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**Urban Mass
Transportation
Administration**

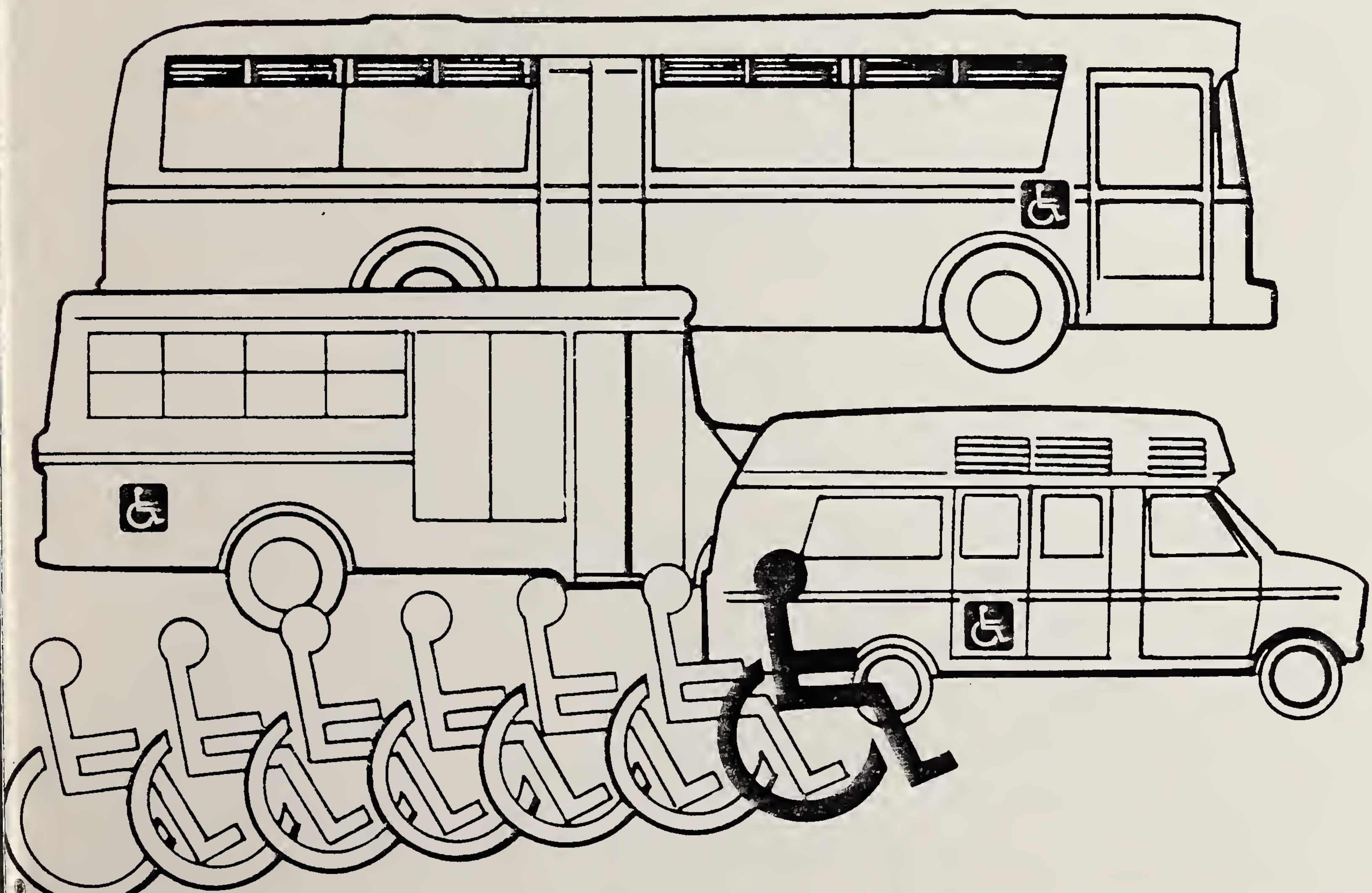
National Workshop on Bus-Wheelchair Accessibility

Guideline Specifications for

Active Wheelchair Lifts
Passive Wheelchair Lifts
Wheelchair Ramps
Wheelchair Securement Devices

