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PASSENGER SAFETY AND CONVENIENCE SERVICES IN AUTOMATED GUIDEWAY TRANSIT

VOLUME I: DATA COLLECTION, SCENARIOS, AND EVALUATION

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FINAL REPORT

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16. Abstract

In conventional transit operations, vehicle operators and station attendants have been assigned secondary roles connected with passenger safety and convenience services (PS&CS). Giving directions, offering personal assistance to the ill, the handicapped or the confused and even providing first aid to the injured are among the services routinely provided. These same services must be provided on AGT in order to establish passenger acceptance of an unmanned environment and to ensure their safety, comfort and well being. This report provides information related to accommodating passenger safety and convenience services for AGT systems. Included are:

- o Literature and personal interview findings documenting methods/procedures for detecting and resolving PS&CS problems in current transit operations.
- o Scenarios depicting potential PS&CS problems applicable to AGT systems.
- o Selection of methods/procedures from current practices for detecting and resolving PS&CS problems in AGT.
- o Analysis and evaluation of the effectiveness of selected candidate methods/procedures.
- o Recommended methods/procedures for accommodating PS&CS problems in AGT.

The final objective is a Guidebook detailing the most effective methods and procedures for providing PS&CS in AGT systems. The Guidebook is Volume II, Report No. UMTA-MA-0048-79-5.

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PREFACE

The U.S. Department of Transportation's Urban Mass Transportation Administration (UMTA), in order to examine specific Automated Guideway Transit (AGT) developments and concepts, has undertaken a new program of studies and technology investigations called the Automated Guideway Transit Technology (AGTT) program.

The objective of one segment of the AGTT program, the Systems Safety and Passenger Security Study (SS&PS), is the development of guidelines for the assurance of actual and perceived passenger safety and security in AGT systems. This work has been contracted, through the Transportation Systems Center (TSC), to a team composed of Dunlap and Associates, Inc., the University of Virginia, and the Vought Corporation.

The Systems Safety and Passenger Security (SS&PS) study has involved six related but separate tasks. Three were concerned with the development of guidebooks dealing with 1) passenger security, 2) evacuation and rescue, and 3) passenger safety and convenience services. A fourth task required the development of a passenger value structure model; a fifth involved research on the retention of seated passengers during emergency stops; and a sixth involved the conduct of a joint Government and Industry workshop to review and revise the three guidebooks.

The Passenger Safety and Convenience Services task has as its objective the production of a guidebook detailing the most effective methods and procedures for providing passenger safety and convenience services in AGT systems.

The author wishes to acknowledge the time and cooperation received while visiting various transit properties in the U.S. and Canada. Without the cooperation of transit officials and other experts, completion of this task would have been impossible. The author also wishes to thank the UMTA and TSC technical personnel for their assistance in the performance and documentation of this work, and in particular Duncan MacKinnon and Robert Hoyler, program manager and monitor respectively for UMTA, and Donald Sussman, project monitor for TSC, and his professional associates, Janis Stoklosa and Walter Hawkins.

METRIC CONVERSION FACTORS

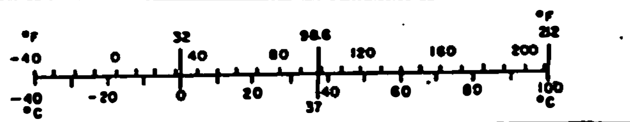
Approximate Conversions to Metric Measures

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

*1 in ≡ 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

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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EXECUTIVE SUMMARY

This report documents the results of a study conducted to produce a guidebook detailing methods and procedures for detecting and resolving the occurrence of Passenger Safety and Convenience Serivce (PS&CS) problems for Automated Guideway Transit (AGT). These methods and procedures are needed in providing aid or special assistance to the lost or confused, the ill or injured or the elderly and handicapped passenger. In other cases, they are associated with system related malfunctions such as inoperative fare equipment, graphics and doors. The methods and procedures also address passenger needs associated with abnormal weather, large crowds, fire/smoke and other related transit emergencies.

In conventional transit, station attendants and vehicle operators are available to detect and resolve special passenger problems. In the unmanned AGT environment, routine passenger services are typically provided through automation. However, when equipment or passenger failures occur or other abnormal events interrupt these automated services, it is important that these situations are detected and resolved in a timely manner. To establish passenger acceptance of unmanned systems and to insure their safety, recommended methods and procedures have been generated to accommodate these abnormal occurrences.

In performing this task, currently used methods and procedures for both conventional and AGT were compiled through interviews with transit officials and by review of available literature. The resulting data were systematically screened, analyzed and assessed for their effectiveness in accommodating potential passenger problems in future AGT systems. The resulting recommended methods and procedures for accommodating Passenger Safety and Convenience Service (PS&CS) in AGT are provided in Chapter 5 of Volume II. These methods and procedures address means of detecting and reporting as well as responses to thirteen different types of passenger problem occurrences.

Each problem area discussed was analyzed with respect to four basic detection methods (CCTV, sensors, passengers and AGT personnel) to determine which one or combination was most effective for detecting specific problems. Likewise, four basic response methods (voice communications, dispatching AGT personnel, remote control and altering system operations) were assessed for the most effective response to specific problem occurrences. Negative implications and cost considerations associated with each recommended method and procedure have also been identified. Where applicable, new and untried methods have been addressed.

CHAPTER 1. INTRODUCTION

A. Statement of the Problem

Automated Guideway Transit (AGT) represents a concept aimed at providing more service per unit of labor than taxis, buses or conventional rapid transit. The thrust of automation in AGT systems is directed not only at the development of driverless vehicles, but also towards its application to such other service as passenger information systems, safety, security, ticketing and fare collection.

Along with their primary roles as drivers, ticket sellers and collectors, and on-board attendants, transit personnel have in the past been assigned secondary roles connected with passenger safety and convenience services. The presence of trained personnel on or about the transit system has represented the key interface in handling passenger problems, particularly those resulting from passenger disabilities in the many forms they can occur. Giving directions, offering personal assistance to the ill, the handicapped or the confused and even providing first aid to the injured in the case of accidents are among the services they have provided. These same services must be provided on AGT in order to establish passenger acceptance of an unmanned environment and to ensure their safety, comfort, and well being.

Because AGT systems are essentially unmanned, the possibility exists that passenger problems may go undetected for long periods of time, unless means are provided for the passengers to readily make known their needs. Disfunctioned passengers may require detection by some external means. User/operator communications associated with passenger emergencies must be optimized. Improved methodology for detecting, responding to and accommodating passenger needs must be further defined for AGT applications.

Telephones, two-way radio communication, public address systems, and CCTV are all possible means of improving the passenger/operator interface associated with detection and notification. However, these are not the total solution, and can in themselves create severe workload demands on system operators. All facets of problem detection and resolution must be considered and practical solutions developed.

B. Objective and Scope

1. Objective

The major objective of this task was to produce a guidebook detailing the most effective methods and procedures for insuring passenger safety and convenience services for AGT systems. Its contents provide guidance for AGT system planners and designers engaged in assessing proposed methods and procedures. Recommended solutions have been evaluated as to effectiveness cost, frequency of need and social considerations. Negative implications of recommended methods and procedures have also been documented.

It should be noted that the primary intent of this document is to provide guidance associated with abnormal occurrences that have an impact on routine passenger services or safety. These abnormal occurrences may result from people or equipment related failures or may be associated with the presence of large crowds, severe weather or fires and related emergencies. The intent is not to provide specific guidelines for handling routine passenger services and safety measures. It has been assumed that the normal equipment, facilities and operating procedures that provide these routine services are adequate. It has been further assumed that vehicles and stations are not routinely manned.

2. Scope

This study has assessed current practices for providing passenger safety and convenience services as applicable to highly automated transit systems. Guidelines have been developed suggesting methods and procedures to provide these services for AGT systems.

This effort was based upon the following subtasks:

- Data collection involving literature reviews and personal interviews to define current practices used for providing passenger safety and convenience services.

- Development of scenarios depicting realistic AGT problems.

- Selection of candidate methods and procedures for AGT problem resolution. New and untried methods have also been identified.

- Evaluation of selected methods and procedures.

- Preparation of a final guidebook containing recommended methods and procedures.

As a major part of this task, methods have been developed and assessed that offer solutions to:

- Detection and reporting of passenger safety and service needs.

- Response to accommodate detected passenger needs.

CHAPTER 2. TECHNICAL APPROACH

The technical approach used to produce the comprehensive guidebook for provision of passenger safety and convenience services for AGT systems is outlined below in narrative form. Figure 2-1 provides a schematic diagram which outlines the major subtasks involved.

1. Data Collection - A computerized literature search, interviews with private and government transportation experts and contacts with others have been conducted to document current practices for providing passenger safety and convenience services.

2. Scenario Development - Scenarios have been developed using collected data to depict realistic passenger safety and convenience service problem areas as applicable to AGT systems. Selection, weighing and functional grouping techniques have been applied to yield a manageable set of scenarios.

3. Methods and Procedures Selection - Collected data has been used to select appropriate safety and convenience services methods and procedures evaluated against defined scenarios. New and untried methods and procedures have also been addressed.

4. Methods and Procedures Evaluation - Evaluation Criteria has been applied to the selected methods and procedures to assess their effectiveness in resolving the scenario situations.

5. Prepare Deliverables - Three interim reports and a final report were produced. This document represents the final report which is a composite of the various interim reports and contains the final guidebook in Volume II.

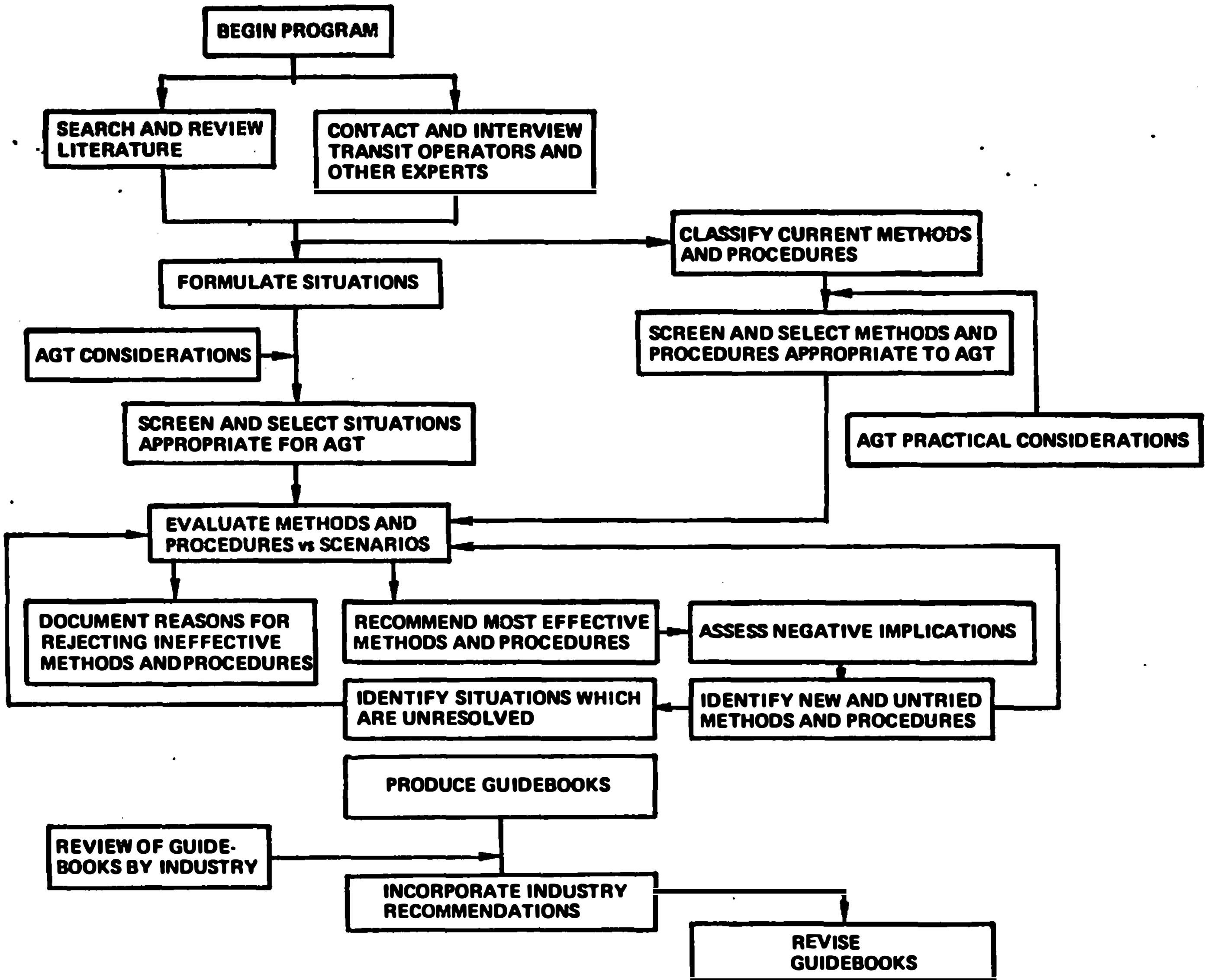

FIGURE 2-1. TECHNICAL APPROACH SCHEMATIC

CHAPTER 3. DATA COLLECTION

The Data Collection Subtask consisted of two separate parts: (1) a literature search, and (2) interviews with transit officials and experts located throughout the United States and Canada.

