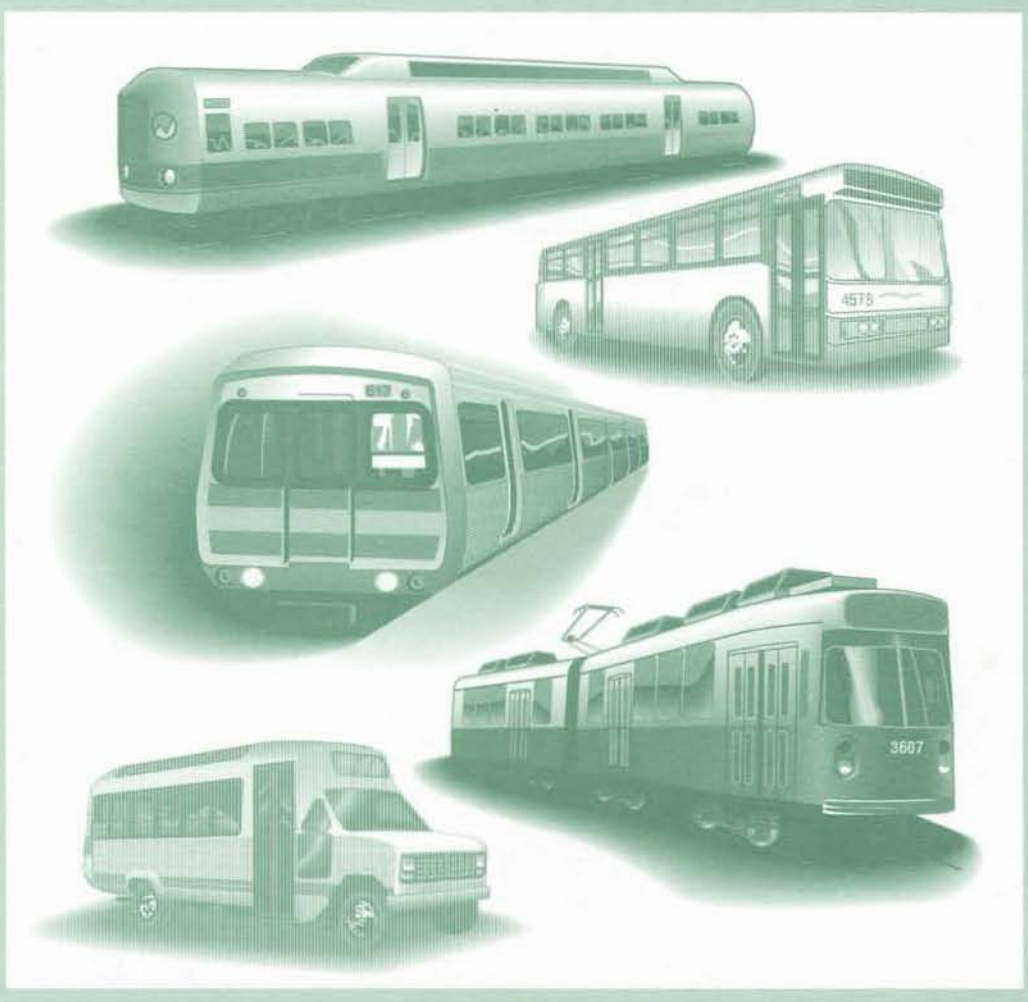
UMTA-MA-06-0186-89-1
DOT-VNTSC-UMTA-89-4

U.S. Department of Transportation
Federal Transit Administration

Recommended Emergency Preparedness Guidelines for Elderly and Disabled Rail Transit Passengers

U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, Massachusetts 02142-1093

August 1989
Final Report
Reprint
May 1997



FEDERAL TRANSIT ADMINISTRATION

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
UMTA-MA-06-0186-89-1		

4. Title and Subtitle	5. Report Date
Recommended Emergency Preparedness Guidelines for Elderly and Disabled Rail Transit Passengers	August 1989 Reprint May 1997
	6. Performing Organization Code: **DTS-43**
7. Author(s): William T. Hathaway, Stephanie H. Markos, and John N. Balog*	8. Performing Organization Report No.: **DOT-TSC-UMTA-89-4**
9. Performing Organization Name and Address: U.S. Department of Transportation, Research and Special Programs Administration, Transportation Systems Center, Cambridge, MA 02142-1093	10. Work Unit No. (TRAIS): UT901/U9502
	11. Contract or Grant No.
12. Sponsoring Agency Name and Address: U.S. Department of Transportation, Urban Mass Transportation Administration, Office of Technical Assistance and Safety, Washington, DC 20590	13. Type of Report and Period Covered: Final Report, November 1987 - March 1989
	14. Sponsoring Agency Code: UTS-3

15. Supplementary Notes
*Ketron Inc.
350 Technology Drive, Suite 20
Malvern, PA 19355

16. Abstract

Rail transit has become an important source of transportation for many elderly and disabled persons. The principal reasons for this increased use are improved accessibility, low cost, and expanded areas of service. For the purposes of this report, "elderly" is defined as any member of the population who is 60 years of age or older, and "disabled" is defined as any person who has some type of disability.

The Urban Mass Transportation Administration (UMTA) has recognized the need to consider the unique characteristics of elderly and disabled passengers in rail transit emergency response planning. The needs of these passengers can be addressed through carefully planned emergency response procedures, proper training of transit and emergency response personnel, and effective use of equipment. The recommendations contained herein are therefore intended to assist rail transit and emergency response organization personnel in evaluating their emergency response plans in terms of the needs of elderly and disabled passengers and, if necessary, to modify or supplement those plans accordingly. Section 2 discusses types of emergencies, characteristics of elderly and disabled individuals, and the rail transit environment. Included in Sections 3 and 6 are minimum recommendations, procedures, and criteria which should be employed by all rail transit systems to enhance their particular emergency plans for addressing the needs of elderly and disabled passengers. Sections 4 and 5 present minimum recommendations which will assist in the evacuation of elderly and disabled passengers from rail transit vehicles and facilities. The guidelines in these two sections are intended to be used primarily for the planning of new systems, extensions to existing systems, and system rehabilitation.

This report is intended to supplement the UMTA publication Recommended Emergency Preparedness Guidelines for Rail Transit Systems. That report contains general guidelines designed to assist rail transit systems in assessing, developing, documenting, and improving their capabilities for responding to emergencies and in coordinating those efforts with emergency response organizations.

17. Keywords	18. Distribution Statement
Rail, Rail Transit, Emergency Preparedness, Emergency Plan, Emergency Response, Emergency Equipment, Evacuation, Access and Egress, Elderly, Disabled, Handicapped	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	80	

PREFACE

The mass transportation system in the United States has seen an increase in the number of elderly and disabled persons who use mass transit. With this increase in use, the Urban Mass Transportation Administration (UMTA) has recognized the need to consider the unique characteristics and needs of elderly and disabled passengers in rail transit emergency response planning. The needs of these passengers can be addressed through carefully planned emergency response procedures, proper training of rail transit system and other emergency response organization personnel, and effective use of equipment.

This document contains recommendations designed to assist rail transit system and emergency response organization personnel in evaluating and modifying or supplementing their emergency response plans to address the needs of elderly and disabled passengers during rail transit emergencies.

These recommended guidelines were prepared under the sponsorship of UMTA, Office of Technical Assistance and Safety. The authors wish to thank Franz Gimmler and Ronald Kangas, of the UMTA Office of Safety, for their direction and guidance during the preparation of this document.

The authors wish to thank the following individuals for their assistance in preparing this document: William H. Henderson, Senior Services of Snohomish County, WA; Fred Goodine and Joseph Curtin, Massachusetts Bay Transportation Authority; Lyle Peterson and Kevin O'Brien of New Jersey Transit; Roger Wood, Charles Hallock, Robert Carpenter, and William Murray, Washington Metropolitan Area Transit Authority; Guy Wright and Thomas Rickert of San Francisco Municipal Railway; and Jason Baker, Gibbs & Hill Inc. Finally, the authors wish to express their appreciation to Robert Gaumer for his assistance in editing this report.

METRIC/ ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in) = 2.5 centimeters (cm)
1 foot (ft) = 30 centimeters (cm)
1 yard (yd) = 0.9 meter (m)
1 mile (mi) = 1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2) = 6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2) = 0.09 square meter (m^2)
1 square yard (sq yd, yd^2) = 0.8 square meter (m^2)
1 square mile (sq mi, mi^2) = 2.6 square kilometers (km^2)
1 acre = 0.4 hectares (he) = 4,000 square meters (m^2)

MASS-WEIGHT (APPROXIMATE)

1 ounce (oz) = 28 grams (gr)
1 pound (lb) = .45 kilogram (kg)
1 short ton = 2,000 pounds (lb) = 0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp) = 5 milliliters(ml)
1 tablespoon (tbsp) = 15 milliliters(ml)
1 fluid ounce (fl oz) = 30 milliliters(ml)
1 cup (c) = 0.24 liter (l)
1pint(pt)= 0.47 liter (l)
1 quart (qt) = 0.96 liter (I)
1 gallon (gal) = 3.8 liters (l)
1 cubic foot (cu ft, ft^3) = 0.03 cubic meter *(m^3)*
1 cubic yard(cu yd,yd^3) = 0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x-32)(5/9)]°F = y'C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm) = 0.04 inch (in)
1 centimeter (cm) = 0.4 inch (in)
1 meter (m) = 3.3 feet (ft)
1 meter (m) = 1.1 yards (yd)
1 kilometer (km) = 0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2) =0.16 square inch (sq in, in^2)
1 square meter (m^2) =1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2) = 0.4 square mile (sq mi, mi^2)
1 hectare (he) = 10,000 square meters (m^2) = 2.5 acres

MASS • WEIGHT (APPROXIMATE)

1 gram(gr) = 0.036 ounce (oz)
1 kilogram (kg) = 2.2 pounds (lb)
1 tonne (t) = 1,000 kilograms (kg) = 1.1 short tons

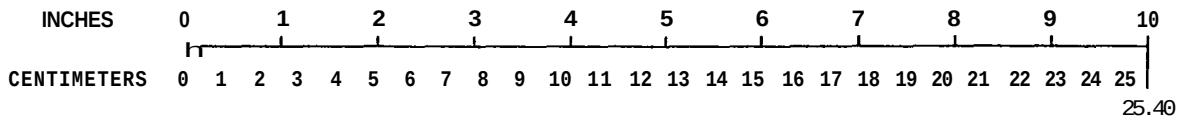
VOLUME (APPROXIMATE)

1 milliliter(ml) = 0.03 fluid ounce (fl oz)
1 liter (l) = 2.1 pints (pt)
1 liter (l) = 1.06 quarts (qt)
1 liter (l) = 0.26 gallon (gal)
1 cubic meter (m^3) = 36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3) = 1.3 cubic yards (cu yd, yd^3)

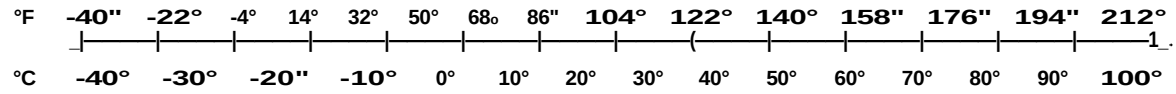
TEMPERATURE (EXACT)

[(9/5)y + 32]°C = x°F

QUICK INCH-CENTIMETER LENGTH CONVERSION



QUICK FAHRENHEIT-CELCIUS TEMPERATURE CONVERSION



For more exact and/or other conversion factors, see NBS Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50. SO Catalog No. C13 10 286.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

LIST OF FIGURES

TABLE

1. INTRODUCTION

Rail transit has become an important source of transportation for many elderly and disabled persons. The principal reasons for this increased usage are improved accessibility, low cost, and expanded areas of service. For the purposes of this document, "elderly" is defined as any member of the population who is 60 years of age or older, and "disabled" is defined as any person who has some type of disability.

Because of improved accessibility in transit systems, elderly and disabled persons who use wheelchairs or other personal assistive devices or who have visual impairments or medical, physical, or mental conditions are usually able to move within rail transit facilities and vehicles with no more effort than required in any other structure or vehicle. However, while many elderly and disabled passengers may have little difficulty using rail transit service under normal circumstances, they may not be able to move with the speed, agility, and sureness needed to evacuate rail transit vehicles and structures safely and quickly during emergencies.

In general, rail transit system emergency response planning, procedures, and methods have tended to focus on the general public rather than on elderly and disabled passengers. The elderly and disabled may present particular difficulties because of limited mobility, health conditions, or other reasons unrelated to the emergency. For example, even in an emergency that causes no injuries to the passengers, elderly and disabled persons may have special needs requiring attention by transit system personnel, until emergency response personnel arrive. Thus, many emergency procedures applicable to the general public will not be practical for elderly and disabled passengers.

1.1 PURPOSE AND SCOPE

The Urban Mass Transportation Administration (UMTA) has recognized the need to consider the unique characteristics of elderly and disabled passengers in rail transit emergency response planning. The needs of these passengers can be addressed through carefully planned emergency response procedures, proper training of transit and emergency response personnel, and effective use of equipment. The recommendations contained herein are therefore intended to assist rail transit and

emergency response organization personnel to evaluate their emergency response plans in terms of the needs of elderly and disabled passengers and, if necessary, to modify or supplement those plans accordingly. Included in Sections 3 and 6 of this document are minimum recommendations, procedures, and criteria which should be employed by all rail transit systems to enhance their particular emergency plans for addressing the needs of elderly and disabled passengers. Sections 4 and 5 present minimum recommendations which will assist in the evacuation of elderly and disabled passengers. It is intended that the guidelines in these two sections be used primarily for the planning of new systems, extensions to existing systems, and system rehabilitation.

This document is intended to supplement the UMTA publication Recommended Emergency Preparedness Guidelines for Rail Transit Systems1. That report contains general guidelines designed to assist rail transit systems in assessing, developing, documenting, and improving their capabilities for responding to emergencies and in coordinating those efforts with emergency response organizations.

1.2 PROJECT APPROACH

A rail transit emergency is a complex situation requiring many people to function swiftly, efficiently, and calmly to ensure passenger safety. There are several factors which could affect the safety of elderly and disabled passengers. First, the actual environmental conditions present in an emergency may pose a threat to the elderly and disabled. Because of circulation or respiratory problems, elderly and disabled passengers may be more sensitive to excessive heat, cold, or air contamination. Furthermore, emergency response personnel who are knowledgeable and skilled may be unable to reach the elderly or disabled or may be unable to transport critical equipment to the scene. Second, limited mobility, inability to communicate, and health problems unrelated to the emergency may slow the evacuation effort. Third, although emergency response personnel may be able to reach the emergency scene, their effectiveness in assisting elderly and disabled passengers can be limited because of the improper use of equipment or inadequate or infrequent training in evacuation procedures.