Office of Technical Assistance
Office of Bus and Paratransit Systems

May 7–9, 1986



UMTA Technical Assistance Program

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Guideline Specifications for
Active Wheelchair Lifts

May 7-9, 1986
Seattle, Washington

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ACKNOWLEDGMENTS

These guideline specifications are the culmination of many hours of hard work by persons representing all facets of the accessible transit and paratransit industry. The Urban Mass Transportation Administration (UMTA) recognized that the technology associated with accessible transportation could be improved and sponsored an Advisory Panel in order to develop industry guideline specifications. Representing different viewpoints and different interests, the members of the Advisory Panel met, discussed issues, and developed these guideline specifications. It is a credit to the Advisory Panel and the dedication of its members that a formal vote never had to be taken and that the guideline specifications were developed on the basis of consensus.

Several people need to be acknowledged for the assistance they provided to the Advisory Panel in the development of these guidelines. George I. Izumi, the UMTA Project Manager, was responsible for planning and organizing the Advisory Panel, planning for the Workshop, and contributed greatly to the development of the guidelines. Vincent R. DeMarco, the UMTA Program Manager, was responsible for guiding the efforts of the Advisory Panel and for planning and conducting the Workshop. Two other persons from the U.S. Department of Transportation also provided assistance. Christina Chang of the Transportation Systems Center helped to organize and run the Workshop and prepare Workshop Proceedings. Scott York of the National Highway Traffic Safety Administration participated in the Advisory Panel meetings and assisted in clarifying certain safety issues. The Battelle project team of Gerald A. Francis (consultant), Martin Gombert (ATE Management and Service Company, Inc.), Rolland D. King, and David M. Norstrom was responsible for developing the draft guideline specifications and serving as a technical resource to the Advisory Panel. Special recognition is given to Mr. Norstrom who skillfully managed the guideline development process and led the discussions of the Advisory Panel meetings that obtained a general consensus of the Advisory Panel on each guideline subject. Finally, appreciation goes to each member of the Advisory Panel who gave of their time and contributed their expertise to the development of these industry guidelines.

PREFACE

On September 17, 1985, the Administrator, Ralph L. Stanley, of the Urban Mass Transportation Administration called together a meeting with representatives of transit agencies, handicapped organizations, rehabilitation specialists and manufacturers of buses and wheelchair lifts to hear first hand the problems and issues regarding transit bus wheelchair accessibility. As a result of this meeting, the Administrator requested that an UMTA Advisory Panel be formed to plan a National Bus Wheelchair Accessibility Workshop and to guide the development of a set of guideline specifications for the equipment required for transit bus and paratransit vehicle wheelchair accessibility. A contract was issued to Battelle to assist UMTA in this effort.

As a result of surveying the transit industry for input and meeting with the Advisory Panel, Battelle prepared a draft set of guideline specifications for wheelchair lifts, securement devices and ramps for presentation and discussion at the National Bus Wheelchair Accessibility Workshop held in Seattle, Washington, on May 7 through 9, 1986. Using the inputs developed during the Workshop and the written comments submitted following the Workshop, the Advisory Panel prepared these final guideline specifications.

These guideline specifications are advisory in nature. The intention of the guideline specifications is to provide transit agencies with a model that they could use, as appropriate, in the development of their specifications for wheelchair accessibility. In the guideline specifications, where the word "should" is used, the recommendation of the Advisory Panel is that the suggested item or value be included in a general specification. Where the word "may" is used, the Advisory Panel recommends that the item or choice of values be considered for inclusion based upon local operating conditions. The Advisory Panel has developed these guidelines for use throughout the United States. It recognizes that unique local conditions could make an item suggested for inclusion inappropriate and a local public transportation provider would be required to make the appropriate changes (e.g. to accommodate extreme environmental conditions).

This guideline specification is one of four specifications developed by the Advisory Panel, which developed separate guideline specifications for passive wheelchair lifts (those used primarily on transit buses), active wheelchair lifts (those used primarily on paratransit vehicles), ramps and securement devices. Members of the Advisory Panel participated actively in the development of each individual guideline specification based upon their experience and interest. Although the Advisory Panel discussed many related accessibility issues, these guideline specifications focus only on the technical requirements of a specific piece of equipment. They have been prepared to assist in the purchase of such equipment either separately or as part of an overall vehicle procurement.