A. Literature Search

1. Description of Search

An extensive computerized literature search was conducted primarily through the use of several indices. The specific indices included the following six major file sources:

- Computerized Engineering Index (COMPENDEX)
- National Technical Information Service (NTIS)
- Smithsonian Science Information Exchange (SSIE)
- Transportation Research Information System Network (TRISNET)
- National Aeronautics and Space Administration (NASA)
- Defense Documentation Center (DDC)

Various other sources were explored in obtaining relevant data to this task. These included:

- Vendor contacts for literature on available equipment applicable to providing passenger service, i.e., turnstiles, fare collection, money changers, CCTV, smoke/fire sensors, sprinkler systems, elevators, escalators, graphics, etc.
- Review of numerous back and current issues of weekly and monthly transit journals.
- Requests for copies of publications and inhouse data which was relevant to Passenger Safety and Convenience Services from each transit system visited.

2. Screening of Document Abstracts

Results of the computerized literature searches produced a lengthy listing of documents with abstracts. Each abstract was carefully screened to determine its applicability to the Passenger Safety and Convenience Service Task. Documents which appeared applicable to this study were procured.

3. Document Examination

Documents received were reviewed for data pertinent to the various tasks. The number of documents that contained relevant information to passenger safety and convenience services for AGT systems was sparse. Typically most studies merely touch upon the type of services provided and briefly cover the equipment used. Specific operational methods and procedures or related problem areas for providing passenger service were almost never covered in depth.

4. Findings

a. General Survey Findings

As previously mentioned, the literature search, for the most part, provided little information that was directly relevant to passenger safety and convenience services for AGT systems. Published information on providing for the elderly and handicapped is quite extensive, whereas little written material exists on accommodating lost children or articles, aid to the illiterate, accommodation of large crowds, etc. Seldom, if ever, were methods or procedures for addressing contingencies, malfunctions or other abnormal events associated with providing these passenger services ever covered.

The following summary addresses those areas where information was most readily available. In some cases, the information contained herein is a summary of the literature findings. In other cases, where many pages of detailed design guidelines were presented in the literature, the specific documents are referenced.

Areas covered in this overview include:

- General Safety
- General Passenger Service

- Elderly and Handicapped

- First Aid

- Information Systems

b. General Safety

"Safety First" is being forced to take on new meaning in all forms of transportation that affect the public interest. The transit industry is under demand to insure the everyday movement of people not only swiftly, conveniently and economically, but with a priority directed to the issue of safety.

With the advent of AGT systems, this objective becomes even more important. Driverless vehicles must not only be safe; they must be perceived safe by the user, to ensure public acceptance and increased ridership. Although each transit property has its own safety programs, APTA has established a Passenger Safety Committee to bring transit properties together and co-ordinate efforts in achieving the above objective.

This committee has developed a series of safety guidelines for Urban Rapid Transit Systems.[1] Although these guidelines cover more than just the issue of passenger safety addressed in this study, they contain specific Transportation Operations and Emergency Procedures which are applicable to a number of areas of concern. Recommended guidelines for use during emergencies such as fires, equipment failures, flooding, bomb threats, etc., are provided.

Other System Safety related guidelines for urban mass transportation have been well documented.[2] These guidelines show how programs can be developed to ensure satisfactory operational safety levels. Extensive information is provided for establishing safety foundations, safety management and planning, safety analysis techniques, safety trade-off considerations, safety data bases, and safety standards and specifications. Numerous references are also included to allow the user to pursue in more depth those specific areas of concern.

c. General Passenger Service

In AGT systems, the immediate presence of transit personnel to provide passenger services will be absent or reduced. Thus, the need for improved or more sophisticated equipment becomes evident. Not only should this equipment provide the capability to furnish the routine passenger services, it should also include provisions that will aid in detecting and resolving various abnormal situations or malfunctions. New equipment will not only affect station and vehicle design but also central control.

Many of the passenger service needs for AGT systems are station related, consequently station design becomes more sophisticated than in the past. Several references[3,4,5,6,7] provide guidelines related to general station design. Topics and/or guidelines typically furnished by these references include:

- Station size and arrangements
- Passenger traffic patterns
- Stairs, ramps, escalators, elevators, moving walkways, loading platforms, etc.
- Turnstile/Entrance/Exit Control
- Ticketing Systems
- Parking
- Information Systems
- Public phones and communications
- Concessions
- Fire protection
- Lighting, ventilation, aesthetics, etc.

Although these references do not specifically address AGT systems, much of the information has some application to passenger safety and services for unmanned systems. Sussman[8], addresses more specifically the total AGT environment. This document provides design and evaluation criteria related to the human factors aspect of AGT. In many cases these human factor aspects are synonymous with passenger safety and convenience services. Reference 29 provides information related to the assessment of passenger safety and convenience services for an operational AGT system.

d. Elderly and Handicapped (E&H)

Provisions for the E&H are receiving increased attention in all forms of public transit and are well documented in the literature. Because of the special requirements of providing for the E&H in unmanned systems, this literature is referenced under the subcategories that follow.

1) E&H Regulations

Inadequate regulations and a lack of enforcement have hampered the accommodation of E&H by public transit in the past. Recent federal regulations[29] implementing the Urban Mass Transportation Act of 1964 and the Federal Highway Act of 1973 have done much to change this situation. Crain[9] provides a current summary of existing E&H regulations.

2) E&H Population

The number of E&H individuals who are potential riders of public transit will have a major influence on the scope of E&H provisions on AGT. Reference 10, 11, and 13 provide statistical bases for estimating the transportation ridership potential of both elderly and handicapped populations.

3) E&H Definition and Classes

Section 16(e) of the Urban Mass Transportation Act of 1964 defines the condition of transportation handicapped persons. In dealing with their accommodation on different modes of transportation it is desirable to further classify the handicaps involved and the degree of disability resulting. References 9 and 14 are helpful in this respect.

4) E&H Travel Barriers

Typical travel barriers which prevent or restrict the use of public transportation by E&H are well documented[9,10,13]. Assessments of barriers still existing on current systems and recommendations on their elimination are found in References 15 and 16. Design guidelines and detailed recommendations on elimination of E&H travel barriers are provided in References 9, 10, 11, 15, 17 and 18. Cost information on incorporating E&H provisions on WMATA are documented in Reference 11. Training of personnel for assisting E&H is furnished in Reference 19. Extensive bibliographies relating to other E&H transportation needs are covered in References 20 and 21.

e. First Aid

To better understand the need for first aid provisions in AGT systems, it would be desirable to know the types and frequencies of illness and injuries occurring in the public transit environment. This data is not documented but accident statistics do provide data on accident locations which may be categorized as follows:

- Station related accidents
- Boarding related accidents
- On-board related accidents
- Alighting relating accidents.

Literature from two sources[22, 23] reflects that the greatest number of accidents occur in the "station area" (approximately 60 and 80% respectively). "On-board" vehicle accidents occur next most frequently, followed by "boarding", and "alighting" incidents.

Accidents related to stairs (both fixed and motorized) are responsible for the majority of station related accidents. Stair related accidents, alone, out number all the combined incidents that occur in the area of "Boarding", "On-Board", and "Alighting". Station platform and ramp or passageway accidents are responsible for the second highest number of station accidents.

On-board accidents are primarily related to train movement or car equipment. Doors are responsible for the majority of Boarding and Alighting related injuries.

f. Information Systems

Signage, graphics and related passenger information systems are an area of major concern in public transit. Newspapers and transit periodicals frequently report on the confusion caused the passenger, the inadequacy of original signage designs and the fact that signage changes are continuously occurring in transit properties. This is a vexing and costly problem. Proposed revision of WMATA station signage was to cost $186,000 in March 1977 and this was for a system of which only a small initial portion had at that time been opened to the public.[24]

No graphics standards or guidelines exist for systems designers to use and apparently little coordination takes place between transit properties in this area.[3]

Efforts are underway to develop and assess a complete set of symbol signs for use in transportation - related facilities.[25] Preliminary guidelines have been produced in connection with this effort in order to illustrate the desirable application of these symbols to signage and accompanying word graphics.

Some regard that standardization of graphics and information systems is not feasible. Katz[3] feels that the New York passenger can be provided information in a totally different manner than someone in Chicago or San Francisco. Reference 26 indicates that the NYCTA has recently installed matrix-type signage for train timetables in all stations for two of its subway lines. The BART system, on the other hand, has found their original matrix-type charts unsatisfactory.

In addition to content or format, signage locations are of vital importance. Future AGT systems should reflect the "point-of-decision" concept as application to signage location. Frequently, all the information is displayed at one point, rather than providing the required information to a passenger as decision points are approached.[3]

The elderly and handicapped present even a further challenge to the information system designer. Many systems currently provide directional or warning information which depends solely on sight or hearing. When one of these facilities is absent or degraded in a user, confusion or danger to the passenger may result.[17]

B. Current Transit Practices

1. Transit Personnel Interviews

To obtain first hand information relevant to system safety and passenger security, a number of rapid transit and AGT properties were visited. The intent of these visits was to discuss and observe currently used methods and procedures that are relevant to all five tasks of this study. Discussions here will, of course, be limited to information relevant to Task III, "Passenger Safety and Convenience Services".

a. Properties Visited

Eleven operational sites were selected for visits and comprehensive interviews. These properties included:

- Seattle-Tacoma Airport (Sea Tac)
- Seattle Monorail
- San Francisco Bay Area Rapid Transit (BART)
- San Francisco Municipal Railroad (MUNI)
- Dallas/Ft. Worth Airport AIRTRANS
- Toronto Transit Commission (TTC)
- Morgantown People Mover (MPM)
- Washington Metropolitan Area Transit Authority (WMATA)
- Port Authority Trans Hudson (PATH)
- Port Authority Transit Corporation, N. J. (PATCO)
- Roosevelt Island N. Y. Aerial Tramway.

In addition, less extensive interviews were conducted during visits made to the following additional properties:

- Fairlane Detroit System
- Busch Gardens, Williamsburg, Va.
- Houston Intercontinental Airport Monorail

- Transit Expressway, South Park. Pa.

b. Interview Procedure

Prior to visiting each property, a data file was accumulated and reviewed to obtain a basic knowledge of the system. In addition, the investigation team toured each system just prior to the interview. This preparation provided better insight into system operations, reduced demands on the site personnel and allowed more time to discuss specific data needs. Typically the interviews began with the System Manager, Supervisor of Operations, etc. After an overview of the system, members of the investigation team paired up with various operational specialists to obtain data relevant to each task. Detailed discussions were typically conducted with specialists representing the following functions:

- Transit Police and Security
- Line Operations, Station Attendants, Central Control
- System Safety and Fire Safety Supervisors
- Marketing, Public Relations, Training
- Evacuation and Rescue
- Maintenance.

These visits proved to be a most vital source of operational information. Although more time would be desirable at each site, the contacts established made it easy to seek additional information by telephone when required.

c. Other Information Sources

In addition to the personal interviews and literature survey, other data sources included:

- Telephone contacts with firms known to have transit graphic experience to obtain information relevant to establishing some basic guidelines for providing graphics in transit applications.

- Telephone and/or personal contacts with government agencies concerned with Elderly and Handicapped (E&H) problems to ensure accessibility to all the latest E&H information.

- Wheelchair visit to Dallas/Ft. Worth Airport and AIRTRANS to assess first hand the problems that a wheelchair user may encounter in a typical AGT system.

2. Summary of Present Practices

A wide variety of methods and procedures are currently being used throughout the transit industry for accommodating passenger safety and convenience service needs. To simplify the task of summarizing these methods and procedures, information has been compiled into the following categories:

- Types of Problems
- Detection of Problems
- Communication Requirements
- Response Agencies and Procedures.

a. Types of Problems

Table 3-1 lists the passenger safety and convenience service problems identified as areas of concern for this study task. To properly quantify or rank these problem areas becomes a major undertaking and could in itself be a separate study. Although most sites keep daily logs on incidents and problems, little effort is made to reduce this data. Some transit properties have Customer or Public Relations Departments who handle passenger complaints. Most of these complaints, however, are centered around such things as train delays, scheduling, fare prices, security, etc., and do not cover all problem areas addressed by this task. During some visits, different operational personnel at the same property gave completely

TABLE 3-1. TYPICAL PROBLEMS RELATED TO PASSENGER SAFETY AND CONVENIENCE SERVICES

1. Medical/first aid provisions for ill or injured
2. Aid to lost and confused
3. Aid to the illiterate
4. Aid in recovering lost/strayed children
5. Aid in recovering lost articles
6. Aid to handicapped and elderly (H&E)
7. Identification and rectification of nuisance problems :
   - Inoperative directional/information signs/ announcements
   - Inoperative turnstiles, fare equipment, doors, etc.
   - Soiled vehicles and stations
   - Animals or foreign objects in system
8. Accommodation of special traffic - large crowds associated with sporting events, conventions, holidays, etc.
9. Provisions for abnormal weather
10. Fire/smoke detection
11. Passenger reassurance during delays and emergencies

different opinions on which were the most significant problems. Furthermore, a major problem at one property may be insignificant at another, because of system, equipment, or location differences.