To develop the recommended guidelines contained in this document, the following approach has been used:

- The characteristics of elderly and disabled passengers are described, and the possible effects of these characteristics on emergency response, particularly evacuation, within the rail transit environment are indicated.
- Typical emergency scenarios are identified, and their potential consequences for elderly and disabled passengers are highlighted.
- Specific recommendations which consider the needs of elderly and disabled passengers are provided to assist rail transit systems in emergency response planning. This planning consists of developing procedures and providing personnel training and safety features that can enhance evacuation of these passengers.

1.3 ADDITIONAL SUPPORTING DOCUMENTATION

The following documents provide additional information which should be reviewed by rail transit and emergency response organization personnel:

- Passenger Assistance Techniques: A Training Manual for Vehicle Operators of Systems Transporting the Elderly and Handicapped[2]
- American National Standard for Buildings and Facilities - Providing Accessibility and Usability for Physically Handicapped People[3]
- NFPA 101. Life Safety Code[4]
- NFPA 130, Standard for Fixed Guideway Transit Systems[5]

Another resource used in preparing parts of this report was material prepared in support of a research project[6] performed for UMTA which surveyed methods for the evacuation and rescue of elderly and handicapped passengers from all public transit vehicles and structures.

2. EMERGENCY RESPONSE CONSIDERATIONS

The majority of rail transit operational problems do not become emergencies and are resolved without evacuation of passengers. Current emergency preparedness policies de-emphasize immediate evacuation from rail vehicles. During the majority of train emergencies, rail transit personnel attempt to move the train to the next station where stairs, ramps, escalators, and elevators may be used by passengers to exit the system. If the train cannot move or if the train cannot proceed because of hazardous conditions, a rescue train may be sent to the emergency site and positioned alongside or at one end of the affected train. This procedure allows passengers to leave the affected train and then be transported directly to a station. This alternative is preferable to having the passengers leave the train and walk along the trainway because of hazards such as obstructions, the third (power) rail, and inclement weather. Moreover, the ratio of passengers to transit personnel on board the average four-car train (and many systems operate trains of up to ten cars) may be as high as 600 to 1.

2.1 TYPES OF EMERGENCIES AND RESPONSE PROCEDURES

An understanding of the types of emergencies which are likely to occur and their related hazards is necessary for effective emergency response planning. Typical emergency scenarios include the following:

- Passenger collapse or fall on a vehicle or in a station;
- Stalled train;
- Collision or derailment;
- Fire or smoke in a trainway, station, or vehicle;
- Collision or derailment with injuries and with fire or smoke; and
- Sudden stop by vehicle.

In a scenario where there is no immediate danger (e.g., a stalled train), persons with medical conditions may experience stress and require medication. Even during circumstances which are under control (from the point of view of rail transit and emergency response organization personnel), passengers may panic if they feel

trapped, if communication with the outside is cut off, or if personnel are having difficulty reaching them. If it becomes necessary to evacuate a train, uninjured passengers are easiest to evacuate because they usually require only confident, informative leadership and only minimal assistance in walking. Even if uninjured, elderly and disabled passengers may need medical care or physical assistance to evacuate the emergency scene. Moreover, the evacuation of elderly or disabled passengers may be difficult if emergency response personnel cannot reach them or are unable to transport emergency equipment to the scene.

During a rail transit emergency, the type of response and the decision whether to evacuate elderly and disabled passengers may be affected by one or more of the following considerations:

- Type of emergency;
- Extent of the emergency response procedures;
- Mobility limitations, communication ability, and health conditions of elderly and disabled passengers;
- Location of the emergency;
- Type of facilities, structures, and vehicles;
- Type and amount of equipment available for evacuation; and
- Training of transit and other emergency response personnel.

Descriptions of potential emergency scenarios, the specific hazards they pose for elderly and disabled passengers, and recommended emergency response procedural guidelines are presented in Section 3.

2.2 CHARACTERISTICS OF ELDERLY AND DISABLED INDIVIDUALS

Elderly and disabled persons vary considerably in extent of mobility, communications ability, and other medical, physical, or mental conditions which they may possess. Elderly or disabled passengers who use rail transit may be:

- Able to walk without assistance;
- Able to walk with the use of a cane, a walker, or crutches;

- Wheelchair users;
- Visually impaired or blind;
- Hearing impaired or deaf;
- Speech impaired;
- Mentally impaired; or
- Some combination thereof.

During an emergency, elderly and disabled persons may therefore have some degree of difficulty performing any of the following:

- Going up or down stairs, inclines, or ladders;
- Stooping, kneeling, or crouching;
- Walking long distances, even at a very slow pace;
- Crawling;
- Waiting or standing;
- Moving in crowds;
- Sitting down or getting up;
- Reaching for, handling, or grasping objects;
- Moving dynamically (i.e., running, jumping, or reacting instantly);
- Moving within confined spaces;
- Establishing accurate depth perception; and
- Communicating (i.e., understanding instructions and making their own needs understood).

Although many elderly and disabled passengers may have little difficulty using rail transit under normal circumstances, the limitations listed above may prevent them from moving with the speed, agility, and sureness needed to evacuate rail transit

vehicles and structures safely and quickly during emergencies. Reference 2 contains extensive information about the characteristics and potential limitations of the elderly and disabled, and describes types of personal assistance devices used. A major consideration for emergency response planning is how mobility, communications, and other impairments may impede an effort to evacuate passengers from the rail transit environment.

2.2.1 Mobility

As noted in Section 2.1, uninjured, fully mobile passengers are the easiest to evacuate because they usually require only confident, informative leadership and minimal assistance in walking, while elderly and disabled passengers, on the other hand, may require special assistance to leave the vehicle or station and medical care. Both the ability of these passengers to move under their own power and the ability of rail transit and emergency response personnel to adapt to their needs and limitations directly affect evacuation operations. Transit system and emergency response personnel must decide when and how to move passengers and how to evacuate them through side and end doors of vehicles, up and down exit stairways, etc. Thus, passengers with limited mobility can impede an evacuation effort. During a rail transit emergency, mobility impaired passengers could find it difficult to do any of the following:

- Move through the aisle of a rail transit vehicle to an exit (passengers who use wheelchairs, walkers, canes, crutches, prostheses, or other personal assistive devices may find such movement especially difficult; in fact, such passengers may become trapped by these devices);
- Exit a vehicle without assistance if required to use a ladder, to climb through a window, or to move through a vehicle that has derailed and is severely tilted or overturned;
- Negotiate walkways, trainways, and emergency stairways that are obstructed, uneven, at varying levels, or narrower than a wheelchair or walker; and
- Travel long distances quickly without resting repeatedly (ANSI3 estimates that elderly or disabled persons would average only 200 feet in 2 minutes on level surfaces.).

2.2.2 Communications

The ability of passengers to hear, read, and understand instructions, or make themselves heard and understood during rail transit emergencies will affect response operations. For example, the inability of a passenger to understand an instruction because of a hearing or visual impairment could make it difficult to move that person to safety. Such an impairment may also make it difficult for these passengers to remain calm and confident because of a feeling that they are trapped or will not receive help.

The key point in communication is whether passengers are able to understand oral and written instructions and are then able to follow directions. During an emergency, elderly and disabled passengers may not be able to do any of the following:

- Understand that there is an emergency requiring evacuation from the area;
- Read and understand signs or instructions; and
- Hear and understand instructions.

2.2.3 Medical, Physical, and Mental Conditions

Many medical, physical, and mental conditions do not significantly limit the functional capabilities of elderly and disabled persons or may pose only temporary limitations, and may not be perceptible to an outside observer. Medical conditions which may not be continuously disabling include epilepsy, diabetes, asthma and other respiratory ailments, arthritis, and heart disease. Physical conditions include back or spinal conditions, degenerative muscle or bone conditions, cerebral palsy, nervous disorders, and missing or paralyzed limbs. Mental conditions include, memory loss, senility, retardation, and various degrees of psychological and psychiatric disorders, such as schizophrenia.

Under normal circumstances, rail transit passengers with medical conditions such as epilepsy and diabetes or who have cardiovascular, respiratory, or other impairments do not usually require special assistance while using transit facilities and vehicles. However, a stroke or heart attack, asthma flare-up, fainting, epileptic episode, a fall, etc. could in and of themselves be considered an emergencies, requiring medical assistance and evacuation. Because some passenger limitations are not readily

apparent, transit or emergency response personnel or other passengers may not recognize the immediate or potential need for special assistance to elderly or disabled passengers. Moreover, the lack of medication due to time delays and lack of medical assistance from those knowledgeable of a given condition or disability may cause or exaggerate conditions. In addition, elderly or disabled passengers may be more prone to injury from falls.

In summary, passengers with medical, physical, and mental conditions may be unable to do any of the following:

- Prevent the onset of adverse health conditions such as heart attacks, angina, shortness of breath, and palpitations under the stress of the situation;
- Function independently if medical conditions that require special treatment are aggravated, particularly if appropriate transit or emergency response personnel are unprepared or unable to provide the appropriate treatment, or if those in need are not carrying the necessary medication with them; and
- Actively contribute to evacuation efforts.

It should be recognized that the mobility, communications, and medical, physical, and mental limitations reviewed in this section are not shared by all elderly and disabled persons. Moreover, these limitations may exist in a variety of different combinations and degrees of severity.

2.3 RAIL TRANSIT ENVIRONMENTAL FACTORS

Compared with an automobile or a bus, rail transit represents a more confined transportation environment. This "confined envelope" consists of the rail transit train (one to ten vehicles) and physical structures (trainways and stations). The trainways and stations may be located in tunnels, on a grade, in open cuts, or on elevated structures. Each of these environments pose concerns for elderly and disabled passengers during emergency situations.

The following environmental factors directly affect the success of emergency response efforts:

- Type and location of the rail transit vehicle, trainway, or station;

- Trainway obstructions;
- Air quality (ventilation);
- Visibility;
- Weather; and
- Access of emergency response personnel with equipment to the trainway, station, or vehicle.

While these factors affect the evacuation of all passengers, they are a particular problem when evacuating elderly and disabled passengers. Negotiating a rail transit trainway, structure, or even a vehicle aisle and operating the control (or handle) for an emergency exit may require a degree of balance, strength, agility, and steadiness which many elderly and disabled persons may not possess. Moreover, although the station, vehicle, or trainway floor may be relatively free of obstructions, vertical discontinuities and gaps could cause problems for passengers with visual or mobility impairments.

The possibility of contact with the third rail also exists during emergency evacuations. A generally accepted procedure is to remove third rail power from the emergency site. However, because of human error or equipment malfunction, third rail power may not be removed, or it may be restored before evacuation operations are completed. Poor visibility and lack of coverboard protection could also cause the third rail to be hazardous.

Passengers with respiratory conditions such as asthma or emphysema can be particularly affected by lack of oxygen or poor air quality caused by limited ventilation. In addition, lack of ventilation can reduce visibility.

Inclement weather can also compound the difficulties of evacuation and rescue, especially where rail transit vehicles operate in open areas such as ground-level rights-of-way or elevated structures. Rain, snow, sleet, ice, and high winds make evacuation hazardous for transit personnel and all rail passengers, but particularly hazardous for the elderly and disabled. Footing and movement becomes precarious, increasing the risk of falling and sustaining serious injury. In addition, the possibility of touching the third rail increases during inclement weather, as evacuees or emergency response personnel carrying or assisting elderly or disabled passengers

are more likely to lose their footing and slip or slide. Inclement weather can also reduce visibility or obscure lighting.

Finally, inability on the part of emergency response personnel to gain access or transport emergency equipment to the emergency scene can make the evacuation of the elderly and disabled very difficult, even if the emergency itself caused no physical injuries.

Moreover, all of these environmental difficulties tend to become even more acute at night.

Sections 4 and 5 further describe characteristics of typical rail transit vehicles and facilities which could affect the safety of elderly and disabled passengers during emergencies. These sections also identify specific concerns and present recommendations to address those concerns.

2.4 RESPONSE PERSONNEL PERFORMANCE

To be able to respond effectively to the special needs of elderly and disabled passengers during emergencies, it is necessary that rail transit and emergency response personnel possess the appropriate knowledge and skills applicable for those individuals. Proper training is of major importance because inadequate knowledge of the characteristics of the elderly and disabled and the inability to adequately respond to their special needs during a rail transit emergency may cause injury; aggravate physical, medical, and mental conditions; or delay the evacuation. Moreover, it may be necessary for rail transit or emergency response personnel to assist these passengers prior to the evacuation effort, by re-positioning them to permit proper breathing or to relieve pressure which may not cause injury but may create excruciating pain. Thus, emergency response training which includes these types of concerns is essential to address the particular needs of elderly and disabled passengers. Section 6 contains a more detailed discussion of training programs and presents recommendations which provide guidelines for training program scope and content. In addition, Section 6 discusses the benefits of emergency drills/simulations and describes the role of passenger awareness and transit system information sharing.

3. EMERGENCY SCENARIOS AND EMERGENCY PLANNING AND PROCEDURES

The majority of rail transit systems have developed formal emergency response procedures. Although rail transit emergency response procedures contain references to elderly and disabled passengers, these procedures generally do not address the special needs that may make the evacuation of those passengers more critical and complex than that of other passengers. For example, one rail transit system reference to evacuation of wheelchair users is limited only to instructing its employees to avoid trying to take wheekhairs through end doors because the wheelchairs can become wedged between cars and can hinder the evacuation of other passengers. This type of instruction does not provide positive methods to use when evacuating wheelchair users and does not address the broader range of procedures which could be helpful when evacuating elderly and disabled passengers under different types of conditions.

Evacuation of elderly and disabled individuals from rail transit emergencies may be more complicated and difficult than evacuation of other persons for the following reasons:

- Passengers may have conditions (physical, medical, or mental) which could be aggravated or which affect the type of treatment and manner of administration.
- Passengers may become trapped or impaled by the aids that generally improve their mobility (e.g., wheelchairs, walkers, crutches, prosthesis).
- Passengers may not be able to physically contribute to extrication maneuvers.
- Passengers may have to be immobilized before they can be removed from the vehicle or station.
- Passengers may not be able to communicate or understand instructions.
- Passengers may not be rational.