ADVISORY PANEL

The following individuals participated in the Advisory Panel for the development of the draft guideline specifications of passive wheelchair lifts, active wheelchair lifts, ramps, and wheelchair securement devices.

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1.0 GENERAL

1.1 Scope

These guideline specifications relate to active lifts that are used by handicapped individuals to assist in boarding public transportation vehicles. An active lift is defined as a lift that when stowed may interfere with the use of the vehicle entrance in which the lift is located. As a result, active lifts usually have an entrance door separate from the regular passenger door. These guideline specifications have been developed with special concern for the safety of passengers using a lift and reliability of lift operations.

1.2 Definitions

The following definitions apply for this document.

Accessible Vehicle - A vehicle that has been equipped to allow boarding by passengers who by reason of handicap are physically unable to board a vehicle that has not been so equipped.

Active Lift - An active lift is one that when stowed may interfere with the use of the vehicle entrance where the lift is located and that when being raised or lowered operates primarily outside the body of the vehicle.

Arc Lift - This term denotes the type of lift that has an arcing motion during operation as differentiated from elevator lift.

Automatic Lift - This term refers to an active lift that has powered up, down, fold, and unfold functions.

dBA - This term denotes decibels with reference to 0.0002 microbar as measured on the "A" scale.

Design Load - The maximum weight capacity a lift is designed to raise or lower.

Drifting - The unintended movement of a lift from a stowed position.

Elevator Lift - This term denotes the type of lift that has a vertical up and down movement as differentiated from an arc lift.

Factor of Safety (Design Safety Factor) - The factor of safety is the ultimate strength of a material divided by the working stress. A structure fails or breaks when loaded to its ultimate strength. A structure deforms or takes set when loaded to its yield strength.

Fail-safe - A characteristic of a system and its elements whereby any malfunctions affecting safety will cause the system to revert to a known safe state.

Fold - The term designating the operation of lift from an operating position to a stowed position on the vehicle.

Interlock - The arrangement in which the operation or position of one mechanism automatically allows or prevents the operation of another.

Lift or Wheelchair Lift - A level change device used to assist those with limited mobility in the use of transit and paratransit services. The term lift and wheelchair lift are used interchangeably in this document.

Maintenance Personnel Skill Levels - Maintenance personnel skills used in this document are defined in accordance with the White Book specifications as follows:

5M: Specialist Mechanic or Class A Mechanic Leader
4M: Journeyman or Class A Mechanic
3M: Service Mechanic or Class B Serviceman
2M: Mechanic Helper or Coach Serviceman
1M: Cleaner, Fueler, Oiler, Hostler, or Shifter.

May - This term is to be construed as permissive.

Mechanical and Hydraulic Components - Mechanical and hydraulic components include all parts of the lift drive or control system that are subject to wear and degradation due to the operation of the lift.

Paratransit Operation - Paratransit operation refers to a public transportation operation (service, vehicles, facilities, etc.) that is not a transit operation.

Passive Lift - A passive lift is one that when stowed allows the unimpeded use of the vehicle door in which the lift is located.

Pinching Point - A location where two closely spaced parts of machinery can move together to create a human hazard.

Semi-Automatic Lift - This term refers to an active lift that has powered up and down functions and requires manual operation for folding and unfolding the lift.

Shear Area - A hazardous condition or location where a moving part approaches or crosses a fixed part.

Should - The term is to be construed as recommended by the Advisory Panel.

Slip Resistant - A characteristic of a surface of a material that reduces unintended relative motion with respect to another surface with which it has contact.

Structural Elements - The structural elements of the wheelchair lift include those that support working loads and attach the lift to the vehicle. They do not include mechanical and hydraulic components associated with operation and control of the lift.

Transit Operation - Transit operation refers to a public transportation operation (service, vehicles, facilities, etc.) that operates with fixed routes and fixed schedules.

Unfold - The term designating the operation of a lift from a stowed position on the vehicle to an operating position.

White Book -This term is the common name for "Baseline Advance Design Transit Coach Specifications," originally published by UMTA on April 4, 1977. It is now available from the American Public Transit Association.

Wheelchair - A seating arrangement that is positioned on wheels, may be powered or unpowered, and can be used to assist mobility limited individuals.

Wheelchair Securement Device - A device anchored to a vehicle and used to limit the movement of a wheelchair when the vehicle is in motion.