However, it was found that some passenger safety and convenience service problem areas did more consistently occur from one property to another. The following are four problem areas that are of particular significance in both the world of rapid rail transit as well as AGT.

1) Lost and Confused Passengers

This is by far the most frequently occurring, although generally non-hazardous, problem addressed by this study task and one which becomes an increasing design challenge the closer we move to fully automated transit.

The majority of transit properties visited acknowledge that they have a problem with signage and the resulting passenger confusion, but the problem is not perceived as significant or requiring priority attention. There appears to be a tendency to blame the passenger with the frequently heard remark, "People don't read signs." This may be true, but further questioning uncovers additional findings as follows:

- Signs are poorly placed
- Too much information presented at individual decision points
- Combined use of signage and audio not exploited and coordinated
- Inoperative active (dynamic) signage with no passive backup
- Information or graphics is unclear
- Signage subordinated to aesthetic impact rather than passenger needs
- Sign systems do not provide complete origin to destination directions.

The transit properties generally describe signage change programs just completed, underway or being contemplated. Some have permanent multidisciplinary committees who meet and periodically take action. In most cases, the original signage provided by the architect or contractor proved inadequate. Many sites have gone through 2 or 3 complete signage changes.

Present practice includes the use of symbols, information signs, directions, route maps, fare information displays, station signs, dynamic or active graphics and audio announcements. Their use, however, is rarely approached by the properties as a total information system aimed at responding to passenger needs.

The "hassle" and confusion of public transit is believed by some to be a deterrent to increased transit patronage, but a strong impetus does not yet exit to mount a concerted attack on its correction. The work initiated on Symbol Signs,[25] mentioned earlier in this report, is a step in this direction and may lead a set of guidelines for the transit industry similar in scope to the Manual on Uniform Traffice Control Devices for Streets and Highways.[28]

2) <u>Inadequate or Inoperative Fare Equipment</u>

This is a non-hazardous but frequently occurring problem that is directly associated with automation.

Included here are the problems connected with automatic changemakers, ticketing, add-a-fare equipment, and the associated turnstiles. Most of these are reliability problems associated with Automatic Fare Collection (AFC) Systems using magnetic cards. Two of the three sites visited using AFC systems have made vendor changes in an effort to correct fare collection problems. Changemaking equipment also suffers from reliability problems, primarily because the equipment has not been designed ruggedly enough to withstand the heavy usage in a transit environment. These problems not only create a source of irritation to the passenger but create increased workload demands on the system operators. Even in systems where standard coin operated turnstiles are being used, numerous sources of irritation exist for the user. These include such things as:

- Difficulty in locating coin slot and then inserting coin (particularly for elderly and handicapped)

- Difficulty in negotiating turnstiles with packages or luggage

- Mechanically operated turnstile bars are a potential source of injury, particularly for passengers with luggage, or where turnstiles are inadequately marked and passenger attempts to exit through an entrance turnstile.

3) Elderly and Handicapped (E&H)

This is an infrequently occurring but a potentially hazardous problem of particular relevance to the future of AGT. The concern is not in respect to the system access provided for E&H, but their accommodation under emergencies.

Provisions for the E&H vary from systems that are totally incompatible to systems that are essentially barrier-free for routine E&H usage. Some of the older subway systems make no attempt to accommodate E&H and simply provide alternate transportation above ground, i.e., buses, vans, etc. Another system had strict E&H requirements imposed on the system after it was well into the construction phase and consequently had to provide E&H provisions as an add-on feature. This resulted in a system that for all practical purposes is barrier-free, but still contains sources of irritation and inconvenience for the E&H. However, the major problem confronted by every transit system which attempts to accommodate E&H is not during normal operations but during emergency operations. When evacuation and/or rescue is required, even the most modern systems have barriers which are not negotiable by a large portion of the E&H population unless personnel assistance is provided. The technology exists to overcome these barriers, but the cost of providing for such infrequent occurrences is extremely high.

4) Concern with Serious Injury

This is a hazardous but non-frequently occurring problem which is not cited in published literature but which is mentioned as a constant concern by the transit properties.

Any transit operation, irrespective of its safety efforts, has some degree of fear releated to passengers becoming seriously injured. Personnel, at one site with an unblemished safety record, openly admitted that their main passenger-related concern is the fear of eventually killing someone. Other sites do not as openly express this same opinion, but this concern is evident in the instinctive reaction to shut-off guideway power at the slightest sign of almost any problem. Suicide attempts by passengers deliverately jumping in front of moving vehicles is a common occurrence at several of the large properties and is an area of growing concern.

In AGT systems, a particular fear is expressed of passengers or transit personnel getting onto the guideway while vehicle operations are underway. This concern is more acute in systems with open station platforms, but is still articulated by officials at systems with fully enclosed stations and station doors. In the latter case, it is more directed at the conditions that can result from uncontrolled passenger evacuations onto guideways during vehicle delays or stoppages. In these situations, despite the precautions provided by the system, there is a risk of persons being struck by moving vehicles, contacting the power rails or even falling from elevated guideway structures. The opinion is expressed by some AGT personnel that an automated system should be able to protect passengers from injury to a greater extent than a conventional and manned system.

b. <u>Detection of Problems</u>

Current practices for detection of passenger safety and convenience service problems categorically fall into four areas:

- CCTV
- Special sensors
- Passengers
- Transit Personnel.

1) CCTV

Since transit personnel will be few in a true AGT system, CCTV and special sensors become increasingly important for problem detection. The current usage of CCTV is primarily limited to monitoring station areas. The intended use of the CCTV system, however, differs between operational sites.

In some systems, its primary function is safety related; monitoring an open platform area, with a secondary function of monitoring turnstile operations, etc. In this application, there is typically one TV monitor at central control for each TV camera in the system. The number of monitors may be as many as 24 and may require up to three people to continuously monitor the TV displays and handle the communications required. This approach appears to be very effective for monitoring an open platform or where turnstile jumpers or turnstile problems are a major problem. An area of concern arises here as to the number of monitors that one person can effectively monitor and for what period of time.

In systems with closed station areas, the CCTV systems are more typically used to monitor station crowds or the occurrence of abnormal or unusual events. In this application, as few as two monitors may be provided at central control to monitor up to 26 cameras. An automatic sequencing feature allows a systematic viewing of the various stations, along with the capability to manually select any desired camera. In addition, an automatic feature will instantaneously display the station where a vehicle or station malfunction has occurred. This type of application has certain limitations because of the interrupted viewing of camera access areas.

In other transit properties, such as WMATA and BART, the CCTV monitors are located in the station attendant booths. At WMATA, they serve primarily to monitor the station platforms, whereas at BART they are used to monitor elevator access.

CCTV also provides several other functions that have not been mentioned. These include such things as:

- Deterrence to crime and vandalism
- Reassurance to passengers that they are being watched over
- Smoke/fire detection

- Monitoring of routine station and vehicle door operations or unscheduled door openings in station area or vehicle/ station door alignment

- Monitoring of passenger loading

- Aid to detection of lost, confused or ill/ injured passengers

- Monitoring active (dynamic) graphics systems

- Detection of nuisance problems such as soiled stations, inoperative ticketing/ fare equipment, turnstiles, loss of station lighting, etc.

- Verification that vehicle is empty before rerouting or removing a vehicle from service.

In most of the operational sites visited, the CCTV cameras are fixed (no tilt, pan or zoom feature). In nearly all cases, operational personnel expressed a desire to have more flexible control over their cameras. It was also pointed out that while CCTV in stations is a deterrent to crime, improvements were needed to be effective in court for prosecution purposes. These requirements include color, video taping, plus tilt, pan, and zoom control.

CCTV is not being used operationally on transit vehicles at this time. However, this concept is being investigated on an AGT test vehicle operating in an airport environment. Cost and quality of picture have held back vehicle CCTV up to this time. If this concept proves feasible, vehicle CCTV should provide essentially all the same functions on the vehicle that have previously been discussed for station applications plus others. These other features include such things as: increased personal safety, and perception of increased personal safety by passengers on vehicles; reassurance of passenger safety to central control operators during system malfunctions, delays, or emergencies; verification of unscheduled door openings; verification that a vehicle is empty prior to rerouting or removing the vehicle from service, etc. These items become most critical with respect to passenger safety and convenience in future AGT applications.

2) Special Sensors

A variety of sensors and detectors are currently being used by operational transit properties. These include such things as smoke/fire/ionizing sensors, status indicators for change equipment, turnstiles, escalators, elevators, station doors, various classes of vehicle malfunctions, etc.

Smoke/fire sensors are being used rather extensively in station areas, sometimes in tunnels but apparently never onboard vehicles. Sensors in station areas are usually in equipment rooms or areas with the highest risk of fires. Alarms or indications associated with station or tunnel sensors are received either in station attendants booths and/or at central control and sometimes at local fire departments. The need for incorporating fire/smoke sensors onboard vehicles is still an area in question. There has been at least one reported situation where the trail car of a multi-car train was set afire and the vehicle was totally destroyed without the onboard operator/driver being aware of the fire.

3) Passengers

Passengers in current transit operations (both conventional and AGT) frequently serve as one of the means of detecting and reporting a variety of problem areas. However, to rely upon passengers as a reliable means of detecting and reporting problems in an AGT environment is unrealistic. Frequently, passengers do not have the knowledge, time or desire to become involved. In other instances, well intentioned passengers may provide information or assistance which may further compound a problem area. Furthermore, the absence of passengers in a system late at night creates a void in the detection process.

4) Transit Personnel

In most transit systems, the majority of passenger safety and convenience service problems are currently being detected and resolved by vehicle operators or station attendants. Other transit personnel such as security, fire, medical, evacuation and rescue, maintenance, supervisors and janitorial, will periodically become involved in special situations. At some sites, many of the specialists will constantly rove the system, thus detecting and resolving problems at random. Most carry radios and can easily be dispatched to needed problem areas. Other properties station these specialists at strategic locations throughout the system and central control will dispatch them as required.

c. Communication Requirements

The need for prompt and reliable communications is essential in the detection of and response to problems related to passenger safety and convenience services. A summary of currently used communication procedures are briefly outlined below:

1) Vehicle Communications

Typically passengers may address onboard vehicle operator or attendant in a conventional system by one of the following:

- personal contact
- actuate alarm (touch sensitive strip or pushbutton) and operator or guard will respond at next stop
- initiate pushbutton for 2-way communication with onboard transit personnel.

On an AGT vehicle, the passenger actuates a passenger emergency button or equivalent. This alerts central control, who in turn, initiates 2-way voice communications with the passenger. Some of the problem areas that were noted in different systems include:

- Some communication systems require the passenger to push a button to talk and release to listen. Often the passenger will not release the activation button, thus central control cannot communicate with the passenger.
- Some systems provide for 2-way communication, but central control has to rely upon the passenger to identify the vehicle and its location.

- In some situations, central control may receive an indication that 2-way voice communications is being requested by a vehicle passenger, but because of workload demands associated with another problem, it may be several seconds or even minutes before a response is made.

Anyone of the above could present a serious problem in situations involving a real emergency.

2) Station Communications

Passenger communication needs in the station areas are usually handled by some form of telephone system. These may vary from a courtesy phone (drop-line requiring no dialing) which connects the passenger to station attendant's booth, to a standard pay telephone which requires dialing the operator for connection with the appropriate transit personnel. At some sites, incoming calls from passengers to central control are handled by trained public relations personnel, who also handle station P/A and train announcements. This appears to be a good approach and alleviates a burden on the central control operators responsible for keeping the system running.

3) Other Communication Devices

In addition to these passenger related communications, other devices are vital to ensure a safe and efficient operation. These are primarily maintenance or operations related and include:

- "Handie Talkie" radios, used by maintenance, security or roving supervision personnel;
- Mobile radio units in maintenance, evacuation and rescue, police or other vehicles;
- Emergency telephones in tunnels where radio communication may be inadequate;

- "Hot Lines" from central control to maintenance, security, fire department, medical, etc.

d. Response Agencies and Procedures

1) Response Agencies

As various passenger safety and convenience service problems become detected, some corrective action must be taken to resolve the situation. In current conventional transit systems, these problems are routinely handled or resolved by onboard operators/attendants or station attendants. If other assistance is required, central control is contacted and appropriately trained specialists from various "Response Agencies" are dispatched. These specialists may be from any one of several operational departments, i.e., security, fire, medical, evacuation and rescue, maintenance, or even central control. The actual organization structure and assigned responsibilities of each of these response agencies varies from one transit property to another but the end result is a coordinated team effort of several disciplines devoted to ensuring a safe and efficient operation.