To develop emergency response procedures that specifically address the needs of elderly and disabled passengers, it is important to understand what kinds of situations may require emergency response. Six basic rail transit emergency scenarios, their associated hazards, and recommended guidelines for developing procedures are presented in this section. These scenarios are listed in Table 3-1. The table also indicates the likelihood of injury and whether evacuation is likely to be required. A brief description of each scenario and the specific concerns associated with the evacuation of elderly and disabled passengers are reviewed in the following subsections.

TABLE 3-1. POTENTIAL EMERGENCY SCENARIOS AND LIKELY CONSEQUENCES

POTENTIAL EMERGENCY SCENARIO	IS INJURY LIKELY TO OCCUR?	IS EVACUATION LIKELY TO BE REQUIRED?
Passenger collapse or fall in vehicle or station	Yes	Not necessarily*
Stalled train (power outage, flooded tunnel, etc.)	No	Not necessarily*
Vehicle collision or derailment without fire	Yes	Yes
Fire or smoke in a station, trainway, or vehicle	Yes	Yes
Collision of vehicles or derailment with fire or smoke	Yes	Yes
Sudden stop of a train	Yes	Not necessarily *

* Depends on the severity of injury or duration of scenario

3.1 PASSENGER COLLAPSE OR FALL

For the purposes of this document, the collapse or fall of an elderly or disabled passenger is considered to be an emergency and should be addressed as such. Respiratory and heart conditions place many elderly and disabled (especially those with hidden impairments) in the group of people most susceptible to collapse. Stress, exhaustion, heat, humidity, and sickness could aggravate these conditions and cause an elderly or disabled passenger to collapse or fall while in a vehicle or station. Visually impaired or mobility impaired passengers could also trip or be unable to maintain their balance and fall. (A passenger could also collapse or fall during an emergency.) Collapse or fall could cause bodily injury (i.e., concussion or broken bones) or may aggravate existing medical conditions.

The degree of risk associated with the collapse or fall of a elderly or disabled passenger is related to the severity and location of the collapse or fall. For example, if a passenger faints from heat but the fall is braced and the passenger recovers within a few minutes, there is probably little or no risk. However, if a passenger faints, hits his or her head, and becomes unconscious, evacuation is required because the blow to the head can cause internal injury. The severity of such an injury may not be immediately apparent, particularly if the passenger recovers consciousness within a few minutes.

It is not usually possible for onlookers, whether passengers or transit personnel, to diagnose the medical reason for or consequence of a collapse or fall. It is therefore unlikely they will know what corrective action to take. In fact, movement of a collapsed or fallen passenger by untrained people could actually cause additional harm. In addition, many passengers take special medication. Although many of these passengers wear medical alert tags or bracelets and carry dosages of their medication, a passenger on special medication who collapses or falls and becomes unconscious will not be able to volunteer information relating to the proper dosage or method of administering the medication. Other passengers might be unaware that this passenger is carrying medication, unfamiliar with correct methods of administration, or ignorant of the correct dosage and thus either not respond or respond incorrectly.

3.2 STALLED TRAIN

A stalled train is the cause of most common rail transit delays. Depending on the length of time and the location of the stalled train, this situation could develop into an emergency situation requiring evacuation. In the absence of injuries, fire, or smoke, a stalled train normally creates no immediate need for either medical aid or evacuation. However, because of their special needs, many elderly and disabled passengers may have difficulty coping with this situation.

The hazards associated with a stalled train are loss of lighting, poor ventilation, extreme heat or cold, inability to communicate adequately (orally and visually), medical conditions, confusion, fear, disorientation, loss of contact with train personnel, and lack of mobility.

If a power failure occurs, for example, and power is not likely to be restored for an extended period of time (e.g., over an hour), transit system officials may decide to evacuate passengers from the affected trains. In that case, the obstacles to evacuation of elderly and disabled passengers range from non-existent to insurmountable, depending on their capabilities, the type and condition of the trainway, and the distance to the nearest emergency exit or station. For example, passengers may be visually impaired, may have limited mobility (e.g., wheelchair users), or could be in a cast or brace, all of which are conditions requiring special assistance during evacuation. During the process of evacuation, the physical strength of elderly and disabled passengers may be overtaxed and medical treatment could be necessary.

If the stalled vehicle is in a tunnel or on an elevated structure, the walkways may be too narrow to accommodate wheelchairs, and those passengers would have to be carried. Other passengers may have difficulty walking along the walkway because of impaired vision or lack of a railing to provide assistance for maintaining balance. Inclement weather could delay the arrival of transit and emergency response personnel, vehicles, and equipment. Ice and snow could aggravate mobility limitations, causing an elderly or disabled passenger to slip, slide, or fall, even if assisted.

In general, the evacuation of passengers from a stalled train will occur only if there is a system-wide power failure without prospect of early restoration. (Such a failure

may occur because of electrical overloads or during a storm.) The procedure generally used is to couple the stalled train to a functioning train and push or pull it to the next station.

3.3 VEHICLE COLLISION OR DERAILMENT WITHOUT FIRE OR SMOKE

Two serious concerns for passengers in a collision or derailment are the delay in the response of rescue personnel and unavailability of adequate first aid. If injuries occur, timeliness in the treatment of the injured passengers is the highest priority. First aid from fellow passengers or transit personnel may help but will probably be inadequate. Although injured passengers must be taken from the disabled vehicle, swiftness of evacuation is generally secondary to immediate treatment.

Elderly and disabled passengers may not be aware of their own injuries. For example, if a passenger indicates severe pain in a leg, response personnel may assume that the leg has been broken. On the other hand, wheelchair passengers with paralyzed limbs may suffer broken bones or suffer burns without being aware of the injury. In addition, some elderly or disabled persons may be more susceptible than other passengers to shock and injury.

Evacuation from a vehicle that has been damaged from the collision or derailment can be more difficult for elderly or disabled passengers than evacuation from a stalled train, especially if the accident has blocked the exit or the path to the exit. Elderly or disabled passengers may be unable to extricate themselves from their seats or to leave through end doors. Medical, physical, or mental conditions may also leave passengers unable to assist in their own evacuation.

3.4 FIRE OR SMOKE

Fire in a rail transit system is a life threatening situation, which requires rapid evacuation of all passengers to avoid casualties resulting from burns or smoke and toxic gas inhalation. During a fire, the special needs or impairments of the elderly and disabled may put them at particular risk.

When any emergency involving fire or smoke occurs, evacuation must be accomplished rapidly to minimize the chance that passengers will be burned or overcome by smoke. The passengers in the greatest danger are those persons who

cannot walk at all, who are able to walk only at a slow pace, or who have respiratory conditions.

Fire often causes panic and confusion. Smoke may decrease visibility, making it hard for passengers to find emergency exits. Oxygen is reduced, making breathing difficult. Stamina decreases, and thus the ability to withstand the rigors of evacuation diminishes. This decreased stamina is particularly critical if passengers must climb long staircases to exit the station or trainway.

3.5 VEHICLE COLLISION OR DERAILMENT WITH FIRE OR SMOKE

The most serious emergency which could occur in a rail transit system is a vehicle collision or derailment that involves fire. This combination of circumstances makes evacuation more difficult than for either condition separately, yet evacuation is more imperative. Immediate evacuation of injured passengers takes precedence over treatment of the injured atthescene.

The hazards of this scenario are similar to those in the fire or smoke scenario: burns and smoke and toxic gas inhalation. In addition, the hazards are aggravated by the possibility that many passengers and on-board personnel might sustain injury during the collision or derailment and may require immediate treatment.

3.6 SUDDEN STOP OF TRAIN

Passengers are not normally prepared for the sudden stop of a fast-moving train. A sudden stop is usually caused by something external to the normal operation of the train such as an object on the track or trainway. Another cause could be the activation of the train emergency brake by a passenger or a member of the train crew.

The hazards of a sudden stop are in certain respects similar to those associated with collisions, which are also sudden stops. In any case, the force of a sudden stop is likely to knock passengers off their feet or out of their seats and thus cause physical injury. Passengers may believe that there has been a collision or derailment and begin to panic. Once again, the elderly and disabled could be at somewhat greater risk because of their limitations and special needs. Passengers using wheelchairs, walkers, canes, or other personal assistive devices may be separated from them by a

sudden stop or may be unable to brace themselves. The surprise and stress of the stop may also aggravate some health conditions.

As in the passenger collapse or fall and vehicle collision or derailment without fire or smoke scenarios, the priority is to administer medical treatment to the injured rather than to evacuate the vehicle. Once injured passengers are stabilized, however, they may need to be evacuated and taken to a medical facility.

3.7 GENERAL GUIDELINES FOR DEVELOPING EMERGENCY RESPONSE PROCEDURES

Rail transit systems and emergency response organizations should develop procedures which their personnel can use to ensure the swift and efficient evacuation of elderly and disabled passengers from an emergency scene.

The following questions constitute a suggested checklist for determining what action to take when elderly and disabled passengers are involved in a rail transit emergency:

- What type of emergency is present (i.e., train derailment or collision, fire, passenger collapse or fall, etc.)?
- Is the emergency on a train or in a station? If on a train, is the train at grade, on elevated track, or in a tunnel? If in a station, is the station at grade, elevated, or underground?
- How many elderly and disabled persons are on board the train or in the station?
- Where are the elderly and disabled passengers located on the train (i.e., in which cars)?
- What are the specific impairments or disabilities of each person?
  - Limited or no mobility
  - Visual or hearing impairment
  - Other medical, physical, or mental condition

- Are passengers able to understand oral directions? Are transit or emergency response personnel able to communicate by written means or with hand signals?
- What kind of injuries do the elderly and disabled have?
- What kind of special equipment is available at the scene or must be brought in? Who provides this equipment?
- What is the nearest access point for the rail transit and emergency response personnel and egress point through which to evacuate?
- How many train or station personnel are immediately available at the scene?
- Who decides when (in what order) the elderly and disabled are evacuated and on what basis?
- Who coordinates the evacuation: rail transit personnel or emergency response organization personnel?

The following general guidelines are intended to assist rail transit and emergency response organization personnel in preparing for a range of potential contingencies. There are many procedures that are applicable regardless of emergency scenario, although each scenario has its own characteristics. These guidelines should be adapted to meet the specific needs of elderly and disabled passengers and the particular type and location of the emergency.

- If possible, all passengers involved in an emergency should be asked to state and describe any disabilities or medical conditions to avoid aggravation of these conditions.
- If a passenger collapses or falls, the train crew or station personnel should contact Central Control and request an ambulance to meet the train at the nearest accessible station.
- After a sudden stop, the train crew should check with passengers to see if injuries have occurred.

- Available transit personnel who are appropriately trained should administer basic first aid until emergency medical services (EMS) personnel arrive.

- Transit and emergency response personnel should look for passengers who may require medical treatment for conditions that are not directly related to an emergency and that may not be readily discernible, such as diabetes and epilepsy. The most obvious source of personal medical information is medical alert tags.

- Transit and emergency response personnel should be aware that an apparently severely distorted limb or apparent dismemberment may only be an artificial limb or other prosthesis.

- Appropriate transitand emergency response personnel should be familiar with basic procedures for communicating with persons who have visual, hearing, and speech impairments. (See Appendix A.)

- Emergency response personnel should be familiar with the various techniques for carrying passengers who are paralyzed or who have other mobility limitations to avoid further injury. (See examples in Appendix B.)

- During inclement weather, separate procedures may be required depending on whetherthe stalled train is located atground level or on an elevated trainway. Emergency procedures should specify techniques and equipment for evacuation during the inclement weather conditions (such as snow, ice, flooding, etc.) that are likely to occur in the system's region.

- An alternate evacuation route should be designated in advance in case the original route cannot be used by elderly and disabled passengers.

- If station or vehicle ventilation can be controlled, rail transit personnel should be familiar with the location of vents, manual operation, and backup systems and procedures to follow if there is a malfunction.

- Requests for assistance from able-bodied passengers and instructions on evacuating elderly and disabled passengers should be given directly by the appropriate personnel.

4. VEHICLES

The rail transit vehicle is one of two environments (the transit station being the other) which rail transit passengers normally come into contact with. Typical high-platform rail transit vehicles (Figure 4-1) and typical low-platform rail transit vehicles (Figure 4-2) operate by electricity, usually 600 volts D.C., received from a third rail or from an overhead catenary wire. Power passes into the vehicle through a current collector or pantograph. The number of vehicles in the train may vary from one to ten cars; the number of rail transit personnel on board also varies, but is generally limited to not more than two individuals.

The purpose of the guidelines presented in this section is to identify those vehicle features which would be useful when evacuating elderly and disabled passengers during emergencies.* These guidelines are meant to be used primarily when procuring new vehicles or when rehabilitating existing vehicles.

4.1 SEATING AND INTERIOR ARRANGEMENT

Rail transit vehicles have one of three basic interior seating arrangements: longitudinal, transverse, or transverse-longitudinal. Longitudinal seats (Figure 4-3) are located along the sides of the vehicle facing the interior. Vehicles with longitudinal seating usually have vertical stanchions, which serve as hand grips, along the outer edge of the seats and along the centerline. The vehicle may also have hand grips located overhead or on seat backs. Transverse seats are located in rows so that passengers sit behind one another facing an end of the vehicle (Figure 4-4). Vehicles with transverse seating usually have overhead hand grips or horizontal bars and limited use of stanchions. Most transverse seat backs have hand holds to supplement the overhead hand grips or bars. Some vehicles have a combination of transverse and longitudinal seating. In those cases, longitudinal seats are usually located near doorways to reduce congestion.

4.1.1 Concerns

The first obstacle that elderly and disabled passengers may face during an emergency is moving through the interior of the vehicle to reach an exit door. The

* For additional information concerning vehicle emergency features, see Reference 1, Recommended Emergency Preparedness Guidelines for Rail Transit Systems.

