elements.

Presumably, equipment requirements for particular transit systems adopting SSFC will be developed on the basis of the characteristics, objectives, and resources of those systems, and it is likely that general equipment requirements developed by particular systems will correspond to one or another of the five SSFC variations or configurations discussed in Section 3. Equipment utilization and configuration decisions, however, cannot be undertaken in isolation, since, as indicated in Section 3, the amount and location of equipment have considerable effects on other fare collection system elements. A decision, for example, to fully automate ticket sales should take into account the implications of extensive use of automated vending equipment for fare regulation enforcement, system information and system support activities. The procurement and placement of SSFC equipment does not create a SSFC system; attempts to use such equipment without creating an adequate system framework may result in both inefficient fare collection and passenger resistance to self service. Sections 2 and 3 have sought to outline the elements which comprise such a system framework so that available SSFC equipment can be integrated into an overall fare collection system which functions smoothly and effectively for both transit properties and transit riders.

TABLE 2 - SUMMARY OF KEY REQUIREMENTS

In order to facilitate passenger self-service and less restricted access to transit service, SSFC systems must include

√ fare payment documents (tickets, passes) which can

- be widely and readily distributed
- bear any necessary specific trip/fare data

√ a means of adding specific trip/fare data to tickets (validation).

In order to enforce fare payment in a SSFC system, transit systems must have

√ authority to

- require passengers to purchase and retain a fare payment document
- require passengers to produce proof of payment documents upon the request of authorized personnel
- require passengers to identify themselves upon request
- assess on-the-spot fines or issue citations
- enforce fare violation penalties

√ enforcement policies which

- define violations subject to penalty
- set standards by which violations will be determined
- establish penalties for fare violations
- describe nature of follow-up activity

√ enforcement program which

- establishes an overall plan or strategy for "random" inspection
- governs the deployment and performance of inspection personnel
- ensures the monitoring and analysis of enforcement data and outcomes
- conducts follow-up enforcement activities

√ inspection procedures which include

- request for passenger proof of payment document
- inspection of document and verification of proper fare payment
- identification of fare regulation violators
- assessment of fines or issuance of citations
- maintenance of appropriate records

TABLE 2- SUMMARY OF KEY REQUIREMENTS (Concluded)

In order to fulfill the obligation to warn passengers of fare payment regulations and penalties and to promote effective passenger self-service, transit systems adopting SSFC must provide

√ notice of regulations governing fare payment which state that

- payment documents must be purchased and retained
- payment documents are subject to inspection
- penalties will be assessed for fare regulation violation
- penalties will be enforced through follow-up action

√ general system usage information which indicates

- how fare payment documents can be obtained
- where they can be obtained
- how the documents are to be used
- if and how they are to be validated
- where they can be validated

√ specific system usage information for fare computation which provides

- trip data--routes, stops, available service
- fare data--ticket and pass prices, cost of service, available fare options and differentials

In order to ensure the smooth, sustained operation of an SSFC system, transit systems must provide

√ administrative support for the handling of

- general administrative needs
- ticket and pass distribution
- staff training
- marketing and public relations

√ equipment support for

- preventive and unscheduled maintenance of on-board SSFC equipment
- preventive and unscheduled maintenance of off-vehicle SSFC equipment--formation of mobile maintenance teams
- service of off-vehicle vending equipment--revenue collection and restocking

While it is beyond the scope of this paper to outline the specific means by which the identified requirements can be fulfilled for particular transit systems, an immediate intended use is as a guide for SSFC demonstration project development and implementation. Transit properties selected as demonstration sites will be participating in the translation of the SSFC concept into specific operational system designs. These designs, of course, will be strongly shaped by site specific concerns and conditions. Fare policies and structures and service and fleet configurations will do much to determine the nature of equipment utilization and the arrangements to be made to fulfill non-hardware system requirements. The point to be stressed, however, is that active consideration of and attention to a range of concerns--site characteristics, equipment configurations, and system support elements--are necessary for both the development of an effective SSFC system and the conduct of a successful demonstration project. The non-hardware requirement discussed have considerable significance for demonstration project performance as well as for SSFC system operation--particularly requirements involving data collection and analysis and equipment support. Transit properties participating in the SSFC demonstration project must be able and willing to participate effectively in the careful planning and evaluation of the operational SSFC systems which are the intended outcomes of the proposed demonstration project.

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