In addition, to these transit agencies, many systems rely upon and interface with similar types of city, county, state or private agencies in which the system operates. In the event of major occurrences, police, medical or fire assistance is requested by the transit property from local agencies in adjacent jurisdictions.

In operational systems without station attendants or vehicle personnel, routine passenger safety and convenience service problems are resolved by other means. On a sporadic basis, roving transit personnel such as security, maintenance, supervisors or even janitorial people may aid the distressed passenger. More frequently, these occurrences are typically handled by central control personnel with the aid of CCTV, telephone, P/A or 2-way radio communications. In some cases, central control may resolve the problem with the aid of the above mentioned means. In other situations, central control will dispatch specialist personnel as required.

2) Response Procedures

Currently used methods/procedures

for handling specific passenger safety and convenience services problems are numerous and lengthy. A summary of these currently used practices is provided in Appendix D.

CHAPTER 4. SCENARIO DEVELOPMENT

A. Approach

As an aid to develop meaningful guidelines for passenger safety and convenience services in AGT systems, it is necessary to develop a comprehensive and realistic set of scenarios depicting possible problem areas that are likely to occur. To achieve a better understanding of the types of problems that could be anticipated in an AGT environment, and the situations under which they might occur, the following sources or considerations were used:

- Historical transit experience based upon interviews with transit personnel and supplemented by literature findings.
- Passenger safety and convenience service problem areas as perceived by transit manufacturers.
- Passenger safety and convenience services problem areas peculiar to AGT.

A listing of potential AGT problem areas and associated variables is provided in Table 4-1. To reduce the number of possible scenarios to a representative and realistic set, a three-step selection process was used:

- Selection of "worst" case and "typical" case scenarios to cover the range of intermediate situations.
- Weigh each scenario selection based upon the "probability of occurrence", thereby providing more emphasis or detail for those events which are more likely to occur.
- Weigh each scenario selection based upon the degree of hazard to passenger safety or passenger inconvenience. Hazardous situations and events which create the greatest degree of passenger inconvenience will therefore receive higher priority.

B. Scenario Development

Through a systematic approach of combining each problem

TABLE 4-1. REPRESENTATIVE AGT SCENARIO VARIABLES

System Types	Potential Problem Areas	Situation Variables	Effect of Problem & Associated Variables
. Shuttle-Loop Transit (SLT)	. Passenger Originated	. Location	. Categories or Types
	Injured/ill	Onboard vehicles	(Safety & Convenience)
	Lost/confused	In station	Safety Hazard
. Group Rapid Transit (GRT)	Handicapped/elderly	Moving	Service Delay
	Lost Articles	Stopped between stations	Pass. Annoyance
	Lost/strayed children	In station	Others
. Personal Rapid Transit (PRT)	Passenger anxiety	Open	
	Illiterate/foreign	Closed	. Severity
		In guideway	Catastrophic
		Above	Critical
	. System Originated	Below	Marginal
	Temporary service interruption	At Grade	Negligible
		Adj. Property	
	Malfunctioning doors, turnstiles, ticket equipment, money changers		. Personnel Effected
		. System Conditions	All Passengers
		Crowded	Vehicle Passengers
		Moderately crowded	Station Passengers
	Fire and smoke detection	Virtually empty	One Passenger
	Loss of lighting		Limited Category
	Soiled cars/stations	. Trip Variables	
	Special traffic	Trip duration	. Passenger Condition
	Adverse weather	Waiting time	Normal
	Animals/foreign objects in system	Transfer time	Mentally/physically degraded
		. Day/Night	Mentally/physically incapacitated

(Continued on Next Page)

TABLE 4-1. REPRESENTATIVE AGT SCENARIO VARIABLES (CONTINUED)

System Types	Potential Problem Areas	Situation Variables	Effect of Problem & Associated Variables
		• <u>Weather</u>	
		Normal	
		Rain/flooding	
		Snow/ice	
		High winds	
		• <u>Site Location</u>	
		Airport	
		Downtown	
		Campus	
		Amusement park	
		Urban/rural	
		• <u>System Status</u>	
		Normal operation	
		Degraded mode	
		• <u>Passenger Time Constraints</u>	
		Critical	
		Normal	
		• <u>Central Control Workload</u>	
		Heavy	
		Medium	
		Light	

with the different situation variables (location, system condition, trip variables, weather, etc.), hypothetical scenario situations were conceived. In several cases, the situation variables had no real influence on a specific problem, hence the number of scenario possibilities were reduced. The remaining scenarios were then studied with respect to frequency of occurrence, and the potential passenger hazards or inconveniences that may occur. Fortunately, the more frequently occurring problems are typically the less hazardous to the passenger. For example, the occurrences of lost/confused passengers, lost articles, malfunctioning ticketing equipment, soiled cars, etc., are frequent, but these usually result in only annoyances or delays and do not create a serious hazard to the passengers. Situations associated with fires, serious illness/injuries and uncontrolled entries into the guideway are less frequent but pose immediate dangers. In these cases, the need for almost instantaneous detection and response is critical to prevent serious injuries or loss of life.

Through the approach discussed above, scenarios were developed for each significant and unique problem areas defined. The resulting scenarios examples are presented in Table 4-2. As noted, only two scenarios were generated for each identified problem. One illustrates a realistic "worst case" set of situations, while the other denotes a more "typical" problem area. The "worst case" scenario is not the absolute worst set of circumstances that could theoretically occur. Sound judgement was used to rule out the ridiculous combinations. Even then, it is feasible that some worst case scenarios cannot realistically be solved in AGT. Cost makes it impractical to fully accommodate 100 percent of all possible problems. These scenarios should create an awareness to the designer of rather infrequent but possible situations that may occur thereby providing an ultimate goal to strive for. If the "worst case" situations can be accommodated, the associated "typical" scenario cases should be resolved with relative ease. The "typical" situations in this case refers to those routine problems that may occur on an almost daily basis, e.g., lost/confused passengers, equipment malfunctions, lost articles, etc.

It should be pointed out that the included scenarios cannot serve as a total answer for every possible AGT application. Each new system, be it PRT, GRT or SLT, will have its own unique requirements because of site location, system configuration, or different operational philosophy, etc. For example, the Sea Tac system has a highly controlled underground guideway with enclosed stations, hence the occurrence of foreign objects (people, animals,

TABLE 4-2. TYPICAL EXAMPLES OF PASSENGER SAFETY AND CONVENIENCE SERVICE SCENARIOS

A. POTENTIALLY HAZARDOUS OCCURRENCES

1. FIRE/SMOKE

Worst Case:
- Fire breaks out onboard vehicle and smoke fills interior
- Vehicle is crowded, and is running between stations on elevated guideway
- Late at night and raining thus visibility and footing is degraded
- Double guideway provides possibility for passengers to egress into adjacent vehicle traffic

Typical Case:
- Trash container in closed station area is deliberately or accidently set on fire by passenger's cigarette
- System is virtually empty, night time

2. TEMPORARY SERVICE DELAY

Worst Case:
- Vehicle malfunction has caused large queue to form between stations
- Numerous passengers attempting to make tight connecting flight or vehicle transfer
- Destination of many vehicle passengers within sight and walking distance
- System is crowded, raining and at night
- Corrective action being taken and service restoration is expected shortly
- Passengers growing restless and contemplating abandoning the vehicles

Typical Case:
- Vehicle malfunctions and a small queue results in a remote area
- Daytime, weather normal and passenger time constraints not critical
- Service restoration anticipated within 5-10 minutes

TABLE 4-2. TYPICAL EXAMPLES OF PASSENGER SAFETY AND CONVENIENCE SERVICE SCENARIOS (CONTINUED)

3. FOREIGN OBJECTS IN SYSTEM

Worst Case:
- Large crane at construction site adjacent to system has its boom overhanging the guideway
- System crowded
- Passing vehicles will impact crane unless corrective action is taken

Typical Case:
- Stray animal wanders onto the guideway
- Guideway is elevated and no easy means of egress for animal
- Vehicle speed precludes animal from outrunning approaching vehicle

4. ILL/INJURED PASSENGER

Worst Case:
- Passenger experiences heart attack onboard vehicle and is immobilized
- Vehicle stopped between stations due to service interruption
- Late at night - vehicle is empty except for heart attack victim

Typical Case:
- Passenger falls down stairs entering below grade station
- Injured but still mobile but will require medical assistance
- System moderately crowded

5. HANDICAPPED/ELDERLY*

Worst Case:
- Unattended wheelchair passenger with restricted limb capability boards vehicle
- Vehicle departs station and smoke begins to fill the car
- Vehicle is virtually empty
- Long trip duration

* Assuming a barrier-free system for normal service.

TABLE 4-2. TYPICAL EXAMPLES OF PASSENGER SAFETY AND CONVENIENCE SERVICE SCENARIOS (CONTINUED)

5. HANDICAPPED/ELDERLY (CONT.)

Typical Case:
- Elderly person deboards vehicle and attempts to leave subway station
- Elevator is inoperative and passenger is unable to use escalator/stairs
- Moderate crowd

B. TYPICALLY NON HAZARDOUS OCCURRENCES

1. LOST/CONFUSED PASSENGER

Worst Case:
- Foreign traveler boards wrong vehicle in an attempt to catch connecting airline flight
- Time is of the essence to catch last flight
- Passenger not fluent in local language
- System is virtually empty

Typical Case:
- First time user fails to read signs and boards wrong vehicle
- Senses mistake after several station stops
- Remaining passengers are not able to provide necessary directions to his desired destination

2. LOST ARTICLES

Worst Case:
- Passenger leaves package containing valuable onboard vehicle
- Vehicle number and destination unknown
- System virtually empty, late at night and incident occurs in high crime rate area of city
- Passenger who lost article is nearly hysterical

Typical Case:
- Passenger leaves briefcase on vehicle
- Vehicle route and approximate time of incident known
- System moderately crowded

TABLE 4-2. TYPICAL EXAMPLES OF PASSENGER SAFETY AND CONVENIENCE SERVICE SCENARIOS (CONTINUED)

3. INOPERATIVE MONEY CHANGER OR TICKET ISSUING EQUIPMENT

Worst Case:
- Passenger inserts $5.00 bill into money changer and machine refuses money or keeps bill. Passenger has no other money.
- Station is open, cold and virtually empty.
- Late at night and near system closing time
- No station attendant

Typical Case:
- Passenger inserts money into change machine or into ticket issuing equipment and nothing happens
- Mid day, moderate crowd
- Short wait time till next train
- Passenger has other money and other equipment available
- No station attendant

4. INOPERATIVE TURNSTILE

Worst Case:
- Station with limited number of turnstiles has multiple failures
- Station is open and weather is cold
- Station crowded with passengers attempting to catch arriving train
- Train is last one of the evening

Typical Case:
- Automatic fare collection (AFC) turnstile fails to accept valid magnetic card
- Passenger familiar with system
- Frequency of service high
- Moderate crowd

5. INOPERATIVE GRAPHICS

Worst Case:
- Destination/boarding graphics in multi-route system malfunction
- Station PA announcements regarding vehicle destinations are not routinely made
- Passengers needing immediate transportation to meet connecting flight and boards the first vehicle that arrives
- Vehicle boarded does not serve desired destination.

TABLE 4-2. TYPICAL EXAMPLES OF PASSENGER SAFETY AND CONVENIENCE SERVICE SCENARIOS (CONTINUED)

5. INOPERATIVE GRAPHICS (CONT.)

Typical Case:
- Boarding graphics in station fail
- Passenger sense problem and refuses to board vehicle - seeks assistance
- System moderately crowded

6. SOILED VEHICLES/STATIONS

Worst Case:
- Ill person has vomited in vehicle and departed
- Awaiting passengers at next station attempt to board but odor is very offensive
- Late at night - last vehicle or long wait
- Station is open and weather is cold

Typical Case:
- Passenger has spilled soft drink on stairway entering underground station, creating a potential hazard to users
- Moderate crowd
- Station has high frequency use by elderly persons

7. SPECIAL TRAFFIC (LARGE CROWDS)

Worst Case:
- Unscheduled appearance by VIP and resulting parade creates large unexpected crowd converging on downtown area
- Passengers have originated from wide geographical area and converged on several downtown station areas
- Weather is cold and threat of snow/ice

Typical Case:
- Local football team has regularly scheduled game
- Passengers/spectators from wide metropolitan area converge upon two stations near the stadium
- Weather conditions normal

TABLE 4-2. TYPICAL EXAMPLES OF PASSENGER SAFETY AND CONVENIENCE SERVICE SCENARIOS (CONTINUED)

8. INOPERATIVE OR UNSCHEDULED STATION BOARDING DOORS/VEHICLE DOORS

Worst Case:

- Crowded vehicle on elevated guideway has inadvertant door opening and stops short of station
- Desired destination of many passengers within sight and walking distance
- Late at night and time is important to passengers
- Adjacent guideway provides possible pathway to passenger to obtain destination

Typical Case:

- Vehicle enters station and stops
- Doors fail to open
- Vehicle and station crowded - numerous passengers desire to board and deboard
- Vehicle may dwell out and depart station or vehicle may set there indefinitely
- Return trip may require up to 20 minutes

9. LOST/SEPARATED CHILD

Worst Case:

- Closing vehicle doors, separate child from parents
- Child remains onboard vehicle
- Parents don't remember vehicle number or final destination of vehicle
- Parents not fluent in local language
- Late at night, system virtually empty
- Incident occurs in high crime area

Typical Case:

- Child left behind in station as parents board vehicle to destination
- Child familiar with system and knows destination of parents
- Moderate crowd
- Trip duration and waiting time short

debris, etc.) in the guideway is non-existing. If any AGT system were placed at grade in a metropolitan environment, foreign object control could become a major problem. This illustrates the need to assess each new system and its application, for unique circumstances that may influence specific problem areas.