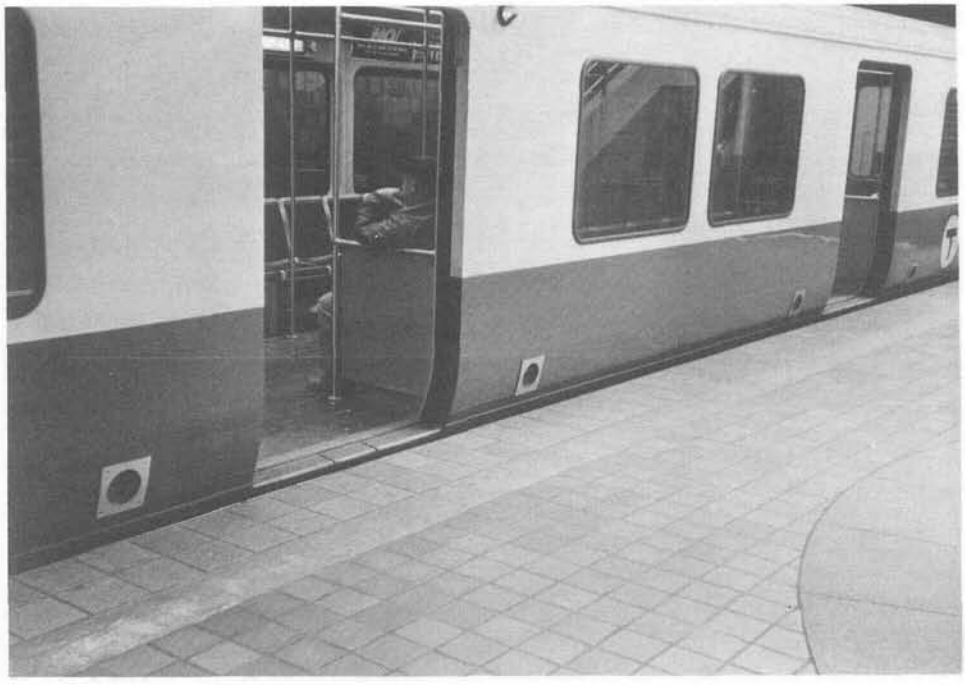


FIGURE 4-1. HIGH-PLATFORM RAIL TRANSIT VEHICLE

FIGURE 4-2. LOW-PLATFORM RAIL TRANSIT VEHICLE

FIGURE 4-3. LONGITUDINAL ARRANGEMENT OF SEATS

FIGURE 4-4. TRANSVERSE ARRANGEMENT OF SEATS

seating arrangement and the location of stanchions, hand grips, etc. may determine how quickly passengers can move to the exits. Transverse seating will slow the movement of the ambulatory or semi-ambulatory passengers more than longitudinal seating. However, either seating arrangement may restrict or even prevent the movement of passengers using wheelchairs or other personal assistive devices. The narrow aisles of the transverse seating arrangement are likely to pose considerable difficulty to those passengers using personal assistive devices. Although longitudinal seating provides a wider aisle, a row of vertical stanchions along the center line of the vehicle can impede passengers using personal assistive devices.

Elderly and disabled passengers may have difficulty reaching overhead bars or grips to maintain their position or balance or to break a fall. Padded and covered hand grips on seats, which enhance comfort and provide protection from sudden impact, cannot always be gripped firmly by elderly and disabled persons and may thus contribute to falls.

4.1.2 Recommendations

Seating arrangements that provide for the evacuation needs of the elderly and disabled should be considered. (Those rail transit systems that are already accessible to the elderly and disabled generally have designated areas for securing wheelchairs and may have aisles wide enough for wheelchairs to pass.)

- When designing new vehicles or rehabilitating older vehicles, rail transit systems should configure the interior seating with aisles wide enough for wheelchair users and other passengers using personal assistive devices to provide an unobstructed exit path.

- In some cases, the bases of vertical stanchions may need to be set back or angled toward the sides of the vehicle to minimize interference with crutches, canes, etc., and to provide sufficient width for moving wheelchairs.

- Consideration should be given to locating seating areas for elderly and disabled passengers within the vehicle which allow direct, short-distance, unhindered access to one of the principal vehicle exits.

- Provisions should be made for securing wheelchairs at a location close to, but not blocking, one of the vehicle exits.

- Handgrips and stanchions which can be reached and gripped firmly by the elderly and disabled should be provided throughout the vehicle.

- Consideration should be given to textured surfaces for handgrips and stanchions to permit a more secure grip.

4.2 ACCESS AND EGRESS

Two or more sets of sliding bi-part or bi-fold doors are usually located on each side of the vehicle for passengers to enter or exit at station stops. Single doors may be located at each end of heavy rail vehicles to allow passengers to walk from one vehicle to the next. Heavy rail vehicles typically use platforms which are the same height as the vehicle floor, thereby eliminating the need for steps (as illustrated in Figure 4-1). The majority of light rail transit vehicles, on the other hand, have steps at each side door requiring passengers to step up or down to enter or leave the vehicle (as illustrated in Figure 4-2). Certain light rail vehicles are equipped with steps which convert for high-platform use or with lift equipment which transfers wheelchair passengers from street level up to the vehicle floor.

Emergency access to and egress from a rail transit vehicle may be achieved through side doors, end doors, and windows. Not all vehicles have doors on both sides, and/or end doors. Some doors and windows cannot be opened by passengers. The majority of rail transit systems have ladders stored either within vehicles or along the rights-of-way to aid in evacuation. Most low-platform vehicles have a stepwell to the trainway level that eliminates the need for ladders during an evacuation (unless the location of the train is on an elevated structure during the emergency).

4.2.1 Concerns

Unless passengers understand how to operate the emergency door-opening features, they may believe that the windows are the only way to exit. If the vehicle doors cannot be opened immediately from either the inside or the outside, passengers may panic and break windows, and elderly and disabled passengers could be injured as others scramble to get out of the vehicle. The elderly and disabled may be unable to evacuate the vehicle through the windows or may risk

injury if they try to do so. Lack of clear identification or lighting could make it difficult to locate the doors or other emergency exits. Moreover, because of confusion or anxiety, elderly and disabled passengers may not understand operating instructions. Furthermore, if a power loss occurs for the door controls, it may be impossible for transit personnel to open both of the vehicle side doors from the normal control station (in the train cab). Certain side-door emergency controls permit the opening of only one bi-part sliding door; this could make it very difficult to move certain passengers through the side doorway.

Impaired mobility and other physical or medical conditions may make getting down from the train to the trainway at the end doors and getting from the side doors to the walkways extremely difficult, if not impossible. Although most rail transit systems have ladders on the vehicles or along the trainway, these ladders may be extremely difficult or impossible for elderly and disabled passengers to use and may slow the evacuation as well.

4.2.2 Recommendation

- Rail transit systems should evaluate special evacuation equipment and should use it as appropriate to enable the swift removal of elderly and disabled passengers from the vehicle (see Appendix C).

4.3 VISIBILITY

The power for the rail transit vehicle is provided from a third rail or a catenary wire. For interior lighting, this power is generally converted through the low-voltage power supply. There is also an emergency back-up lighting supply powered by batteries, independent of the main system. Most emergency lighting systems are designed to illuminate the areas around the side and end exit doors, as well as strategic locations within the vehicle itself.

4.3.1 Concerns

Elderly and disabled passengers will benefit from having as much visibility as possible to read graphics, find medication, and see where they are going. Lighting also has a psychological, calming effect.

Inadequate visibility within the vehicle could compound the difficulties of the elderly and disabled passengers during an emergency. If the normal lighting or

emergency lighting fails, passengers may believe that conditions are worse than they really are. Inadequate lighting may also make it difficult or impossible to read any emergency information posted in the vehicle, to locate the emergency exit, or to move within the vehicle to the emergency exit. In the darkness, passengers with impaired vision could stumble or fall while trying to reach the exit point or while descending or ascending the vehicle.

4.3.2 Recommendations

- Rail transit systems should review vehicle emergency lighting requirements to ensure that sufficient light is available during an emergency for the safe evacuation of all passengers.
- Consideration should be given to providing emergency lighting at or close to floor level to illuminate potential evacuation paths to exits.
- Consideration should be given to the use of contrasting colors and luminous paint or materials for floor and wall areas to identify the area around exit doors.
- Train crew personnel should announce reductions in lighting over the public address system to avoid alarming passengers.

4.4 GRAPHICS

Graphics are the informational symbols indicating the location and use of essential vehicle equipment. Rail transit systems use a variety of graphics within the vehicles. They are essential to identify and operate emergency exits, emergency equipment, etc.

4.4.1 Concerns

The information conveyed by graphics in rail transit systems can be confusing. Vehicle emergency exits may not be clearly marked, and directions on how to operate the exits are not always visible or understandable. Even worse, there may not be any signs marking exits or instructing their use. In the absence of such signs, passengers may unintentionally operate exits or emergency equipment incorrectly or in a dangerous manner. While inadequate or nonexistent identification of emergency exits and exiting instructions could impede or delay the evacuation of

any passenger, the impact could be even greater on the visually impaired. Furthermore, if energy is expended on an erroneous action, elderly and disabled passengers may severely tax or even deplete their energy and strength for taking corrective action.

4.4.2 Recommendations

- Signs that clearly identify the direction and location of emergency exit doors and exit ladders and how to open and use them should be provided in each vehicle.

- The use of luminous or light-reflective paint should be considered for use on all signs, arrows, or other graphics which indicate the location of emergency exits.

- Instructions should be posted in strategic locations within the vehicle and should be positioned to receive sufficient lighting from both the vehicle's regular and emergency lights. The instructions should be written in language that the lay person can understand quickly, using letters that are large enough for people with some sight impairment to read. Clear, recognizable illustrations will help comprehension.

- In addition to English, the posted emergency instructions should be provided in the language of the local community.

4.5 VENTILATION

Rail transit vehicles may have forced ventilation or an air conditioning system. Forced ventilation uses fans and dampers to bring in fresh air from the outside and to circulate it throughout the vehicle. Air conditioning cools and recirculates the same supply of air over and over.

4.5.1 Concerns

Smoke or inadequate oxygen supply may aggravate respiratory conditions of elderly and diasbled passengers. Breathing becomes difficult, stamina decreases, and thus the ability to withstand the rigors of evacuation diminishes. Visibility may diminish, making it hard for elderly and disabled passengers to locate exits.

4.5.2 Recommendation

- A means to control or shut off the outside air intake dampers, fans, and other air circulation equipment should be provided in each vehicle.

4.6 COMMUNICATIONS

There are two methods of communication, other than face-to-face, available for use on vehicles: public address (PA) systems and intercoms. PA systems enable the train crew and Central Control to announce instructions to the passengers. Intercoms, where provided, allow passengers to talk to the train crew in an emergency.

4.6.1 Concerns

A lack of or inadequate communication to passengers can cause anxiety and confusion, particularly for the elderly and disabled. The key point in communication is whether elderly and disabled passengers are able to understand instructions and follow directions. For example, the inability of an elderly or disabled passenger to understand an instruction because of visual, hearing, or mental impairment could make it difficult to move that person to safety.

Failure of the public address system could also prevent passengers from hearing instructions.

4.6.2 Recommendations

- A means for passengers to talk directly to the train crew should be provided within each vehicle. This means should be clearly identified, and instructions for its use should be prominently displayed.

- Alternate means of communication as a backup to the public address system (such as a bull horn) should be provided in each train cab.

5. FACILITIES

The design and construction of stations, elevated structures, tunnels, and platforms vary from system to system, as well as within systems. Heavy and light rail vehicles operate in a variety of physical environments. Stations can be underground, elevated, at grade, or within open cuts. Trains operate along trainways located in tunnels and underwater tubes, on elevated structures, and on the surface (at grade, within open cuts, and on city streets). Trainways may use separate "dedicated" rights-of-way, run under bodies of water, or may operate on city streets. Trainways may contain one to six tracks and may have separate tracks for local and express trains. Each of these environments presents different concerns which should be addressed to ensure the safety of elderly and disabled passengers during emergency response, particularly with respect to evacuation. The remainder of this section reviews these concerns and presents recommended guidelines to address them.

The recommendations presented in the following subsections are designed to assist rail transit systems to ensure that their facilities and structures do not hinder the effective evacuation of elderly and disabled passengers. These guidelines focus primarily on transit system trainways and are intended for use primarily in planning new systems, system extensions, and system rehabilitation.*

5.1 ACCESS AND EGRESS

Various factors influence the type and location of access and egress points for stations and trainways, including designated emergency exits. These include the location, height, and depth of the station or trainway; date of construction (i.e., recent vs. older); and local building codes. Various means are used to provide rail transit station access and egress including fare gates, rotating bars, stairs, escalators, elevators, and emergency exits.

5.1.1 Concerns

During a train evacuation, passengers may be able to exit directly from the vehicle to a walkway or may have to step down from the vehicle to the trainway. The elderly

* For additional information concerning emergency features for facilities and equipment, see Reference 1, Recommended Emergency Preparedness Guidelines for Rail Transit Systems.

and disabled may have greater difficulty than other passengers leaving the vehicle because of the vehicle floor height in relation to the trainway or walkway. An emergency exit from the trainway may be used if located nearby, or passengers may have to walk along the trainway or walkway to the closest station. Because of mobility limitations, visual impairments, or other conditions, elderly and disabled passengers may find it difficult to negotiate the trainway, walkway, or exit.

Elderly and disabled passengers, e.g., those with vision and mobility impairments, may be especially susceptible to tripping or falling while trying to negotiate the evacuation path. Ties, ballast, cable, etc. along the trainway roadbed, walkways, and adjacent transit property (left during or after construction or rehabilitation); water leakage or flooding; and uneven or slippery walking surfaces (because of grates, ice, etc.) could all hinder passengers attempting to leave an emergency scene. The components of the roadbed itself, such as the third (power) rail, ties, drains, and ballast that lie between the rails or near the third rail may cause loss of footing. Passengers who are disoriented or who possess mobility limitations could also touch the third rail. In emergencies where power is lost or turned off by the system control center, the danger of third rail contact is reduced, but if power is restored before evacuation is completed, passengers could be injured. Moreover, passengers must watch for rail crossovers, signaling apparatus, train control apparatus, and the possible movement of other trains. Dim tunnel lighting (or darkness due to power loss or heavy smoke) could aggravate these hazards.

The dedicated trainways of many new systems (and recent extensions of older systems) contain walkways, while many older systems do not. The typical walkway is between 20 and 30 inches wide running along one wall of the trainway. The majority of walkways are located at roadbed level; however, some walkways are built 2.5 to 3.5 feet above track level in tunnels. Although some walkways do have handrails, others do not. Walkway surfaces may be slippery, uneven, or quite narrow. A walkway may be wide enough for the general passenger, yet too narrow for persons using walkers, crutches, and wheelchairs. In tunnels and on elevated structures, if there are no handrails, if the wall curves, if the walkway is narrow, or if electrical equipment or stand pipes protrude, walkways will be difficult to negotiate, especially for persons with impaired mobility. Because most wheelchairs are too wide to negotiate the typical 20-inch-wide walkway, the vast majority of wheelchair users would not be able to use walkways. Even if the walkway were 30 inches wide (standard wheelchair width), passage would still be precarious, particularly if the

third (power) rail is alongside it. The reliability of emergency exit door operation is also a concern. Exit doors may be stuck or jammed, awkward to open, or locked. Some exit doors must be pushed open from below, a task that can be difficult even for general passengers. This is particularly true for very heavy horizontal exit doors unless they are properly counterbalanced.