C. Scenario Discussion and Future Considerations

The adequacy of these scenarios to cover all safety and convenience service problems in future AGT systems is unknown at this time. Only time and experience will prove their worth. However, it is noteworthy at this time to look one step beyond these scenarios and address an overview of detection and response method associated with their occurrences. In AGT systems, it is the area of DETECTION that becomes the really unique and important aspect of passenger service and safety. Although detection is an area of concern in the next chapter of this report, it is felt that some discussion be provided at this time to better understand the total picture.

In non-AGT systems, the detection and rectification of many routine passenger service problems are by onboard operators and/or station attendants. With the absence of these personnel in an AGT environment, other means of detection and resolution are required. The problems themselves are typically not unique to AGT transit systems nor are the situation variables all that different from conventional transit operations. Whether the problem occurs onboard a vehicle or in a station, at day or night, during adverse weather, or with the system crowded or empty, detection becomes the first order of importance. Furthermore, the response to a problem, once detected, may not differ greatly from currently used practices, except for some unique equipment and personnel variations. For example, if a person is injured in an unmanned station or vehicle, once detected, the response will typically be the same as in a manned system - that is, dispatching medical assistance. Of course in a manned system, the station attendant would most likely be the detection source, whereas in an AGT system, other means would be required. Roving transit personnel, CCTV, special sensors, and passengers serve as current modes of detection in present AGT systems. These, of course, are supplemented by readily accessible radio/telephone communication to central control. Functions currently being handled by vehicle or station personnel will have to be accommodated with special equipment or transferred to central control and resolved via radio, telephone, P/A, CCTV or by dispatching the required personnel.

In summary then, the new and unique challenge associated with passenger safety and convenience services in AGT systems is in the area of <u>detection</u>. Typically many of the same basic types of problems will occur, and many of the responses will be similar; however, the method of detecting these problem areas in AGT environment will differ considerably from conventional transit operations.

CHAPTER 5.
METHODS AND PROCEDURES SELECTION AND EVALUATION

A. Introduction

This section discusses the analyses that were performed in deriving recommended methods and procedures for accommodating passenger safety and convenience services problems. It describes the approach used for each analysis, samples of each analysis and a summary of results for each of the following:

- Detail problem analysis
- Methods and procedures screening and selection analysis
- Effectiveness evaluation of candidate methods and procedures

No attempt is made to show all of the details of each analysis.. The approach used for conducting each analysis and a sample for each is provided. For convenience, the results are summarized in table form to allow an overview of the information related to 14 passenger safety and convenience services problems. The final results of all the analyses, e. g., recommended methods and procedures, are provided in Chapter 5 of the guidebook.

B. Problem Analysis

Prior to selecting and evaluating the effectiveness of various candidate methods for specific problem resolution, it was discovered that a more in-depth understanding of each problem was required. To achieve this additional insight, a "problem analysis worksheet" was generated and used to systematically assess each problem area. Figure 5-1 identifies and defines the parameters that were used for this analysis. An example of one typical problem analysis is provided in Table 5-1. Table 5-2 provides a summary of the results of the total problem analysis effort. In essence, parameters 1 through 5 on the worksheet determined parameters 6 and 7, "Detection and Response Priorities". The detection and response priorities established here, were later instrumental in evaluating the effectiveness of candidate methods and procedures.

DEFINITION OF PARAMETERS USED TO ANALYZE PASSENGER SAFETY AND CONVENIENCE PROBLEMS

1. <u>Problem Type</u> - Any one of the 14 categories of problems.
2. <u>Probability of Occurrence</u> - Denotes frequency or interval at which problem may occur (sensitive to system size) A. High - Problems that typically occur several times a day B. Medium - Problems that typically occur only a few times a week or month C. Low - Problems occurring more on a monthly basis or a few times a year
3. <u>Probable Occurrence Site</u> - Denotes area(s) where a particular problem may occur; i. e., station, vehicle, guideway.
4. <u>Effect of Problem</u> - (on passenger, system or service) A. Safety hazard - Denotes a situation which could result in one of the following: . Catastrophic - May cause death or equipment/system loss . Critical - May cause severe injury or major equipment/system damage . Marginal - May cause minor injury or minor equipment/system damage . Negligible - Will not result in personnel injury or equipment/system damage B. Service Delay - Denotes a situation which could result in an interruption in service for a substantial number of passengers . Major - Interruptions greater than 20 minutes . Minor - Interruptions less than 20 minutes C. Passenger Annoyance - Problems that typically delay or annoy only a few passengers; i. e., lost or separated child, lost articles, etc.

FIGURE 5-1. PROBLEM ANALYSIS PARAMETER DEFINITIONS

5. <u>Problem Impact on Passenger Service</u> - Denotes the degree to which passenger service may be affected.

   A. All passengers

   B. Many passengers

   C. Few passengers.

6. <u>Detection Priority</u>

   A. High - Rapid detection required to prevent safety hazard (injury or death) or potential catastrophic event

   B. Medium - Occurrence where injury is not an immediate threat but impact on passenger service may be substantial

   C. Low - Situation where passenger safety is not threatened and only a few passengers may be delayed or annoyed

7. <u>Response Priority</u> - Denotes relative time importance for correcting a problem. Problems dictating a high detection priority will necessitate a fast response to minimize injuries, delays or annoyance to passengers. High, Medium and Low response categories correspond to similar categories for detection priority.

FIGURE 5-1. PROBLEM ANALYSIS PARAMETER DEFINITIONS (CONTINUED)

TABLE 5-1. SAMPLE PROBLEM ANALYSIS OF POTENTIAL PASSENGER SAFETY AND CONVENIENCE SERVICE OCCURRENCE

PROBLEM-ANALYSIS WORKSHEET	
1. <u>Problem Type</u>	Lost or Separated Child
2. <u>Probability of Occurrence</u> A. High B. Medium C. Low	<u>Medium</u> for most applications - Occurence should be only a few times a week or month.
3. <u>Probable Occurrence Site</u> A. In Stations B. On Vehicle C. In Guideway	Probability is about equal for <u>stations</u> as on <u>vehicles</u>.
4. <u>Effect of Problem</u> A. Safety Hazard Catastrophic Critical Marginal Negligible	<u>Negligible</u> in most cases - Could be <u>catastrophic</u> or <u>critical</u> if child is small and stations are open to the guideway.
B. Service Delay Major Minor	None
C. Passenger Annoyance	For those associated with the lost child party.
5. <u>Problem Impact on Pass. Service</u> A. All passengers B. Many passengers C. Few Passengers	<u>Few</u>

TABLE 5-1. SAMPLE PROBLEM ANALYSIS OF POTENTIAL PASSENGER SAFETY AND CONVENIENCE SERVICE OCCURRENCE (CONTINUED)

6. Detection Priority A. High B. Medium C. Low	Low since passenger safety is not threatened in most cases.
7. Response Priority A. High B. Medium C. Low	Low in most cases.
8. Misc. Comments Problem could be compounded by age of child, language barrier, crowd conditions, type of platform or station (open or closed), size of system; i.e., number of stations, vehicles and miles of guideway, crime rate in area, etc.	

TABLE 5-2. SUMMARY OF PROBLEM ANALYSIS RESULTS FOR POTENTIAL PASSENGER SAFETY AND CONVENIENCE SERVICE OCCURRENCES

1. Problem Type	Ill and Injured Passenger	Lost and Confused Passenger	Illiterate Pass	Lost Child	Lost Articles	E & H	Inoper. Graphics	Inoper. Equip.	Soiled Vehicles and Stations	Foreign Objects in Guideway	Large Crowds	Adverse Weather	Fire or Smoke	Passenger Reassurance
2. Probability of Occurrence (System Size Sensitive) A. High B. Med C. Low	B	A	B	B	A	B or C	B	A	B	C (people) B (animals and debris)	C	B or C (site location sensitive)	C	A
3. Probable Occurrence Site A. In Stations B. On Vehicle C. In Guideway	A & B	A & B	A & B	A & B	A & B	A & B	A & B (if vehicle has dynamic graphic)	A	A & B	C (is major concern)	A & B	D (entire system)	A & B	A & B (B is most critical)
4. Effect of Problem A. Safety Hazard - Catastrophic - Critical - Marginal - Negligible B. Service Delay - Major - Minor C. Passenger Annoyance	A, B or C	C	C	C (most cases) A (on rare occasions)	C	C	B & C	A & B (For door problems) C (for others)	C	A & B	B & C	A (due to increased threat of falls) B & C (due to general service slow down)	A & B	C (most cases) May lead to (A) if not provided.
5. Problem Impact on Passenger Service A. All Passengers B. Many Passengers C. Few Passengers	C B (on rare occasions)	C	C	C	C	C	B	B or C	C	B	A	A or B	A, B or C	A, B or C
6. Detection Priority A. High B. Med C. Low	A	C	C	C	C	C	B	A (for doors) C (for others)	C	A	B	B	A	B
7. Response Priority A. High B. Med C. Low	A	C	C	C	C	C	B	A (for doors) C (for others)	C	A	B	B	A	B

This approach enabled identification of the critical areas associated with each problem. Of the parameters listed, "Effect of the Problem", is most significant. Those problems which were found to be a safety hazard with the potential of being catastrophic or critical in nature, would, of course, dictate a need for the highest probability of rapid detection and response. Other parameters such as probability of occurrence, probable occurrence site and impact on passenger service, etc., also influence the detection and response method but are normally less significant. Fortunately, those problem areas which are potentially the most hazardous, typically occur infrequently. This can probably be attributed to safety considerations that have been traditionally used during system design and operational procedures which have been established through many years of transit experience.

C. Methods and Procedure Selection and Analysis

1. Categorization of Basic Methods and Procedures

During earlier efforts, a comprehensive list of current practices used for accommodating passenger safety and convenience service problems in both conventional and AGT systems was compiled. A summary of these are provided in Appendix D.

For analysis purposes, these practices were divided into two categories:

- Methods and procedures used to detect and report problems
- Methods and procedures used to respond to problems

a. Basic Detection and Reporting Methods

Passenger safety and convenience services problems in an AGT environment can be detected and reported by any one or combination of the following basic methods:

- CCTV
- Special sensors
- Transit personnel
- Passengers.

These basic detection methods differ little from those currently being used in conventional transit. However, there is a distinct shift in emphasis for each method when applied to AGT systems. Transit personnel (station attendants and vehicle operators) and passengers are key detection sources in conventional transit. In AGT, the emphasis shifts to the use of CCTV and special sensors which are monitored at central control.

b. Basic Response Methods

As with the detection methods, there are also four basic response methods that can typically be used to resolve various passenger safety and convenience service problems. They include:

- Providing instructions directly to the affected passenger(s) via telephone, radio or public address (PA).
- Dispatching personnel to problem site to correct the problem (security, maintenance, medical, supervision, fire, etc.).
- Exercising remote control features from central control that are directly related to passenger interface equipment (free wheel or lock turnstiles, commands to open, close, or recycle station and vehicle boarding doors, unlock wheelchair gates, allow access to elevators, etc.).
- Altering system operations which affect a large portion of the system or passengers (reroute vehicles, alter vehicle speeds, remove power to guideway, initiate switch overrides, bypass stations, etc.).

Although the above methods are rather general, they served as a basis by which various problems could be screened and categorized before further analysis. There are, of course, many variations that can occur within the framework of each method that alters its applicability to specific problems. These variations will be discussed later.