Some tunnels contain vertical shafts equipped with stairways, ladders, or a combination of both leading to an emergency exit. Vertical exits, in particular, are hazardous because they can act like chimneys if there is a fire, exposing passengers to fire and smoke; moreover, these vertical shafts would be extremely difficult for most elderly and disabled passengers to ascend. For these passengers, the nearest exit may not be the appropriate pathway for egress. For example, if egress must be accomplished by ascending a ladder, it is likely that many elderly and disabled will either not be able to use it at all or be very slow in climbing.

Another concern regarding access and egress is that the counterflow of emergency response personnel at access and egress points where passengers are exiting can create confusion and prevent personnel and equipment from reaching the emergency scene. This may create special difficulties for the elderly and disabled who must wait for response personnel and equipment.

Access and egress points in stations are typically easier than those in trainways for elderly and disabled persons to negotiate, particularly those stations equipped with ramps, elevators, or escalators.

5.1.2 Recommendations

- ANSI Standard A117.13 should be reviewed and its guidelines followed during the design or rehabilitation of transit station ramps, stairs, floor surfaces, doors, etc.

- Where feasible, rail transit systems should install walkways along one side of all trainways to reduce the possibility of stumbling and falling and should also provide walkway crossovers to allow passengers, emergency response personnel, and equipment to cross from one trainway to another.

- When constructing new systems or rehabilitating existing ones, high-platform rail transit systems should install, wherever feasible, walkways that are the same height as the bottom of the vehicle doors and the floor to eliminate the need to step down the 4 to 5 feet to the trainway.

- Wherever feasible, widening the walkways that are already in place should be considered.

- Wherever feasible, new walkways should be designed wide enough to accommodate wheelchairs.

- Walkways should have smooth, non-skid surfaces.

- Handrails should be installed along the walkways wherever possible so that elderly and disabled passengers can walk along the evacuation route with minimal or no assistance.

- Walkways and exits should be illuminated and clearly marked (see Sections 5.2 and 5.3).

- At emergency exits not designed for mobility impaired passengers, instructions should be posted directing passengers and response personnel to the nearest exit that will accommodate people with mobility limitations.

5.2 VISIBILITY

The level of visibility in stations or trainways depends primarily on the design and location of the facility. For example, elevated and at-grade trainways and stations benefit from natural lighting during daylight hours.

5.2.1 Concerns

Adequate lighting has the psychological benefit of reducing panic and calming passengers. Although tunnels are usually illuminated, the lighting may be dim, especially in comparison with normal daylight, and an emergency or inclement weather may cause a power outage with a consequent loss of lighting. Visibility on elevated structures and at-grade trainways can be reduced by fog, snow, or rain, and many of these facilities are not illuminated at night.

Visually impaired passengers may have even more difficulty than other passengers in negotiating a walkway or trainway when visibility is poor. Inadequate lighting or poor visibility makes walking along elevated structures, tunnel walkways, and trainways even more precarious than usual.

5.2.2 Recommendations

- Emergency lighting in stations should comply with the requirements of NFPA 101 Life Safety Code.
- Lighting should provide sufficient illumination to allow passengers to proceed safely through tunnels and along elevated walkways.
- Walkways and railings should be marked with luminous paint or reflective tape to improve visibility.
- Walkways and access and egress points should be well marked and well lighted.

5.3 GRAPHICS

Rail transit systems use a variety of graphics in their stations and trainways. Graphics are the informational symbols indicating the location of crucial passenger station facilities and equipment such as walkways, access and egress points, emergency exits, emergency equipment, etc. They may also convey information such as instructions for opening the exits or operating the emergency equipment, the distance to a given exit, or a hazard associated with a trainway. Signs of various sizes and shapes may be placed on walls, posted between tracks, and suspended from overhead structures.

5.3.1 Concerns

The information conveyed by graphics used within trainways, in particular, can be unclear and, consequently, misunderstood by the general public. Because passengers will not necessarily know what a sign or symbol means or may not be able to interpret it correctly and completely, they run the risk of following the wrong path or taking other incorrect or potentially dangerous action. They may fail to recognize exits because they are poorly marked or poorly lit. Of course, if there is

no sign at all, these risks are even greater. In a tunnel, it may be especially difficult for passengers to correct an error before conditions worsen.

The danger to elderly or disabled individuals could be greater than for other passengers. Because of visual impairments, these passengers might not be able to see signs which indicate the location of exits.

5.3.2 Recommendations

- ANSI Standard A117.13 should be reviewed for guidance relating to color, contrast, size of lettering, etc. for signs.
- Graphics should be consistent, clear, easy to read, and easy to understand by rail system personnel, emergency response personnel, and passengers.
- Each emergency exit should be identified by a sign and should include clear instructions for use. Consideration should be given to providing bilingual and pictograph signs, where appropriate.
- Signs indicating the distance to and direction of the closest passenger station and emergency exits should be posted, especially in tunnels. An alternate exit and its distance should also be indicated.
- Signs should be large enough so that those with sight impairments can read them, and the information should be presented horizontally.
- The use of luminous or light-reflective paint should be considered for use for all signs, arrows, or other graphics which indicate the location of emergency exits.
- Exits which lead only to stairways should be clearly marked to indicate that no wheelchair access exists.

5.4 VENTILATION

Passive or active ventilation is present in all transit structures. Some older systems have natural (passive) ventilation, while others have mechanical (active) ventilation. Mechanical ventilation actively circulates air and can be controlled to direct smoke away from passengers, thereby maintaining visibility and allowing people to

breathe in tunnels and stations. The movement of trains also provides air movement.

5.4.1 Concerns

All rail transit passengers are at high risk if a station or tunnel ventilation system is not functioning correctly, but the risk for elderly and disabled passengers with medical conditions, such as coronary weakness and asthma, is especially high. Ventilation is a special concern because it may take over an hour for emergency response personnel to reach the scene; equipment may require even more time. Fire or smoke may further delay efforts. A malfunctioning or improperly used ventilation system puts not only the elderly and disabled at risk, but all passengers, rail transit personnel, and emergency response personnel as well.

5.4.2 Recommendations

Properly functioning ventilation systems are essential. To ensure that tunnel and station ventilation is available when needed for emergency evacuation, rail transit systems should consider the following:

- Where mechanical ventilation is available, transit systems should review all station and tunnel ventilation systems and conduct a testing program to ensure that smoke can be directed away from the evacuation effort.
- Rail transit station and tunnel ventilation should be bi-directional and controlled to direct airflow away from access and egress routes during a tunnel or station fire.

5.5 COMMUNICATIONS

The typical means of communicating with passengers used in rail transit stations is the public address system. In many systems, it is possible for Central Control and/or the station crew to talk directly to passengers. In some cases, it is also possible for the passengers to talk to Central Control or transit police by means of a direct telephone line in case of emergency.

5.5.1 Concerns

A lack of or inadequate communication to passengers can cause anxiety and confusion, particularly for the elderly and disabled. The key point in communication is whether elderly and disabled passengers are able to understand instructions and follow directions. For example, the inability of an elderly or disabled passenger to understand an instruction because of a visual, hearing, or mental impairment could make it difficult to move that person to safety.

The failure of the public address system could also prevent passengers from hearing instructions.

5.5.2 Recommendation

- Alternate means of communication as a backup to the public address system (such as a bull horn and markers and large marker boards) should be provided in each station.

6. TRAINING

Rail transit personnel and emergency response organization personnel (fire and police departments, emergency medical services [EMS], etc.) are an essential element in the emergency response equation. Their knowledge and skill in carrying out procedures and using emergency equipment are essential to the timely evacuation (if necessary) of elderly and disabled passengers. Given the circumstances of the emergency, training will have a major impact on the ability of personnel to do the following:

- Identify, understand, and cope with the particular needs of elderly and disabled passengers;
- Implement the applicable evacuation procedures; and
- Make use of special equipment as available to assist in the evacuation of these passengers.

The remainder of this section focuses on key training elements for rail transit and emergency response personnel which can be used to address the needs of elderly and disabled passengers. These elements are the scope of the training program, the content of the training program, emergency drills/simulations, passenger awareness, and information sharing.*

6.1 TRAINING PROGRAM SCOPE

Effective training enables rail transit and emergency response organization personnel to develop appropriate skills and keep them sharp. Such a training program will teach the participants the latest evacuation procedures and techniques applicable to elderly and disabled passengers and will familiarize the participants with new equipment and vehicles. To be most effective, training should include participants, frequency, and resources.

* For additional information useful in developing comprehensive training programs, see Reference 1, Recommended Emergency Preparedness Guidelines for Rail Transit Systems.

6.1.1 Participants

Appropriate training which addresses the needs of elderly and disabled passengers should be provided to personnel from all groups that could become involved in responding to rail transit emergencies. These training sessions should include participants from local fire and police departments, rescue squads, emergency medical services personnel, ambulance companies, and other local emergency preparedness groups. Broad-based training is especially important in metropolitan areas where rail transit operates underthe jurisdiction of several communities.

6.1.2 Frequency

Training should be held on a regular basis to ensure that rail transit and emergency response organization personnel understand and remain sensitive to the needs and conditions of elderly and disabled passengers. Periodic training also provides the opportunity for personnel to become aware of new evacuation procedures and equipment to assist in the removal of these passengers.

6.1.3 Resources

Members of interest groups for the elderly and disabled should be contacted to provide input into the development of training program content and presentation.

6.2 TRAINING PROGRAM CONTENT

Transit and emergency response personnel will often have to carry out their functions without any assistance from the elderly and disabled passengers themselves. The minimum training program content should enable personnel to accomplish the following tasks:

- Assess the conditions, limitations, and injuries of elderly and disabled passengers to determine how these factors will affect the evacuation effort;
- Provide first-aid to stabilize injuries;
- Prepare elderly and disabled passengers for evacuation;
- Extricate them from the station or vehicle; and
- Transport them to the nearest hospital, if necessary.

6.2.1 Characteristics of Elderly and Disabled Individuals

A key goal of any rail transit system training program should be to familiarize transit system and emergency response organization personnel with the special characteristics and needs of elderly and disabled persons. (See Section 2 and Reference 2 for more information concerning characteristics of the elderly and disabled.) This training is especially important for new transit systems (including systems which have new extensions or have completed renovations designed to provide better access for the elderly and disabled) and for systems that serve communities with large elderly and disabled populations. Rail transit and other emergency response organization personnel should be familiar with the following:

- Characteristics of elderly and disabled individuals (i.e., mobility, communications, and medical/physical/mental impairments);
- Characteristics of prosthetic, orthopedic, and sensory aids;
- Methods of communicating passengers who have visual, hearing, speech, and mental impairments (see Appendix A.); and
- Concepts for crowd and panic control.

Because of their impaired mobility or other limitations, elderly and disabled persons may require greater care and supervision at the site of an emergency. They may also require more psychological support. For example, wheelchair users have a strong psychological attachment to their chairs and are reluctant to leave them behind. In addition, wheelchairs are expensive and can be very costly to replace.

6.2.2 Notification

Rail transit supervisory and emergency response organization personnel require adequate information to determine the proper procedures and equipment to be used to evacuate elderly and disabled passengers:

- Train and station personnel should be trained to provide complete notification to Central Control concerning the nature and location of emergencies which involve elderly and disabled passengers.

- An estimate of the number of such passengers, any details about the conditions of these passengers, and their specific location on the train (i.e., in which vehicle and where within that vehicle) should also be included.

- It is particularly important to provide outside emergency response personnel with the approximate number, type, and location of elderly and disabled passengers; such information helps them determine which equipment and supplies to bring.

6.2.3 Rail Transit Environment Familiarization

When a rail transit emergency occurs, the environment of the emergency (i.e., the specific type of station, trainway, and vehicle) critically affects the evacuation effort. Therefore, training of rail transit and emergency response organization personnel should include familiarization with the following:

- Rail transit facilities and vehicles and the difficulties they pose for the evacuation of elderly or disabled passengers;

- Location and availability of any special evacuation equipment required for the specific environment; and

- Alternative means of evacuation suitable for elderly and disabled passengers, in case the primary means of evacuation is unavailable or unsuitable.

6.2.4 Evacuation Procedures

Training should be provided to transit and emergency response organization personnel which covers specific procedures which can be used to remove elderly and disabled passengers from the station or vehicle. The procedures should describe the following:

- Proper methods for lifting, carrying, and moving passengers who use wheelchairs, braces, prostheses, and other personal assistive devices (see Appendix B and Reference 2.);

- Methods for communicating with passengers who have visual, hearing, speech, and mental impairments (see Appendix A); and

- Instructions for dealing with guide or helper dogs that may adopt a very protective attitude especially if the passenger is unconscious.

6.2.5 Evacuation Equipment

Rail transit systems maintain various types of equipment for use by their employees and emergency response organization personnel during emergencies. The equipment is likely to differ depending on the location of the emergency. (See Appendix C for a description of different types of emergency equipment.) It is therefore important that training be provided to appropriate rail transit and emergency response organization personnel which describes the proper use of evacuation equipment which can be used to remove elderly or disabled passengers from the particular emergency scene. This training should include the following:

- Familiarity with the types of equipment provided by the rail system which can be used to lift, carry, and move elderly and disabled passengers from the station, vehicle, or trainway;

- Familiarity with the types of equipment provided by the emergency response organization which can be used to lift, carry, and move elderly and disabled passengers from the vehicle, trainway, or station;

- Knowledge of the location and proper use of each piece of equipment; and

- Hands-on practice in the proper use of each piece of equipment.

6.3 EMERGENCY DRILLS/SIMULATIONS

One of the most effective training techniques is the emergency drill/simulation. This type of training is particularly helpful for ensuring that emergency plans, procedures, and equipment address the particular evacuation needs of elderly or disabled passengers. The drill/simulation enables rail transit and emergency response organization personnel to use training guidelines, to practice techniques, and to test their effectiveness. A drill/simulation can reveal the degree of familiarity of both rail transit and emergency response organization personnel with the

physical layout, operations, and emergency exits of the rail transit system and with evacuation equipment. The opportunity thus exists to identify and correct shortcomings in the evacuation procedures for elderly and disabled passengers.

6.3.1 Participation of the Elderly and Disabled

The more realistic the drills/simulations, the more they will reflect potential emergency conditions. Planners usually prefer young, non-disabled persons as subjects in drills/simulations because they are easier to carry and because of the potential risk of injury even under the best of conditions. To make the exercise more realistic, and thus more useful, elderly and disabled participants should be included; however, it is essential that all participants fully understand the potential hazards of participation. Including these persons provides the opportunity to make use of their life experience to more clearly understand the specific problem areas which need more attention, to practice using evacuation equipment, and to help determine what other knowledge, skills, and equipment may be needed or useful during the emergency response effort.

6.3.2 Frequency

Emergency drills/simulations should be conducted at least once every year. This frequency will help ensure that all new transit and emergency response personnel are familiar with the physical characteristics of the elderly and disabled and with the rail transit facilities and evacuation equipment. Annual drills/simulations will also provide refresher training to appropriate personnel, at sufficient intervals, and will permit testing of new techniques, procedures, and equipment.

6.3.3 Wheelchair Procedures Evaluation

When wheelchairs are at an emergency scene, they are generally regarded as obstacles. The decision to evacuate passengers with or without a wheelchair is generally best handled case-by-case by appropriate transit and emergency response personnel depending on the type of wheelchair and environmental conditions. Drills/simulations can be useful in providing hands-on experience with wheelchairs and their users. Although wheelchair users are generally carried bodily from the train during emergencies, wheelchairs can actually be excellent evacuation devices under certain conditions. By pulling a wheelchair back onto its two large wheels, one person can lift even a heavy person over objects such as rails and curbs. Proper

training in this technique is essential. When evacuating stations, emergency personnel should instruct and help wheelchair users to use their chairs whenever possible to move through the station, instead of carrying these passengers. If available, ramps and elevators simplify the evacuation of wheelchair users.

Given the wheelchair user's psychological attachment to and the cost of the wheelchair, emergency personnel should make as determined an effort as the situation allows to retrieve the wheelchairs of any passengers carried from the emergency scene.

6.3.4 Evacuation Equipment Evaluation

Simulations are the best non-emergency means of determining the type of equipment needed. For example, in one rail transit simulation, emergency response personnel used rigid stretchers to evacuate passengers who could not walk. However, because of stanchions, seats, and the width of the aisles, personnel were unable to easily maneuver these stretchers in the vehicle. As a result, transit officials decided that a smaller, more flexible, and more compact stretcher was considerably more effective for moving injured passengers through vehicles and tunnels, and thus the flexible stretcher became the equipment of choice.

Drills/simulations may also give personnel the opportunity to use evacuation equipment, provided that such use is not too expensive for non-emergency use. Even simulated use (which might involve locating the equipment, transporting it, and rehearsing its use) would provide good practice for rail transit and emergency response personnel.

6.3.5 Debriefings

It is important to conduct debriefings for drills/simulations. (NOTE: Debriefings should also be conducted after actual emergency situations are resolved to determine whether procedures should be revised and whether different equipment should be used.) Those persons responsible for debriefing should be trained to ask questions that will test procedures, assess training, and evaluate equipment. They should debrief all participants after a drill/simulation, including the elderly and disabled participants, who can offer valuable insights and thus help transit systems and emergency response organizations revise their emergency evacuation

procedures, if necessary. The following examples are a few of the many questions which can and should be asked:

- Did the transit and emergency response personnel use appropriate methods to lift, carry, or move passengers?
- Were instructions clear?
- Did passengers get the appropriate help needed to evacuate the train, station, or trainway?

6.4 PASSENGER AWARENESS

If elderly and disabled passengers are alone on a train that cannot move but are not injured or face no imminent danger, they could safely await the arrival of trained personnel with appropriate evacuation equipment. In a serious emergency involving smoke or fire, however, passengers may well have to evacuate the train before emergency response personnel forces arrive. Fortunately, elderly and disabled passengers are virtually never alone on a train. Therefore, it is likely that these passengers may be able to rely on Good Samaritans among the other passengers for survival. Many times, fellow passengers will be courageous and responsible enough to help the elderly and disabled. In preparation for those times when able-bodied passengers can assist the elderly and disabled, rail transit systems should take steps to increase passenger awareness about the rail system and basic evacuation procedures and equipment.

Other passengers, in their efforts to be helpful, may not be aware of the particular needs of the elderly or disabled, however. Without proper knowledge, they may make a situation worse.

One effective way of educating the public is to include persons who live in the communities that the rail transit system serves as participants or observers in emergency drills/simulations.

- Elderly and disabled volunteers should be solicited to participate in emergency drills/simulations.

- Special workshops focusing on providing minimum necessary assistance to elderly and disabled passengers could be held for both the general public and the elderly and disabled.

- Various media should be notified of drills/simulations and workshops so that they are adequately publicized and promoted.

- Rail transit systems should also educate passengers about their role in cooperating with emergency evacuation efforts through the use of signs in transit vehicles and stations and through public address announcements in their facilities.

- Within each station, brochures containing basic emergency information should be distributed.

- All information should be printed in English, but transit systems serving large non-English speaking communities should consider printing information in other relevant languages as well.

Appendix D contains examples of transit public education material. Awareness programs could also be publicized through the various media, i.e., radio, television, and newspapers.

6.5 INFORMATION SHARING

Information sharing between rail transit systems, particularly lessons learned from actual experience and drills/simulations, can be extremely useful in developing procedures and training applicable to the evacuation of elderly and disabled passengers. For example, the experience and insight that one transit system may have from evacuating the elderly and disabled during emergencies in various kinds of weather could enable other systems to prepare and refine their own personnel, equipment, and procedures.

Rail transit systems should continue to take advantage of the opportunities to share and exchange their knowledge and experience. Within the rail transit industry, information sharing has been practiced in a variety of ways:

- Many rail transit systems conduct emergency simulation exercises and have invited representatives from other systems and local interest groups to participate or observe;

- Several rail transit systems support research and development, publish the results of their simulation exercises, and disseminate the results to other systems and response organizations[7,8,9]

- Brochures on aging, disabilities, hospitals, emergency medical services, etc. have been written, published, and disseminated among transit systems;

- Most rail transit systems have a system safety department, which will provide safety information to other systems that request it;

- Rail transit systems regularly investigate their own emergencies and make their findings available to the industryi[10];

- In 1982, UMTA held a national workshop[11] on fire and life safety concerns for fire service and rail transit safety personnel;

- The National Transportation Safety Board investigates all major rail transit emergencies, publishes its findings and recommendations, and sends them to systems on its mailing lists and to anyone requesting copies; and

- Safety consultants who work for one or more rail transit systems present their perceptions and methods to all interested systems at national meetings, such as the Transportation Research Board Annual Meeting and the American Public Transit Association Rapid Transit Conference.

7. REFERENCES

1. Hathaway, William T., Stephanie H. Markos, and Robert J. Pawlak, Recommended Emergency Preparedness Guidelines for Rail Transit Systems, U.S. Department of Transportation, Urban Mass Transportation Administration, Final Report, March 1985, revised October 1985. Report No: UMTA-MA-06-0152-85-21.

2. Henderson, William, Raymond L. Dabney, and David D. Thomas, Passenger Assistance Techniques: A Training Manual for Vehicle Operators of Systems Transporting the Elderly and Handicapped. Third Edition, Third Printing. Transportation Management Associates, Ft. Worth, TX, December 1984.

3. ANSI 117.1 1986, American National Standard for Buildings and Facilities - Providing Accessibility and Usability for Physically Handicapped People. American National Standards Institute, New York, 1986.

4. NFPA 101, Life Safety Code. National Fire Protection Association, Quincy, MA.

5. NFPA 130. Standard for Fixed Guideway Transit Systems. National Fire Protection Association, Quincy, MA.

6. Balog, John N., H. Norman Ketola, Frank A. Parker, and T. Thomas Mclnerney, Evacuation and Rescue of Elderly and Handicapped Passengers from Public Transportation Vehicles and Structures, Ketron, Inc., November 1982. Contract No: DTRS-57-81-C-00144.

7. Port Authority Trans-Hudson Corporation, Operation Rescue-An Interagency Simulated Evacuation Drill, Jersey City, NJ, November 16, 1980.

8. Port Authority Trans-Hudson Corporation, Operation Rescue-An Interagency Simulated Evacuation Drill, Jersey City, NJ, May 23, 1982.

9. Toronto Transit Commission, Subway Emergency Simulation: Sunday, October 18, 1981, October 1981.

10. Port Authority Trans-Hudson Corporation, Special Investigation Report: PATH Car No. 725 Fire. March 16. 1982, Jersey City, NJ, May 25, 1982.

11. Hathaway, William T., W.J. Holleran, and S. Hills, Fire and Life Safety Training Needs of Rail Rapid Transit System and Fire Service Personnel, U.S. Department of Transportation, Urban Mass Transportation Administration, Final Report, Reprint, January 1984. Report No: UMTA-MA-06-0098-83-1.

APPENDIX A. BASIC COMMUNICATION PROCEDURES FOR VISUALLY, HEARING, SPEECH, AND MENTALLY IMPAIRED PERSONS*

A. RULES FOR ASSISTING VISUALLY IMPAIRED PASSENGERS

1. Never take hold of a person using a white cane without first telling him/her who you are and what you plan to do.

2. Never take hold of or move a person's white cane until you have told him/her exactly what you are doing and why.

3. When leading, stand on the side opposite the white cane.

4. Always stay one-half pace ahead of the person you are leading. *Remember, if you forget to tell him/her the direction of movement, the one-half pace will allow him/her to follow the movement of your body.* If the person being led is staying beside you, s)he may well fall if you forget to tell him /her the direction of movement.

5. Remember to first tell your passenger the direction of movement (up, down, over) and then the distance of movement (for example, step down six inches).

6. Remember, drop your lead arm back when you and the person are walking through narrow areas. (Be sure to tell the person what you are doing).

7. Be alert to changes in the regularity of the environment (different heights of steps, changes from hard to soft surfaces, etc.).

8. Call out maneuvers to be made, (going up steps.etc).

9. Remember the three orientation points for your passenger to enter or exit a vehicle: the door, door sill, and vehicle seat.

10. Take time to describe new areas to the vision impaired person.

B. RULES FOR ASSISTING HEARING IMPAIRED PASSENGERS

Individuals who are deaf communicate in primarily two ways: (1) lip reading with an oral response; and (2) the use of hand signs and finger spelling.

In communicating with a lip reader:

1. Be sure to face him/her directly so your lips may be seen easily.

2. Do not exaggerate your speech or lip movement. To do so changes the way you form your words.

3. Speak with moderate speed.

---

*Adapted from Appendices B-F, Passenger Assistance Techniques: A Training Manual for Vehicle Operators of Systems Transporting the Elderly and Handicapped, by W.H. Henderson, R. L. Dabney, and D. D. Thomas, 1982. By permission of Transportation Management Associates.

4. Do *not hesitate to repeat yourself.* Remember a good lip reader will understand fifty to sixty percent of what is said. An excellent lip reader will understand seventy to eighty percent of what is said. Repeating helps him/her fill in the blanks.

5. Remember that some peoples' lips cannot be read easily. This does not , necessarily have anything to do with the way they sound. If you should find that your lips are not easily read (after you have spoken to several lip readers), simply have someone else repeat your message to the lip reader.

In communicating with persons using hand signs and finger spelling, remember:

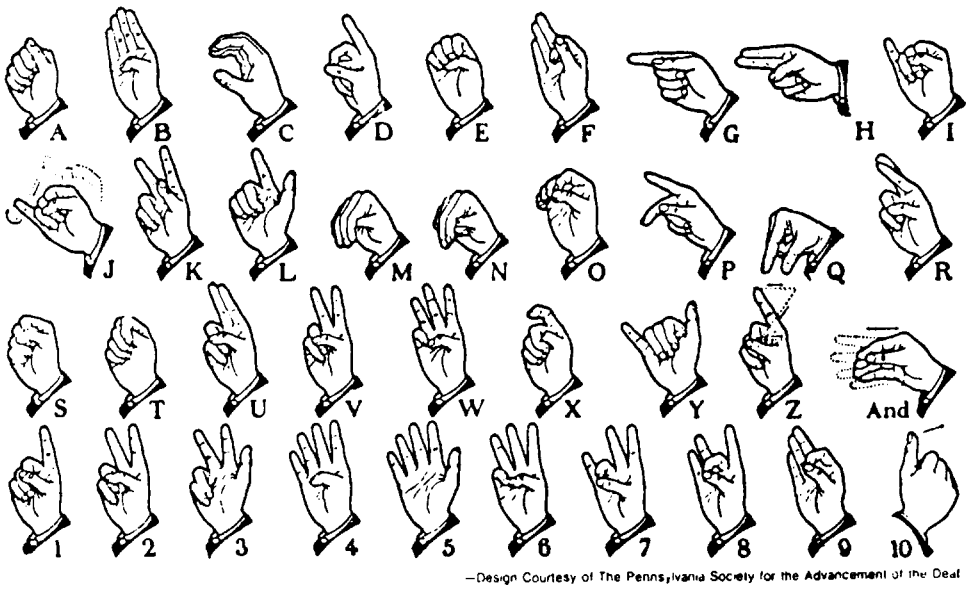
1. To become skillful in the use of hand signs and finger spelling takes quite a bit of practice. However, the manual alphabet and simple signs can be learned quickly.

2. To keep a pad and pencil available for written messages.

3. Learning to read and write is quite difficult for the deaf, so keep your messages simple.

4. For individuals who have been deaf since birth, learning to speak isquite difficult. Their speech will tend to be quite flat and nasal.

5. A person who is not deaf but whom has lost the ability to speak, such as one who has had a laryngectomy (removal of the vocal chords), may use hand signs.



THE MANUAL ALPHABET

Figure Courtesy of the Goodrich Center for the Deaf, Fort Worth, Texas.

C. RULES FOR ASSISTING SPEECH IMPAIRED PASSENGERS

1. Do not acknowledge that you understood what a person has said, if in fact, you have not.

2. Repeat what you "thought" the person said. This gives him/her a chance to confirm or deny your interpretation of what she said.

3. Ask the person to repeat the part you are having trouble understanding. Remember, a person with communication difficulties is quite used to being misunderstood and will appreciate the fact that you are making an effort to fully understand.