2. Screening and Selecting Methods and Procedures

A preliminary screening analysis was performed to determine the general applicability of each of the above detection and response methods to each passenger safety and convenience service problem area. Table 5-3 and 5-4 provide a summary of the screening analysis results for detection and response methods. No attempt was made at this stage of

TABLE 5-3. SCREENING SUMMARY OF BASIC DETECTION AND REPORTING METHODS FOR APPLICATION TO PASSENGER SAFETY AND CONVENIENCE SERVICE PROBLEMS

	POSSIBLE DETECTION AND REPORTING METHODS (BASIC)			
Problem Type	CCTV with monitors at Central Control (1)	Special Sensors with Alarms/Indications at Central Control	AGT Personnel (In the system)	Affected Passenger(s) or Assisting Passenger(s) (2)
1. Ill or injured passenger	Probable method but limited to stations	Not applicable (N.A.)	Applicable throughout the system but on an intermitting basis	Probable method on vehicles and in stations.
2. Lost and confused passenger		N.A.		
3. Illiterate passenger		N.A.		
4. Lost or strayed children		N.A.		
5. Lost articles		N.A.		
6. Elderly and Handicapped (E&H)		Probable method for E&H related equipment		
7. Inoperative information systems (Graphics)		Probable application for sensors		
8. Inoperative equipment (turnstiles, fare equipment, doors, etc.)		Typical application for sensors		
9. Soiled vehicles and stations		N.A.		Possible Method
10. Foreign objects in system (Guideway)	Possible method but limited to guideway adjacent to boarding areas.	Possible method - vehicle impact sensors or equivalent		
11. Accommodation of large crowds	Probable method	Possible Method - vehicle overload sensors		
12. Provisions for adverse weather	Possible method if outside visual access is possible.	Probable Method - weather sensors		
13. Fire/smoke detection	Possible method in stations - aid to verify severity	Typical application for sensors		
14. Pass. reassurance during delays and emergencies	Possible method for stations	Possible method - Assorted system sensors at central control.		

(1) Assuming CCTV installations in stations only. When state-of-the-art allows vehicle CCTV, "station limited" function will disappear.

(2) Assuming vehicle radio or telephone communications are readily available.

TABLE 5-4. SCREENING SUMMARY OF BASIC RESPONSE METHODS FOR APPLICATION TO PASSENGER SAFETY AND CONVENIENCE SERVICE PROBLEMS

		POSSIBLE RESPONSE METHODS (BASIC)			
	Problem Type	Dispatch Appropriate AGT Personnel or Others	Provide Instructions to Passengers Via Communication Means	Exercise Remote Control Capabilities for Passenger Related Equipment	Alter System Operations
1.	Ill or injured passengers	Probable Method - Dispatch Medical	Possible but unlikely method	Possible but unlikely method	Possible Method - may require rerouting vehicles
2.	Lost and confused passengers	Possible Method - Dispatch nearest AGT personnel	Probable Method - Instruct via radio, telephone or PA	↓	Not Applicable
3.	Illiterate passengers	Possible Method - Dispatch nearest AGT personnel	Probable Method - Instruct via radio, telephone or PA	↓	↓
4.	Lost or strayed children	Probable Method - Alert AGT personnel in the system	Possible Method - Make all train and vehicle PA announcements	↓	↓
5.	Lost articles	Probable Method - Alert AGT personnel in the system	Probable Method - Refer pass. to lost and found department	↓	↓
6.	Elderly & Handicapped (E&H)	Probable Method - dispatch nearest AGT personnel	Possible Method - provide instructions	Probable Method - allow special access	↓
7.	Inoperative information systems (Graphics)	Probable - Dispatch maint. and info. personnel	Probable Method - provide information via PA	Possible but unlikely	Possible but unlikely
8.	Inoperative equipment (turnstiles, fare equip., doors, etc)	Probable Method - dispatch maintenance	Possible Method - instruct passengers on alternate solutions	Possible Method - freewheel turnstiles, cycle doors, etc.	Possible for door malfunctions - by-pass station
9.	Soiled vehicles and stations	Probable Method - dispatch maintenance	Not Applicable	Not Applicable	Possible Method - remove vehicle from service or close station
10.	Foreign objects in system (Guideway)	Probable Method - dispatch maintenance, security, and medical as needed.	Possible Method - Reassurance announcements to passengers	Not Applicable	Possible Method - remove guideway power, reroute vehicles, etc.
11.	Accommodation of large crowds	Possible Method - man sta.	Possible Method - inform pass. of delays & provide instructions	Possible Method - initiate door commands	Probable Method - add or reroute vehicles
12.	Provisions for adverse weather	Possible Method - dispatch maintenance	Possible Method - inform pass. of delays & provide instructions	Possible Method - freewheel turnstiles, unlock special gates	Possible Method
13.	Fire/Smoke Detection	Probable Method - dispatch fire personnel	Probable Method - instruct pass. on emergency egress	Possible Method - initiate door command	Possible Method - reroute vehicles, remove guideway power, etc.
14.	Pass. reassurance during delays/emergencies	Possible Method - dispatch security or maintenance	Probable Method - provide PA announcements	Possible Method - initiate door commands	Possible Method

the analysis to rank the effectiveness of the various methods. The tables illustrate whether or not each method may aid in the detection and response process. For example, when attempting to detect the need for aid to the ill or injured, CCTV, AGT personnel and passengers may all aid in some fashion. Special sensors would not be applicable in this case.

Since all methods are not applicable to all problems, the number of methods that had to be assessed in greater detail was reduced. Each of the remaining basic methods that appeared to be applicable to specific problem areas was then investigated in detail. Based upon past and current transit practices, realistic variations of each basic method were compiled for each problem. Table 5-5 presents an example of the specific methods that resulted from using this approach for one problem area, detecting inoperative graphics. Table 5-6 presents a similar example of potential response methods to the same problem. The results of this process provided a list of candidate methods for each problem, which would be evaluated for effectiveness towards resolving that problem.

TABLE 5-5. EXAMPLE OF CANDIDATE METHODS FOR DETECTION OF INOPERATIVE STATION GRAPHICS

BASIC METHOD	SPECIFIC METHOD
CCTV	. Systematic viewing of station graphics by direct viewing on CCTV
SENSORS	. Use sensors to detect malfunctions or incorrect graphics with appropriate readouts at Central Control
AGT PERSONNEL	. Rely upon systematic spot checks of graphics by roving AGT personnel
PASSENGERS	. Rely upon passengers to report malfunctioning graphics
CCTV/SENSOR COMBINATION	. If graphics are not directly visible via CCTV, use graphics malfunction sensors with appropriate indicators that are within the CCTV field of view.

TABLE 5-6. EXAMPLE OF CANDIDATE METHODS FOR RESPONSE TO INOPERATIVE STATION GRAPHICS

BASIC METHOD	SPECIFIC METHOD
DISPATCH AGT PERSONNEL	. Man stations as required until graphics can be restored.
COMMUNICATIONS	. Make PA announcements giving destinations of arriving vehicles until graphics are repaired or station is manned.
REMOTE CONTROL	. Not applicable
ALTER SYSTEM OPERATIONS	. Not likely
OTHERS	. Allow passengers to use other destination information that may be available on arriving vehicles (either signage on exterior of vehicle or onboard graphics within the vehicle.

D. Effectiveness Evaluation of Candidate Methods and Procedures

To determine which candidate detection and response methods would be most effective for accommodating each passenger safety and convenience services problem, two sets of effectiveness criteria were generated, one set for evaluating detection methods and another for response methods. Table 5-7 provides an example of the effectiveness evaluation format used to assess possible detection methods for inoperative graphics. Table 5-8 represents a similar example of the response evaluation for the same problem. This process provided a means by which each method could be compared to other methods and desirable and undesirable features of each could be readily identified.

Of the detection effectiveness parameters listed in Tables 5-7, the first four (Detection Probability, Detection Time, Reporting Probability and Reporting Time) are initially of most concern. Based upon the "Detection Priorities" determined earlier in the Problem Analysis (Table 5-2), each method

TABLE 5-7. DETECTION AND REPORTING METHODS EFFECTIVENESS ANALYSIS WORKSHEET

Problem Type: Inoperative Graphics
Prob. of Occurrence: Med. Prob. Occur. Site: Sta/Veh
Effect of Problem: Service Delay/Passenger Annoyance
Problem Impact: Many Passengers
Detection Priority: Med. Response Priority: Med.

(EXAMPLE OF INOPERATIVE GRAPHICS)

EFFECTIVENESS PARAMETERS	POSSIBLE DETECTION/REPORTING METHODS (BASIC)			
	CCTV	SENSORS WITH INDICATIONS AT CENTRAL CONTROL	AGT PERSONNEL	AFFECTED/ASSISTING PASSENGER
1. DETECTION PROBABILITY (High, Medium, Low)	Potentially HIGH in stations but a function of monitoring personnel awareness and workload. Low onboard vehicles.	HIGH in stations and onboard vehicle	Typically LOW since AGT personnel cannot provide instantaneous coverage of total system.	Potentially HIGH if passengers are present. LOW if not present.
2. DETECTION TIME (Fast, Moderate, Slow)	Potential FAST but a function of monitoring personnel.	FAST	Typically SLOW.	Potentially HIGH if passengers are present; LOW otherwise.
3. REPORTING PROBABILITY (High, Medium, Low)	HIGH if detected.	HIGH	HIGH if detected.	LOW
4. REPORTING TIME (Fast, Moderate, Slow)	FAST	FAST	FAST to MODERATE	MODERATE to SLOW
5. EQUIPMENT COST: . Initial . Recurring (High, Medium, Low)	 HIGH LOW	 MODERATE LOW	 LOW LOW	 LOW LOW
6. AGT PERSONNEL REQUIRED (>6, 3-5, 1-2, None)	1-2 (Monitoring personnel at central control)	1-2 (Monitoring personnel at central control)	Sensitive to size of system may vary from 1 to 6.	1-2 (Central Control personnel to receive reports).
7. IMPACT OF DETECTION METHOD ON: . Passengers . AGT Personnel (High, Medium, Low, NONE)	NONE on passengers HIGH - Requires central control personnel to constantly monitor CCTV.	NONE on passengers LOW - Central control will receive indication automatically	NONE on passengers. MED. - Requires roving personnel to detect and report and central control to receive report.	LOW - Requires phone call by pass. LOW - Requires receiving phone call at central control.

TABLE 5-7. DETECTION AND REPORTING METHODS EFFECTIVENESS ANALYSIS WORKSHEET (CONTINUED)

(EXAMPLES FOR INOPERATIVE GRAPHICS)

EFFECTIVENESS PARAMETERS	POSSIBLE DETECTION/REPORTING METHODS (BASIC)			
	CCTV	SENSORS WITH INDICATIONS AT CENTRAL CONTROL	AGT PERSONNEL	AFFECTED/ASSISTING PASSENGER
8. SAFETY ASPECTS OF DETECTION METHODS (Good, Acceptable, Unsat.)	GOOD	GOOD	GOOD	GOOD
9. PASSENGER ACCEPTANCE (Good, Acceptable, Unsat.)	ACCEPT. - Does not require passenger involvement but may be slow.	GOOD - Fast, automatic and does not require passenger involvement.	ACCEPT. - Does not require passenger involvement but may be slow.	UNSAT. - Requires action by passenger.
10. DEPENDABILITY (High, Medium, Low)	MEDIUM - function of monitoring personnel awareness and workload.	HIGH	HIGH if present. LOW if not.	LOW - Passengers may not be present or desire to report problem.
11. VERSATILITY (High, Medium, Low)	HIGH - CCTV serves numerous functions.	LOW - Sensors on graphics serve one function only.	HIGH - AGT personnel serve a multitude of other functions.	MEDIUM - Passenger can detect and report other problems but may not desire to.

TABLE 5-8. RESPONSE METHODS EFFECTIVENESS ANALYSIS WORKSHEET

Problem Type: Inoperative Graphics	
Prob. of Occurrence: Med.	Prob. Occur. Site: Sta/Veh.
Effect of Problem: Service Delay/Passenger Annoyance	
Problem Impact: Many passengers	
Detection Priority: Med.	Response Priority: Med.

(EXAMPLE FOR INOPERATIVE GRAPHICS)

EFFECTIVENESS PARAMETERS	POSSIBLE RESPONSE METHODS (BASIC)				
	Dispatch Personnel . Maint. . Medical . Supv. . Security . Fire . Others	Instruct Passengers Via: . Radio . Telephone . PA	Exercise Remote Control Features (Passenger Equipment) . Boarding Doors . Special Access . Turnstiles . Others	Alter System Operations	OTHERS (Provide Alternate Graphics)*
1. RESPONSE TIME (High, Medium, Low)	MED to SLOW - Takes time to man stations	FAST - PA announcements require minimal time.	NOT APPLICABLE ↓	NOT APPLICABLE ↓	FAST
2. SPECIAL EQUIPMENT COST . Initial . Recurring (High, Medium, Low)	LOW LOW	LOW - PA is standard equipment in AGT. LOW			. HIGH for vehicle graphics. . LOW for vehicle signage. . LOW recurring cost
3. AGT PERSONNEL REQUIRED (>6, 3-5, 1-2, NONE)	1-2 per affected station . 1 to instruct passenger . 1 to repair graphics	1-2 Total . 1 to make station PA announcements . 1 to repair graphics			NONE to provide back-up service 1 to repair graphics
4. IMPACT OF RESPONSE METHOD ON: . Passenger . AGT Personnel (High, Medium, Low, None)	LOW for passengers Potentially HIGH for dispatch personnel if several stations are affected.	LOW for passengers Potentially HIGH for central control personnel in large systems with multiple routes.			MED. on passengers - requires use of alternate source of information. LOW for AGT Personnel.
5. PASSENGER ACCEPTANCE (Good, Accept., Unsat.)	GOOD - personal assistance is usually well received by passengers.	ACCEPT.			ACCEPT to UNSAT. - Requires extra effort by passenger. May create confusion.
6. SAFETY ASPECTS OF RESPONSE METHOD (Good, Accept., Unsat.)	GOOD	GOOD			GOOD
7. DEPENDABILITY (High, Medium, Low)	HIGH	HIGH			LOW - Passenger may not be aware of alternate source of information.
8. VERSATILITY (High, Medium, Low)	HIGH - dispatched personnel are capable of performing other services.	MED - PA serves other functions but not as versatile as AGT personnel.			LOW - Backup signage has limited applications.

*Alternate signage or graphics on or in vehicles may provide destination information until station graphics are corrected.

was assessed to determine which one would best meet the detection priority requirement. Those problems identified as being potentially hazardous to passenger safety or having a substantial impact on service would require the most reliable and fastest detection. For example, the detection of fire or smoke was determined to have a "high" detection priority. When assessing the possible fire detection methods (CCTV, sensors, AGT personnel and passengers), properly located sensors would offer the highest probability of detection and reporting and the fastest detection and reporting times. Therefore, sensors would become the primary recommended methods for fire and smoke detection in high risk areas such as equipment bays. CCTV would serve as a supplementary method in station areas and transit personnel and passengers would help to fill the remaining detection voids.

The remaining effectiveness criteria such as equipment cost, personnel requirements etc., were also considered. In some cases, prohibitive high equipment cost or personnel requirements would rule out certain methods that might be effective otherwise. For example, providing CCTV cameras on the front of each vehicle to detect foreign objects in the guideway is feasible but is not a cost-effective solution. However, in most cases, these other parameters were more typically used to select one method over an otherwise equally effectivity method.

Through this process of comparing the results of the "problem analysis" with the "effectiveness evaluation criteria", various methods were eliminated and recommended methods and procedures for detecting and resolving passenger safety and convenience services problems were defined. The recommended methods and procedures were then applied to problem scenarios to ensure effectiveness in accommodating typical and worst case situations. If accommodation was not possible, the recommended methods and procedures were reassessed and modified until an acceptable level of effectiveness was obtainable.

E. Summary of Results

Tables 5-9 and 5-10 provide a summary of the results for the analysis and evaluation effort. They provide, in table form, the recommended detection and response methods for each passenger safety and convenience services problem area defined. Presented are primary and secondary methods for accommodating each of the problem categories. Specific details related to each of these recommended methods are provided in Chapter 5 of the Guidebook.

TABLE 5-9. SUMMARY OF RECOMMENDED DETECTION AND REPORTING METHODS FOR PASSENGER SAFETY AND CONVENIENCE SERVICE PROBLEMS

	BASIC DETECTION AND REPORTING METHODS			
PROBLEM TYPE	CCTV with Monitors at Central Control	Equipment Sensors With indications at Central Control	AGT Personnel in The System	Affected/Assisting Passenger(s) via Telephone or Radio
1. Ill or injured passenger	Secondary (Sta)	Not applicable	Secondary (veh. & sta.)	Primary (veh. & sta)
2. Lost and confused passenger	Secondary (Sta)	Not applicable	Secondary (veh. & sta.)	Primary (veh. & sta)
3. Illiterate passenger	Primary (Sta)	Not applicable	Secondary (veh. & sta.)	Primary (veh. & sta)
4. Lost/strayed children	Secondary (Sta)	Not applicable	Secondary (veh. & sta.)	Primary (veh. & sta)
5. Lost articles	Secondary (Sta)	Not applicable	Secondary (veh. & sta.)	Primary (veh. & sta)
6. Elderly and Handicapped (E&H)	Primary (Sta)	Primary - sensors on unique E&H equipment	Secondary (veh. & sta.)	Primary (veh. & sta)
7. Inoperative information systems (graphics)	Alternate primary - if sensors are not provided	Desirable primary - but CCTV may be a suitable alternate	Secondary to CCTV if sensors are not used	Secondary to CCTV if sensors are not used
8. Inoperative equipment				
• Boarding and Emergency Doors*	--	Primary (sensors on boarding and emergency doors)	--	--
• Ticketing equipment turnstiles, etc.	Primarily alternate - if sensors are not provided	Desirable primary-but CCTV may be a suitable alternate	Secondary to CCTV	Secondary to CCTV
9. Soiled vehicles and stations	Secondary (Sta)	Not applicable	Primary (veh. & sta.)	Primary (veh. & sta)
10. Foreign objects in guideway	Secondary in station platform area of guideway	Primary (impact sensors on vehicles for accessible guide-ways)**	Secondary (if vehicle sensors are provided) Primary (if sensors are not provided)	Secondary (if vehicle sensors are provided) Primary (if sensors are not provided)
11. Accommodation of large crowds	Primary (sta)	Secondary(veh. overload sensors)	Secondary (veh. & sta.)	--
12. Provisions for adverse weather	Secondary	Primary (access to weather information)	Secondary	--
13. Fire/smoke detection	Secondary (Sta.)	Primary (in stations, equip. bays, tunnels and vehicles)	Primary in areas where sensors and CCTV is not applicable (low risk areas)	Secondary in areas where sensors/ CCTV is not available. (low risk areas)
14. Pass. reassurance during delays/ emergencies	Secondary (Sta.)	Primary (variety of sensors at central control will make need evident)	Secondary	Secondary

*Includes door malfunctions and unscheduled door openings. **For guideways with highly limited access, vehicle sensors may not be required.

TABLE 5-10. SUMMARY OF RECOMMENDED RESPONSE METHODS FOR PASSENGER SAFETY AND CONVENIENCE SERVICE PROBLEMS

EMS

Problem Type	Dispatch AGT Personnel or Others	Provide Instructions to Passengers Via PA, Telephone or Radio	Exercise Remote Control Capabilities for Passenger Related Equipment	Alter Systems Operations
	BASIC RESPONSE METHODS			
1. Ill or injured passengers	Primary - Dispatch medical/ambulance as required	Secondary - provide reassurance until assistance has arrived.	Not Applicable	May hold or reroute affected vehicle pass. for better access
2. Lost and confused passengers	Secondary - Dispatch personnel only if primary fails	Primary - Instruct via telephone, radio, or PA	Not Applicable	Not Applicable
3. Illiterate passengers	Secondary - Dispatch personnel only if primary fails	Primary - Instruct via telephone, radio, or PA	Not Applicable	Not Applicable
4. Lost/strayed children	Alert AGT personnel in system to search/recover lost child	Primary - all sta & veh. PA announcements requesting lost child to report location	Not Applicable	Not Applicable
5. Lost Articles	Alert AGT personnel to search as time allows	Primary - refer passengers to lost and found department	Not Applicable	Not Applicable
6. Elderly & Handicapped (E&H)	Secondary - Dispatch AGT personnel only if primary methods fail	Primary - Attempt to resolve problem via telephone, radio or PA	Primary - attempt to resolve by remote control features unique to E&H	Not Applicable
7. Inoperative information systems (graphics)	Primary - dispatch AGT personnel for corrective action and to provide route info.	Primary - provide route information via PA until station can be manned	Not Applicable	Not Applicable
8. Inoperative Equipment:				
. Boarding & Emer. Doors*	Dispatch maint. for unsched. door openings & as required for boarding door malf.	Secondary - Instruct pass. as required.	Primary - Actuate door commands for boarding door.	Unscheduled door opening may require removing G/W power
. Ticketing Equip., turnstiles, etc.	Secondary - Dispatch maint. if primary fails or corrective action is required.	Primary - Instruct pass. on solution..	Primary - utilise remote control if applicable	Not Applicable.
9. Soiled vehicles and stations	Primary - Dispatch maint.	Not Applicable	Not Applicable	May require removing vehicle from service.
10. Foreign objects in system (guideway)	Primary - Dispatch maint.	Secondary - provide passengers reassurance	Not Applicable	Primary - Remove guideway power, reroute on stop vehicles as required.
11. Accommodation of large crowds	Secondary - Man stations as required	Secondary - Inform passengers of delays	Secondary - open fire special exits to enhance egress - modify station dwell times.	Primary - Add vehicles, run egress routes, etc.

*Indicates door malfunctions and unscheduled door openings.

TABLE 5-10. SUMMARY OF RECOMMENDED RESPONSE METHODS FOR PASSENGER SAFETY AND CONVENIENCE SERVICE PROBLEMS (CONTINUED)

TABLE 5-10. SUMMARY OF RECOMMENDED RESPONSE METHODS FOR PASSENGER SAFETY AND CONVENIENCE SERVICE PROBLEMS (CONTINUED)

		BASIC RESPONSE METHODS			
	Problem Type	Dispatch AGT Personnel or Others	Provide Instructions to Passengers Via PA, Telephone or Radio	Exercise Remote Control Capabilities for Passenger Related Equipment	Alter Systems Operations
12.	Provisions for adverse weather	Dispatch Maintenance snow removal, etc.	Inform passengers of delays due to adverse weather.	Initiate special heaters or deicing equipment if applicable	Reduce vehicle speeds, initiate guide-way de-icing if applicable.
13.	Fire/Smoke Detection	Primary - Dispatch Fire Department	Primary - Instruct Passengers via PA	Open fire on special exists if available	Reroute vehicles, remove guideway power, etc., as required.
14.	Pass. Reassurance During Delays/Emergencies	For emergencies - Dispatch personnel ASAP. For de-lays - dispatch personnel only as required.	Primary - Station and vehicle PA announcements for delays and emergencies.	For emergencies - door and turnstile command may be required.	Reroute vehicles, remove guideway power, etc., as required.

APPENDIX A

GLOSSARY

Automated Guideway Transit (AGT)

The current dominant means of public transportation are the transit bus and rapid rail systems. The development of computer and automation technology, particularly in the last decade, has led to the formulation of new public transportation concepts which use vehicles capable of automatic operation on separate roadways or guideways. Such systems are generally called Automated Guideway Transit (AGT).

Group Rapid Transit (GRT)

Group Rapid Transit Systems (GRT) utilize automated vehicles on more extensive networks than SLT systems. They tend to have shorter headways than SLT systems, use switching and may or may not employ off-line stations. Vehicles with a capacity of 10 to 70 passengers, operating singly or in trains with headways of 3 to 90 seconds, characterize such systems. State-of-the-Art GRT Systems (e.g., AIRTRANS and Morgantown) operate at headways 15 seconds or greater.

Personal Rapid Transit (PRT)

Personal Rapid Transit Systems (PRT) are usually system concepts characterized by small vehicles (2-9 passengers) carrying parties travelling together by choice. Such systems generally feature off-line stations and an extensive guideway network. Most proposed systems call for vehicles to be operated at headways of three seconds or less.

Shuttle-Loop Transit (SLT)

Shuttle-Loop Transit Systems (SLT) are the simplest type of Automated Guideway Transit Systems and are characterized by vehicles moving along short linear segments or loops with few or no switches. The vehicles may operate singly or trained. Bypasses may be permitted in the shuttle to permit intermediate stations.

APPENDIX B
ABBREVIATIONS/ACRONYMS

AFC	Automatic Fare Collection
AGT	Automated Guideway Transit
AGTT	Automated Guideway Transit Technology
ATC	Automatic Train Control
BART	San Francisco Bay Area Rapid Transit
CCTV	Closed Circuit Television
E&H	Elderly and Handicapped
GRT	Group Rapid Transit
MPM	Morgantown People Mover
PA	Public Address
PASS.	Passenger
PATCO	Port Authority Transit Corporation, N J.
PRT	Personal Rapid Transit
PS & CS	Passenger Safety and Convenience Services
SEA TAC	Seattle-Tacoma Airport Satellite Transit System
SLT	Shuttle-Loop Transit
SS & PS	System Safety and Passenger Security
STA	Station
TSC	Transportation Systems Center
UMTA	Urban Mass Transportation Administration
WMATA	Washington Metropolitan Area Transit Authority

APPENDIX C

LIST OF REFERENCES

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APPENDIX D

SUMMARY OF CURRENT PRACTICES

The following is an overview of response methods and procedures currently being used by the transit industry to resolve typically occuring passenger safety and convenience service problem areas.* In some cases, additional information has been included to provide more insight into some problem areas.