4. Put the person at ease when you ask him/her to repeat something. If a person becomes tense, almost any type of speech impediment will become worse.

D. GUIDELINES FOR ASSISTING MENTALLY IMPAIRED PASSENGERS

Individuals who have lost some part of their mental functions may have:

1. Lessened ability to give or understand directions.

2. A lack of orientation (not aware of where they are or what time it is).

3. Agitation, excitability or lack of emotional control.

4. A harder time learning and remembering rules and routines of the transportation system.

In assisting mentally impaired passengers you should:

1. Repeat - It is often useful.

2. Have patience - It is always necessary.

3. Be firm - Persons may want to do things that are unsafe.

When trying to understand the problems of mentally impaired passengers remember:

1. Everyone - has at times been confused or disoriented by a new situation.

2. Everyone - has at time had a hard time following directions for a new task.

3. Everyone - has at times had trouble finding their way around a new environment.

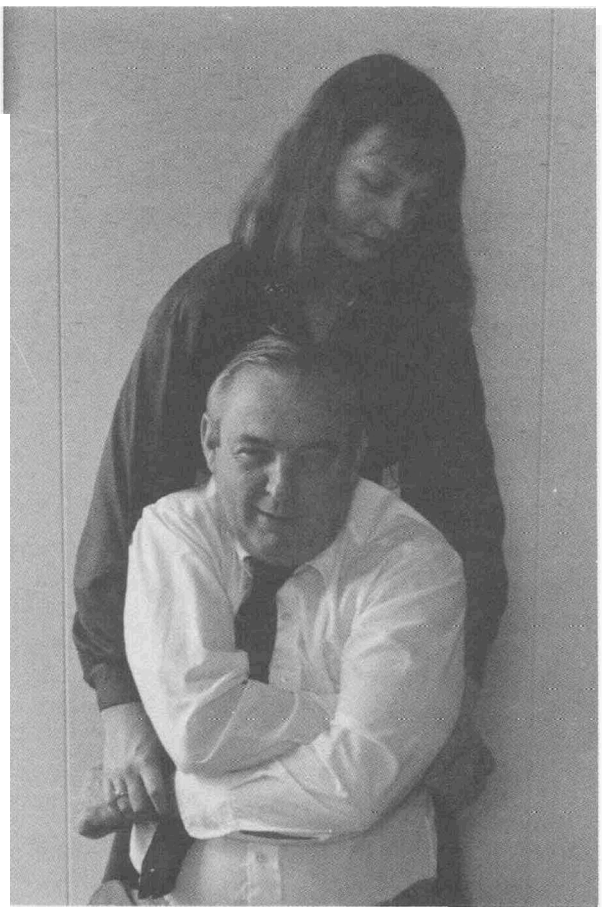
4. Everyone - has at times become agitated, irritated or excited when a familiar routine has been suddenly changed.

Note: A person with mental difficulties will tend to respond to situations on more of an emotional level than an intellectual level. Emotions come into play more quickly than do intellectual responses. Therefore, a person with mental difficulties will tend to be quite sensitive to a person's mannerisms, the way in which they say things as well as what they say, and even facial expressions and body movements.

APPENDIX B. EXAMPLES OF TECHNIQUES WHICH CAN BE USED TO LIFT AND CARRY/DRAG PERSONS

PERSON IS CONSCIOUS

Stand behind the individual to be lifted. Place your arms under armpits and around the chest. The person's hands should be clasped together. Grasp the person's upper forearms and lift straight up.



PERSON IS UNCONSCIOUS

Stand behind the individual to be lifted. Cross the person's arms across front of the body and towards the hips. Grasp the wrists and lift straight up.

APPENDIX C. EMERGENCY EQUIPMENT

To evacuate elderly and disabled passengers as swiftly and as safely as possible, rail transit and emergency response organization personnel must have a sufficient amount of the proper equipment and should be familiar with and know how to operate such equipment.

This appendix lists and describes the items of equipment that could be of value when evacuating both the elderly and disabled and the general population. Some of these items are currently used by rail transit systems and emergency response organizations, while the other items should be evaluated for possible use through emergency simulations (see Section 6, Training). Each rail transit system should estimate the number of elderly and disabled passengers served to accurately determine the amount of emergency equipment needed.

AIR VENTILATION AND AIR CONDITIONING CONTROLS

Most transit vehicles have either forced ventilation or air conditioning. The valves or switches controlling the dampers of the vehicles with forced ventilation provide a means to prevent smoke from seeping into the vehicle through the ventilator openings during an emergency involving fire or smoke. On vehicles with air conditioning, where there usually are no valves or switches controlling the fresh air intake, shutting off the power to the entire system will reduce the flow of smoke through the fresh air ducts.

BACKBOARDS

Backboards can be used in circumstances where it would be difficult to maneuver flexible stretchers -- for example, through a window while removing a passenger from a rail car. Because of their rigidity, backboards may make removal easier, particularly when emergency response personnel are carrying a passenger down (or up) a ladder. Because they provide greater support, they are also useful for passengers who have chronic back problems or who suffer from a spinal injury. However, the width of backboards can be a problem. In addition, at least four people are needed to carry a person on a backboard, and it is difficult to carry

people long distances because of the weight of the individual carried and the uncomfortable position of the carriers' arms (either straight or at a slight angle).

CABLE WINCH

A cable winch can pull an emergency cart loaded with passengers from the disabled train to a station, freeing personnel to assist other passengers.

CLOSED CIRCUIT TELEVISION (CCTV)

A potentially valuable piece of equipment for rail transit systems to consider, where feasible, is closed-circuit television (CCTV) cameras. Many systems have installed a CCTV system for security at certain stations. Activation of CCTV during emergencies could help rescue personnel locate an emergency immediately, assess the degree of risk and damage, evaluate the conditions in the emergency location, determine what emergency equipment rescue personnel should bring, monitor the progress of evacuation and rescue efforts, and provide a record of events. A valuable auxiliary use of CCTV would be to record emergency simulations, which could help trainers improve emergency drills, study emergency response personnel in action, and refine emergency procedures.

EMERGENCY CARTS

Emergency carts which can use the trainway rails to reach the emergency scene can be used in two ways. They can carry emergency response personnel to the train location, and they can carry elderly and disabled passengers from the emergency scene, freeing personnel who might otherwise have to carry them bodily from the site. If the carts are unpowered, however, they may have limited value on inclined sections of trainways.

EVACUATION CHAIRS

Evacuation chairs can be a valuable device for moving the elderly and disabled down a staircase and, possibly, on evacuation ladders. These chairs should be designed to descend the staircase or ladder at the typical angle of inclination and should have wheels large enough to take them over the trackway. They should be lightweight folding chairs that can be stored on vehicles, in stations, or in tunnels.

FLEXIBLE STRETCHERS

Flexible stretchers are often used for evacuation because of their relatively light weight (an important feature if they have to be carried to the scene of an accident) and their maneuverability. Two persons can carry an uninjured passenger on a flexible stretcher, but it is difficult because the sides fold in over the victim and one carrier has to walk backwards. Four persons are needed to carry an injured passenger, and the four-person carry is generally difficult inside a vehicle because of the narrow aisles and vertical stanchions. Flexible stretchers are also inconvenient for removing a victim through a vehicle window because of their lack of rigidity.

HI-RAIL VEHICLES

Hi-rail vehicles have not been evaluated in depth, but they could be used for carrying elderly and disabled passengers to stations, emergency exits, or tunnel portals. They may also be used for pulling or pushing a stranded train from a tunnel if third rail power is down and immediate fire or smoke conditions are present.

LADDERS AND LADDER PADS

Ladders, especially those that are collapsible, can be stored conveniently in a small space on the vehicle, such as in a storage room or in an overhead holder, so that they are protected from damage during a collision or derailment. The location of ladders should provide easy access so that passengers can retrieve them if transit personnel become incapacitated during an accident.

A ladder pad is a small platform on which to place an evacuation ladder. It may simply be a flat wooden platform about three feet long and slightly wider than the track gauge. Such a platform can alleviate the problem of irregular and unstable surfaces and thus ensure stability.

LIFE TAPES

Life tapes (reflective tapes or battery-powered string lights) placed about a foot up from the ground on the walls of tunnels or on the floors of vehicles can help guide emergency response personnel and passengers. Because smoke rises and obscures visibility higher up, life tapes should be placed close to the floor. When the lighting

is poor or when smoke hinders visibility, they can help orient passengers and lead them to vehicle doors and to emergency exits.

RAMPS

Ramps eliminate the need to step up a series of stairs and can expedite the evacuation of passengers who are injured but still able to walk. However, ramps may be very heavy, awkward, and difficult to store. During an interagency simulation several years ago, PATH used a fabricated ramp instead of its standard ladder on one of the participating vehicles. The ramp proved to be highly effective in evacuating ambulatory and injured passengers. Indeed, one firefighter interviewed after the simulation stated that he did not even realize it was a ramp. Difficulties associated with the PATH ramp were its excessive weight and its lack of compactness for storage. An evacuation ramp similar to those that are stored within rental trucks and used to move household goods may be suitable for rail transit vehicles. Also, folding aluminum ramps are available and could be used by personnel to evacuate wheelchair passengers in their wheelchairs when conditions permit. However, aluminum rampsare not for use on or near the third rail.

TELEPHONES

As an aid to communication in evacuation operations, the telephone can complement the CCTV monitor. The mere presence of telephones, placed at regular intervals along the right-of-way in a tunnel or on an elevated structure with a direct connection to Central Control, can provide psychological assurance to passengers being evacuated. By knowing that there is a communication link with the "outside," the passengers would probably be calmer during their ordeal. Furthermore, by using the telephone, lost or disoriented passengers can contact Central Control, alert personnel of their difficulty, and receive instructions or assurances as they wait to be rescued. In addition, if the person watching the TV monitor sees that elderly and disabled passengers are involved in an emergency, that person can quickly estimate their number and quickly assess their needs and then call evacuation personnel on the phone and tell them to bring extra or special equipment. It should be noted that portable, cordless telephones, which operate as radios, do not transmit and receive signals well in tunnels; therefore, phones using cables should be considered for use in tunnels.

All About BART Safety, BART, Oakland, CA. Spring, 1986.

SPECIAL NOTE FOR THE HANDICAPPED

Evacuation of wheelchairs is not possible because the walkways and ramps used for evacuation are too narrow to accommodate a wheelchair Blind persons and those people using mobility aids should ask for assistance from other passengers Deaf people should use other passengers as a guide

SPECIAL NOTE FOR BICYCLISTS

You must have a permit to take your bicycle on BART For permit information call the Office of Passenger Services (464-7133) Bicycles are restricted to the rear of the last car of the tram Do not take bicycles on escalators

In case of emergency evacuation, bicycles are to be left on the tram Do not evacuate bicycles.

SAFETY & COMFORT

For your safety and comfort, please follow the few simple rules that will help keep BART safe, comfortable and clean for everyone

- Smoking, eating, drinking or playing radios and tape recorders are not permitted in stations or on trains Violation of the no smoking ordinance can lead to a citation and fine
- Pets completely enclosed within acceptable carrying cases and police dogs, guide, signal or service dogs are the only pets permitted on BART
- Please keep clear of the platform edge and the exterior of the tram until it comes to a complete stop in the station
- Please do not lean against the doors inside the tram
- Please do not leave papers on trains
- Make sure you have not left any valuables in stations or on trains
- Flammable liquids are not allowed in stations or on trams
- Bicycle riding, roller skating and riding skateboards are not allowed in stations or on trains

Watch your step when boarding & disembarking trains. Be aware that the gap and car level between platform edge and train may vary.

Passenger Initiated Evacuation

Walk between the two primary rails and look for signs on the tunnel walls which will lead you to the nearest station or emergency exit to ground level.

Passenger Initiated Evacuation On Outdoor Elevated And Ground Level Trackbeds

On elevated trackbeds, always exit onto the raised emergency walkway between the tracks.

However, on all outdoor ground level trackbeds, you should evacuate through the emergency door on the right as you face the front of the train. Sit on the door threshold of the car, and carefully slide out and down from the car to the ground.

With both outside evacuations, make your way carefully to the end of the train, staying away from the power rail as well as the train's power pick-up shoes. These you will see protruding from the wheel assemblies near the front and rear of the car on both sides of the train.

Once everyone is clear of the train, wait for rescue personnel. Do not attempt to walk to the next station. You will be safer waiting for the rescue party to arrive.

Evacuating People With Disabilities and Senior Citizens

If there is someone in a wheelchair, he or she will need assistance. The wheelchair will have to be left behind and somebody will have to assist or carry the person out of the car along the walkway to safety. Likewise, senior citizens and visually impaired passengers will need assistance.

SUBWAY EMERGENCY EVACUATION

If an emergency occurs on board:

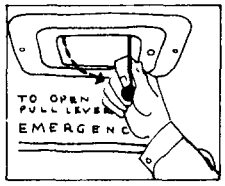
1 *LISTEN* FOR INSTRUCTIONS

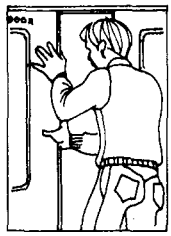
Follow emergency instructions.

2 PREPARE TO *LEAVE* CAR

Doors will normally be opened by the operator. If you see a walkway, use center doors on that side. If not, use any door with the steps down.

Emergency door-release latches are located in the ceiling beside doors. Use only when instructed by operator. After releasing latch, push door outward and sideways to open. Step out carefully.

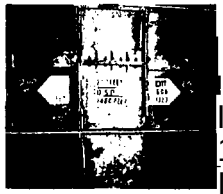




3 *ASSIST* DISABLED PASSENGERS

Help elderly and disabled passengers—leave wheelchairs on board and carry disabled persons to a place of safety.

4 *WALK* TO NEAREST EXIT



Check yellow markers on tunnel walls for nearest exit. Stay close to walls and away from tracks. Track switches may move at any time. The tracks carry no dangerous electric current; however, do not touch any hanging wires or obstructions.

Move quickly, but do not run. Use stairs—*not* elevators—to get to street.

APPENDIX E. BIBLIOGRAPHY

1. Abernathy, C.N., et. al. " Effects of Deceleration and Rate of Deceleration on Live Seated Human Subjects." Transportation Research Record, N646(1977), 12-17.

2. Aldman, B., et. al. Safety in Special Public Transportation. Division for Handicapped Research, Gothenburg University, Sweden. March 1974.

3. Alexander.G.H., et. al. Determination of the Tradeoffs Between Safety, Weight, and Cost of Possible Improvement to Vehicle Structure and Restraints. Battelle Laboratories, Columbus, Ohio. December 1974.