- **Lost/Confused Passengers**

In conventional transit, station and vehicle attendants take an active role in resolving problems associated with lost/confused passengers/children. In AGT systems, corrective instructions are typically given by central control via any combination of communication means and the problem can frequently be resolved without dispatching transit personnel. For example, a lost child may be reunited with its parents by vehicle and station P/A announcements which direct the child to the nearest security officers, airline ticketing agent, gift shop, etc., and have that person call central control. The parents are then directed to that location. In some situations, it has been necessary to dispatch security or alert other personnel to assist in the search.

- **Lost Articles**

Lost articles left onboard non-AGT vehicles are frequently found by vehicle attendants or operators at the end of the line when changing attendant or driver compartments. In other cases, passengers may find articles and turn them over to transit personnel. Other roving transit personnel may also discover and turn in these items. At BART, the station attendants take an active role in recovering lost articles by coordinating with other attendants, Central Control and vehicle operators. TTC has strict bi-laws which include heavy fines and/or imprisonment for passengers who remove lost articles from their system. In AGT systems, Central Control will typically refer passengers who have lost articles to the transit's Lost and Found Department. Periodically, lost articles will be discovered at night when vehicles or stations are being cleaned. Experiences at many of the transit sites indicate that the return rate on lost articles is usually very low unless a concerted effort is made immediately.

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*An extensive set of methods and procedures, used by each applicable site visited, for handling passenger services has been documented. Although not presented here, these will be used when assessing defined scenarios and providing recommended solutions.

- <u>First Aid/Medical</u>

Current practices for providing first aid/medical needs are varied and diverse throughout the transit industry. BART for example has station attendants who are trained in first aid and each attendant's booth is equipped with a first aid kit. AIRTRANS relies upon medical service that is provided at the Dallas/Fort Worth Airport. Trained paramedics and emergency medical vans are a part of the evacuation and rescue team at Sea Tac. Maintenance vehicles are equipped with first aid kits at other sites. At one site, a vehicle containing a sick or injured passenger may be rerouted for quicker access to medical provisions. Other systems may evacuate a vehicle at the nearest station except for the ill or injured passenger, move the vehicle to a siding and provide medical attention in the vehicle. More serious medical requirements are typically accommodated by agreements between each transit property and local ambulance services and hospitals.

- <u>Elderly/Handicapped (E&H)</u>

Provisions for, and special assistance to the Elderly and Handicapped (E&H) in current transit systems, cover nearly the entire spectrum of possibilities. These range from systems that are totally unusable by the E&H to systems that are essentially barrier free and also provide personnel assistance when required. At TTC, above ground transportation in special vans or buses is provided for the E&H. At the Dallas/Fort Worth Airport, the airlines prefer to have unaccompanied E&H passengers call in advance and special transportation or assistance will be provided when riding AIRTRANS. BART and WMATA both have essentially barrier free systems and station attendants are available to assist when required. Fare collection presents a rather unique problem for the E&H. At Sea Tac, no turnstiles are used, thus the problem is eliminated. Another system requires special gates to be opened for wheelchair access. Still another system allows wheelchair users to bypass the turnstiles by using the elevator, but this requires the assistance of the station attendants for fare collection. The BART system even offers a special indoctrination program for the E&H on how to use their system.

- <u>Equipment Failures</u>

For system related problems such as equipment failures (ticketing equipment, turnstiles, graphics, etc.), obviously some type of transit personnel are dispatched for corrective action and/or for providing the required backup service. In some systems, station attendants monitor the associated station equipment and in several cases can correct minor equipment problems. These may include restarting stopped escalators or freeing jammed change machines, ticketing equipment, turnstiles or reloading ticket issuing equipment. For more serious problems, trained technicians or maintenance personnel are obviously required. In most situations, service is not affected because other duplicate equipment is typically available to provide the same function. Occurences of multiple failures during peak operational times have in some cases required manning or providing extra manning in affected stations. Inoperative graphics, which normally provide destination information in systems with multiple routes, have required either manning the stations or making destination announcements via station P/A until graphics have been restored.

- <u>Nuisance Problems</u>

Nuisance problems such as soiled cars or stations or acts of vandalism are usually detected and reported by vehicle or station personnel, roving transit personnel or passengers. Typically, manned vehicles are inspected by the onboard operator at the end of the line. Once reported, central control will dispatch maintenance or janitorial personnel and in most situations the condition is corrected online. For more serious problems, it has been necessary to remove the vehicle from service. Cleaning vehicles nightly is a common practice in transit operations. Some larger subway systems also have a full time janitorial person in each of its major stations who constantly monitors and corrects this type of problem.

- <u>Foreign Objects</u>

The detection, removal or control of foreign objects in transit systems has been an area of some concern. Objects such as stray animals, rocks, bottles, cans, luggage, etc., have presented some special problem particularly when located in the guideway. Animals being struck by ATC vehicles have not only caused service interruptions or damage, but also have created an area of great controversy among local patrons. Cans, rocks, bottles, aluminum foil, etc. have been responsible for power interruptions and rail/tire damage, that have resulted in service delays. To date, nearly all operational AGT systems are in a very controlled environment with very limited access to the guideway. For example: Sea Tac is completely underground; AIRTRANS is within the confines of a controlled access airport and the guideway is either fenced, elevated or protected by airport terminals; TAMPA is at an airport and the guideway access is limited. The Morgantown system probably has the most uncontrolled operational environment as it runs from a college campus to a downtown environment. Other conventional systems have encountered some problems in the area of foreign object control. For systems with onboard operators, the problem is lessened in most cases because the driver can detect and stop the vehicle before impact occurs. However, in some cases, where vehicle speeds of 50 to 80 mph are common, this procedure is still inadequate. Some properties have track crews or maintenance personnel who frequently walk, inspect or repair the track, power rails, or guideway; thus, helping to control the problem. In future AGT systems, this could become an area of greater concern if systems are located in an uncontrolled environment. Special vehicle sensors that scan the guideway/track, contact sensitive feelers on vehicles, or Passenger Emergency Stop capabilities may prove beneficial in certain environments.

- Abnormal Crowds

The accommodation of large crowds associated with sporting events, concerts, conventions, holidays, etc., are currently being handled by any one or combinations of the following:

- Adding extra trains or adding extra vehicles to trains, running express routes, altering routes, or supplementing transit service with buses.
- Modifying normal station dwell times as required.
- Manning stations with extra personnel, i.e., station attendants and security. Security will provide crowd control and assist with ticketing processing. Fare collection may be handled both manually and automatically and emergency fire exit gates are opened to speed up egress. Extra maintenance personnel are also placed on standby in the immediate areas.
- PATCO will, on special occasions such as concerts or sporting events, sell only 2-way fare tickets for some interval of time prior to the event. The intent here is to reduce ticketing demands at one or two stations after the special event lets out and also to reduce the frequency of fare evasion incidents.

- **Abnormal Weather**

Provisions for protecting passengers from adverse weather (ice, snow, heavy rains, etc.) are largely a function of geographical location. Ice and snow present a major problem for Northern sites, while rain and heat are of more concern in the South. Some of the sites visited have stations that were totally enclosed and environmentally controlled. Some of the "near-the-end-of-the-line stations" in subway systems and smaller PRT systems like Morgantown have open but covered station platform areas. Operating schedules are usually such that the frequency of service at these stations is relatively high, thus requiring minimal waiting times. Ice, snow and other severe weather usually presents few problems to the passenger once he has safely reached the station or vehicle. This, of course, is assuming that sidewalks, stairs, escalators and ramps have been properly cleared of snow and ice or proper drainage has been provided for heavy rains. The use of slip resistant surfaces is very important in the station/platform areas, as well as in the vehicle. Tile on vehicle floors has been an area of some concern with the advent of rain and snow. Moisture tracked in by passengers causes the tile to become very slippery. This is further compounded by train movement as well as passengers moving to and from the vehicle doors while the train is still moving. Carpeted floors on the other hand help to reduce this problem, but have maintenance drawbacks. Tracked in moisture can pool and cause accelerated carpet wear. In systems that provide parking facilities for system users, passengers may be required to walk up to a quarter of a mile from the parking lot to the station. In adverse weather, this becomes a rather distasteful ordeal.

- **Emergency Lighting**

Emergency/auxiliary lighting provisions are, by in large, available onboard vehicles and in the station areas for all sites visited. On the vehicles, emergency lighting, and in some cases emergency power for radio communications, is automatically supplied with the loss of primary power. The power sources are predominantly batteries, with typical operational durations of up to three hours. The light source is commonly the same fixture used for normal lighting with only a limited number of lights illuminating for the emergency mode. Station lighting is supplied through the use of emergency generators or batteries.

- <u>Passenger Reassurance</u>

To better understand the need for passenger reassurance, and methods/procedures currently used, the following background information is provided. Passenger reassurance during service delays and/or emergency situations requires attention in two distinct areas, (1) those passengers awaiting service in stations and (2) those passengers onboard affected vehicles. Station related emergencies such as fires, or delays associated with service interruptions, typically present situations that are less hazardous than similar events occuring onboard vehicles. In station related fires or emergencies, egress pathways are usually more numerous and present fewer hazards to fleeing passengers. For impatient passengers awaiting a vehicle in a station during service delays, he or she is reasonably confined in a relatively safe environment. If the same type of emergency or delay occurs onboard a vehicle, the results could potentially be more hazardous. Smoke or minor fires or service delays may cause panicked or impatient passengers to make uncontrolled exits from the vehicle. Uncontrolled exits may in many cases subject the passenger to a more hazardous condition than staying onboard the vehicle. These hazards include such things as passengers falling from the vehicle or guideway, contacting power rails, or being struck by another moving vehicle. Current means of providing passenger assurance consists of one or more of the following:

- <u>Station Related:</u>
  - P/A announcements made by either station attendants or central control
  - Courtesy phones available to passengers to contact station attendants or central control
  - The physical presence of station attendants or other transit personnel
  - CCTV to monitor crowd activity
  - Smoke/fire sensors, sprinkler systems, and the availability of fire extinguishers.
- <u>Vehicle Related:</u>
  - Presence of onboard operator or attendant to

console passengers personally or via vehicle P/A

- Vehicle P/A announcements from central control

- Availability of 2-way communication between passenger and onboard transit personnel or central control

- Availability of emergency exits and fire extinguishers in case of fire.

A rather interesting observation was made when visiting the various properties in regard to passenger reactions during service interruptions. Passengers using transit systems in an airport environment appear to grow impatient more rapidly than passengers onboard subway, commuter or amusement type systems. This, of course, can be attributed to the fear of not making tight airline connections in situations where a delayed vehicle may be stopped within walking distance of the desired airline terminal. The need to provide passenger reassurance during delays in an airport environment then appears to become more crucial to prevent uncontrolled vehicle exits.

- <u>Calling Security</u>

Acts of crime and vandalism present a major problem area for some large subway type transit systems, while other smaller PRT or GRT systems located at amusement parks or airports experience relatively little crime. If and when criminal acts occur, it is imperative that provisions are readily available for contacting security or police personnel. Currently used methods /procedures used for dispatching security personnel include:

- In some situations a passenger may personally contact a security officer directly. For example: Sea Tac has "hi-jacking" security personnel that are on duty in most stations during normal operating hours. PATCO has officers with dogs that ride each train during late night operations. WMATA allows any police officer in uniform to ride their system free, thus increasing the immediate availability of security personnel.

- Onboard manned vehicles, the passenger can call for assistance by alerting the driver or vehicle attendant via a pushbutton or touch sensitive strip. Once alerted, the driver or attendant responds personally or via 2-way communications. In some cases, central control is contacted and security personnel are dispatched as required. It is interesting to note the different philosophies used by transit properties in response to this type of request. At TTC, the vehicle doors are deliberately left closed in the next station in order to trap any offender. BART's philosophy is just the opposite. They deliberately allow a means of escape from the system and attempt to apprehend the violator on the street.

- In unmanned vehicles, passenger requests are made directly to central control via 2-way radio communication. Central will then dispatch security to the next station to await the arriving vehicle. In some cases, they may even reroute or delay a vehicle to allow security enough time to respond.

- In manned stations, the passenger may go directly to the station attendant or in some cases, use the courtesy phone to contact the attendant, who in turn contacts central control. In manned stations, courtesy phones to central control or public telephones are available.

- At BART, all incoming calls to central control are handled by a police dispatcher while in other systems, central control personnel receive all calls and can dispatch security via a "hot line" telephone system or 2-way radio communications. Typically roving foot patrol security officers carry handie-talkies while vehicle patrolmen have vehicle radios. At most transit sites, when additional security assistance is required, security personnel can be readily dispatched from local police jurisdictions.

- It is feasible, but not frequently employed for security personnel to be dispatched by central control by coded messages in "all station" and "all vehicle" P/A announcements. This approach may cause adverse passenger reactions unless announcements are properly coded.

- In some situations, central control may discover the need for dispatching security without a request from other sources. Observing events in stations via CCTV or hearing a disturbance on a vehicle via 2-way communications may generate such a need.

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