4. All About Bart Safety. BART, Oakland, CA Spring, 1986.

5. American National Standards Institute, ANSI 117.1 American National Standard for Buildings and Facilities-Providing Accessibility and Usability for Physically Handicapped People. New York. 1986.

6. American Academy of Orthopedic Surgeons. Emergency Care and Transportation of the Sick and Injured. 1977.

7. American Public Transit Association. Moving People Safely. 3rd edition. 1978.

8. Baloq, John N., et. al. Evacuation and Rescue of Elderly and Disabled Passengers from Paratransit Vans and Buses. U.S. Department of Transportation, Urban Mass Transportation Administration, Final Report, October 1984. Report no.: UMTA-MA-06-0152-84-3.

9. Benjamin, D.E. Evacuation and Rescue in Automated Guideyvay Transit: Volume I: Data Collection, Scenarios, and Evaluation. Vouqht Corporation, Dallas. December 1979. Report no.: UMTA-MA-06-0048-79-2.

10. Benjamin, D.E. Evacuation and Rescue in Automated Guideway Transit: Volume II: Guidebook. Vought Corporation, Dallas. December 1979. Report no.: UMTA-MA-06-0048-79-3.

11. Bergeron J. David. First Responder. Robert J. Brady Company, Bowie, Maryland. 1982.

12. Blethrow, J.G., et. al. Emergency Escape of Handicapped Air Travelers. Federal Aviation Administration. Washington, D.C. July 1977.

13. Bloom, R.F. Closed Circuit Television in Transit Stations: Application Guidelines. Dunlap and Associates, Inc., Darien, Connecticut. August 1980.

14. Boeing Vertol Company. Act-I: Urban Rapid Rail Vehicle and Systems Program: Engineering Test of Act-I Vehicle at Transportation Test Center. U.S. Department of Transportation, Urban Mass Transportation Administration. December 1979.

15. Boeing Vertol Company. Urban Rapid Rail Vehicle and Systems Program. Surface Transportation Systems Department, Philadelphia. July 1974.

16. Bryan, J.L Human Behavior in Fire -- A Bibliography. National Bureau of Standards, Center for Fire Research, Washington, *D.C.* August 1978.

17. Cheaney, E.S.. et. al. Safety in Urban Mass Transportation: Guidelines Manual Battelle Laboratories, Columbus, Ohio. May 1975. Report no.: UMTA RI-I06-0005-752.

18. Cheaney, E.S. ,et. al. Safety in Urban Mass Transportation: Research Report. U.S. Department of Transportation, Urban Mass Transportation Administration. Final Report, March 1976. Report no.: UMTA-RI-06-0005-75-3. (Research Report Summary, Report no.: UMTA RI-106-0005-75-1).

19. Connell,W.M. Safety Priorities in Rail Rapid Transit: Report, Volume 1. Transit Development Corporation, Washington, D.C. Final Report, March 1975. Report no.: UMTA-OC-06-0091-75-1.

20. Connell,W.M. Safety Priorities in Rail Rapid Transit: Exhibits, Volume 2. Transit Development Corporation, Washington, D.C. Final Report, March 1975. Report no.: UMTA-OC-06-0091-75-2.

21. Connell, W.M., and Green, Fred S. Accident Source Compilation. Final Report. Transit Development Corporation, Washington, D.C. 1975.

22. Conrad. R.E., et. al. Determination of the Tradeoffs Between Safety, Weight, and Cost of Possible Improvements to Vehicle Structure and Restraints. Final Report. Battelle Laboratories, Columbus, Ohio. 1974.

23. Grain and Associates. Transportation Problems of the Handicappped: Volume I - The Transportation Handicapped Population, Definition and Counts. U.S. Department of Transportation, Urban Mass Transportation Administration, Final Report, August 1976. Report no.: CA-OG-0092.

24. Grain, J.L. "Role of Paratransit in Servicing the Needs of Special Groups." Transportation Research Board. Special Report N164 (1976).

25. Grain, J.L., et. al. Summary Report: 321 (b) Rail Retrofit Evaluation - Light and Commuter Rail Systems. U.S. Department of Transportation, Urban Mass Transportation Administration, Final Report, Decenber 1980. Report no.: UMTA-CA-06-0125-80-1.

26. Demeter, John. "Transportation for All the People." USA, 4, No. 1(1977), 6-11.

27. Demetsky, M.J., et. al. "A Transit Station Design Process, (Abridgement)." Transportation Research Record, No. 662 (1978), 26-28.

28. Demetsky, M.J.,et. al. A Procedural Guide for the Design of Transit Stations and Terminals. Phase I. University of Virginia, Department of Civil Engineering, Charlottesville, Virginia. June 1977.

29. Demetsky, M.J.,et. al. Methodology for the Design of Urban Transportation Interface Facilities. University of Virginia, Department of Civil Engineering, Charlottesville, Virginia. December 1976.

30. Donnellv, R.. and Arquelles. J. The Implications of BART's Land Use and Urban Development Impacts for the Transportation Disadvantaged. Metropolitan Transportation Commission, Berkeley, California. April 1978.

31. Donnellv, R-, and Arquelles, J. The Implications of BART's Mobility and Accessibility Impacts for the Tralisportation Disadvantaged. Metropolitan Transportation Commission, Berkeley, California. April 1978.

32. Dunlap and Associates, Automated Guideway Transit Technology Program, System Safety and Passenger Security Project. Urban Mass Transportation Administration. U.S. Department ofTransportation, August 1979.

33. Fire and Life Safety for the Handicapped. Reports of the Conference on Fire Safety for the Handicapped and Workshops on Life Safety for the Handicapped, B. M. Levin, Editor. Center for Fire Research National Engineering La'boratory, National Bureau of Standards. Washington, D.C. July 1980.

34. Fiedler, J. "Elevators at Railway and S-Bahn Stations." Eisenbahntechnische Rundschau. 29, No. 4 (April 1980).

35. Flynn, Lois. Emergency Medical Services: A Bibliography. National Highway Traffic Safety Administration, Services Division, Washington, D.C. 1976. Report no. 58-07.

36. Fplspm, Farnham. Extrication and Casualty Handling Technigues. J.P. Lippincott Company, Philadelphia. 1975.

37. Fruin, J.J. "Designing for the Disadvantaged: Optimum Design Considers All Users." ASCE Civil Engineering. 45. No. 3 (March 1975), 65-69.

38. Fucigna, J.T.,et. al. Basic Training Program for Emergency Medical 7echnicians - Ambulance, Concepts and Recommendations. Final Report, Dunlap and Associates, Inc., 1973.

39. Garrard, W.L. et. al. Crashworthinessand Crash Survivability in Personal Rapid Transit Vehicles. International Conference on PRT, Denver, CO. 1975.

40. Gelick. M.S.. and Silver, M.L. Design for the Handicapped in Elevated Transportation Systems. University of Illinois, Chicago. January 1975.

41. Grant, Harvey D. Vehicle Rescue. Robert J. Brady Company, Bowie, Maryland. 1975.

42. Grant, Harvey D. Vehicle Rescue: Instructor's Guide. Robert J. Brady Company, Bowie, Maryland. 1975.

43. Grant, Harvey D., and Murray, Robert H. Emergency Care. 2nd edition. Robert J. Brady Company, Bowie, Maryland. 1978.

44. Grey Advertising,Inc. Summary Report of Data from National Survey of Transportation Handicapped People. U.S. Department of Transportation, Urban Mass Transportation Administration. June 1978.

45. Hansen, T.B., et. al. Assessment of the Inclined Elevator and Its Use in Stockholm. De Leuw, Gather and Company, Washington, D.C. 1978.

46. Hathaway, William T., et. al. Recommended Emergncy Preparedness Guidelines for Rajl Transit Systems. U.S. Department of Transportation, Urban Mass Transportation Administration, Final Report, March 1985. Report no.: UMTA-MA-06-01 52-85-1.

47. Henderson, William H.. et. al. Passenger Assistance Techniques: A Training Manual for Vehicle Operators of Systems Transporting the Elderly and Handicapped. 3rd Edition. Transportation Management Associates, Inc., Austin, Texas. 1987.

48. Hoel, L.A., et. al. Criteria for Evaluating Alternative Transit Station Designs. University of Virginia, Research Laboratories for the Engineering Sciences, Charlottesville, Virginia, 1976.

49. "Interior Lighting of Public Conveyances-- Road and Rail." Journal of the Illuminating Engineering Society, (July 1974), 381-396.

50. Jones. G.P. Development of a Safety Program Plan for the Office of Safety and Product Qualifications, Volume II, Appendix D, On-Going Research by Mitigation Type. University of Southern California, Los Angeles. September 1977. Report no. UMTA-CA-060-105-78-2.

51. Kangas, R., et. al. Handicapped and Elderly Vertical Movement Assessment Study. U.S. Department of Transportation, Transportation Systems Center, Cambridge, Massachusetts. February 1976.

52. Kelly, R.R. "PATH'S Emergency Simulation Exercise." APTA. Emergency Preparedness Workshop. 10 June 1981.

53. Kremel, Franklin M. "The Vehicle and Crash Survivability." Analogy, No. 11, 12-19.

54. Levine, R. BART and the Handicapped. Metropolitan Transportation Commission, Berkeley, California. November 1974.

55. Metro Safety Guide and Map. Community Affairs Department, MUNI, San Francisco. May 1985.

56. Mclnerney, FT. The Feasibility of Retrofitting Lifts on Commuter and Light Rail Vehicles. U.S. Department of Transportation, Urban Mass Transportation Administration, Final Report, September 1980. Report no.: 06-0025-80-11.

57. Michaels, R.M., and Weiler, N.S. Transportation Needs of the Mobility Limited. Evanston, Illinois: Northeastern Illinois Planning Commission, 1974.

58. Mogielnicki, R. Peter, et. al. Patient and I Bystander Response to Medical Emergencies Massachusetts Institute of Technology, Operations Research Center, Cambridge, Massachusetts. July 1975.

59. National Fire Protection Association. Life Safety Code. NFPA 101. National Fire Protection Association, Inc., Quincy, Massachusetts.

60. National Fire Protection Association. Standard for Fixed Guideway Systems, NFPA 130, National Fire Protection Association, Inc., Quincy, Massachusetts.

61. National Highway Traffic Safety Administration, Emergency Medical Services. Crash Victim Extrication Training Course. U.S. Department of Transportation, Washington, D.C. April 1979.

62. National Transportation Safety Board. Safety Effectiveness Evaluation of Rail Rapid Transit Safety. National Transportation Safety Board, Washington, D.C January 1981. Report no. NTSB-SEE-811.

63. National Transportation Safety Board, Bureau of Surface Transportation Safety. Safety Methodology in Rail Rapid Transit System Development. National Transportation Safety Board, Washington, D.C. 16 June 1971. Report no.: NTSB-RSS-71-1.

64. National Transportation Safety Board, Bureau of Accident Investigation. Special Investigation-- Eight Subway Train Fires on New York City Transit Authority with Evacuation of Passengers. National Transportation Safety Board, Washington, D.C. 22 September 1981. Report no.: NTSB-SIR-81-5.

65. Ohio State Department of Education, Division of Vocational Education. Emergency Victim Care. Columbus, Ohio, 1971.

66. Port Authority Trans-Hudson Corporation. Operation Rescue II -- An Interagency Simulated Emergency Exercise. Jersey City, New Jersey. 23 May 1982.

67. Rescue Training Institute. Vehicle Rescue Training Module. Ambler, Pennsylvania.

68. Rescue Training Institute. Search Procedures, Confined and Open Areas. Ambler, Pennsylvania.

69. Rescue Training Institute. Vehicle "Rescue" Techniques. Ambler, Pennsylvania.

70. Rescue Training Institute. Water Rescue Course. Anbler, Pennsylvania.

71. Rider, M.J.,et. al. Use of Wheelchairs as Vehicle Seats; Current Practices and Recommendations. Texas A & M University, College Station, Texas. November, 1976.

72. Safety Information Reporting and Analysis System (SIRAS), Heavy Rail Transit Safety, 1987 Annual Report. U.S. Department of Transportation, Urban Mass Transportation Administration: September 1988. Report no.: UMTA-MA-06-0178-88-1.

73. Safety Awareness with METRO. WMATA, Washington, D.C. December 1987.

74. Schneider, Lawrence W. Protection for the Severely Disabled -- A New Challenge in Occupant Restraint. Highway Safety Research Institute, Ann Arbor, Michigan; Department of Education, National Institute of Handicapped Kesearch, Washington, D.C. November 1978. Contract no.: 23-P-59-59227/5-03.

75. Schneider, Lawrence W., and Melvin, J.W. Sled Test Evaluation of a Wheelchair Restraint System for Use by Handicapped Drivers. HiqFway Safety Research Institute, Ann Arbor, Michigan. Novenber 1978.

76. Schneider, Lawrence W. Dynamic Testing of Restraint Systems and Tie-Downs for Use with Vehicle Occupants in Powered Wheelchairs. Highway Safety Research, Institute, Ann Arbor, Michigan. April 1981.

77. Schumacher, S.P., and Schumacher, J.B. Training Program for Operation of Emergency Vehicles. INNOVATRIX, Inc., Washington, D.C. September 1978.

78. Simpson and Curtin, Inc. Manual of Transit Operations in Civil Emergencies. Philadelphia. April 1974. Report no.: UMTA-PA-06-0028-74-1.

79. Tanaka, H., and Takaoka, S. "Lighting Effect in the Smoke of Tunnel Fire." Railway Technical Research Institute. 15, No. 2 (1974), 83-84.

80. Toronto Transit Commission. Subwav Emergency Simulation: Sunday, October 18.1981. October 1981.

81. Transportation Research Board. Transit Station Use by the Handicapped: Vertical Movement Technology. Unpublished Report 14. Washington, D.C. April 1980.

82. Transportation Systems Center. Transit Systems. U.S. Department of Transportation, Cambridge, Massachusetts. March 1979.

83. Urban Mass Transportation Administrafion. Comments of Transit Agencies - Section 321 Rail Retrofit Studies. U.S. Department of Transportation, March 1980.

84. Wilson-Hill Associates; Moss Rehabilitation Hospital; and M/M Associates. Measurement of Capabilities of Semi-Ambulatory Subjects to Negotiate farriers Encountered in a Transit Bus Environment: Detailed Test Findings. U.S. Department of Transportation, March 1982.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1997—501-108