1.3 Abbreviations

The following abbreviations may be found in the guidelines.

ANSI --- American National Standards Institute

ASME --- American Society of Mechanical Engineers

ASTM --- American Society for Testing and Materials

CSA --- Canadian Standards Association

FMEA --- Failure Modes and Effect Analysis

FMVSS --- Federal Motor Vehicle Safety Standard

NHTSA --- National Highway Traffic Safety Administration

SAE --- Society of Automotive Engineers

SCRTD --- Southern California Rapid Transit District

UFAS --- Uniform Federal Accessibility Standards

UMTA --- Urban Mass Transportation Administration

VA --- Veterans Administration

1.4 Reference Documents

(1) American National Standards Institute
1430 Broadway, New York, N.Y. 10018

ANSI A17-1983
Elevator and Escalator Committee Interpretations
ANSI/ASME A17.1-1984
Safety Code for Elevators and Escalators
ANSI A90.1-1976
Safety Standards for Manlifts

(2) American Public Transit Association. "Baseline Advanced Design Transit Coach Specifications," includes Addendums 1 through 20 that were made to the April 1977 issue of the "Baseline Advanced Design Transit Coach Specifications," published by Urban Mass Transportation Administration. (Commonly known as The White Book.) American Public Transit Association. April 1983.

(3) Baumeister, Theodore, Avallone, Eugene A., and Baumeister, Theodore (III). Mark's Standard Handbook for Mechanical Engineers, Eighth Edition. New York: McGraw-Hill Book Company. 1978.

(4) California Administrative Code, Title 13, Chapter 2, Subchapter 4, Article 15. Wheelchair Lifts.

(5) Canadian Standards Association. "Motor Vehicles for the Transportation of Physically Disabled Persons," CAN3-D409-M84. Ontario, Canada: Rexdale. April 1984.

(6) Canyon Research Group, Inc. "A Requirements Analysis Document for Transit Vehicle Wheelchair Lift Devices." Prepared for Urban Mass Transportation Administration, Westlake Village, California. June 1978.

(7) "Federal Motor Vehicle Safety Standard," Code of Federal Regulations, Title 49, Part 571 No. 207, Seating Systems, and No. 210, Seat Belt Assembly Anchorages.

(8) Henderson, William H., Dabney, Raymond L., and Thomas, David D. Passenger Assistance Techniques: A Training Manual For Vehicle Operators of Systems Transporting the Elderly and Handicapped, Third Edition. Fort Worth, Texas: Transportation Management Associates. 1984.

(9) James, D. I. "A Broader Look At Pedestrian Friction." Rubber Chemistry and Technology, Volume 53, Pages 512-541.

(10) Panero, Julius and Zelnik, Martin. Human Dimensions and Interior Space. New York: Whitney Library of Design. 1979.

(11) Society of Automotive Engineers. Standards, Recommended Practices, Information Reports.

(12) Stewart, Carl F. and Reinl, Herbert G. "Safety Guidelines for Wheelchair Lifts on Public Transit Vehicles." Prepared for Urban Mass Transportation Administration (UMTA-CA-06-0098-80-1). California Department of Transportation. July 1, 1980.

(13) "Uniform Federal Accessibility Standards." Federal Register (49 FR 31528). August 7, 1984.

(14) "Veterans Administration Wheelchair Lift Systems: VA Standard Design and Test Criteria for Safety and Quality of Automatic Wheelchair Lift System for Passenger Motor Vehicles." Federal Register (43 FR 21390). May 17, 1978.

2.0 TECHNICAL REQUIREMENTS

2.1 General Requirements

The wheelchair lift should meet the technical requirements given in Section 2.0.

2.1.1 Operating Environment

The lift should operate in the temperature range of -10 F to 115 F, at relative humidities between 5 percent and 100 percent, and at altitudes up to 5,000 feet above sea level. Degradation of performance due to atmospheric conditions should be minimized at temperatures below -10 F, above 115 F, or at altitudes above 5,000 feet.

Special procedures, hydraulic fluids, and/or lubricants may be used to operate the lift for the low and/or high temperature operating conditions.

Rationale: The urban areas of the United States have broad ranges of climatic conditions. Weather data indicate that many cities have recorded 100 days or more per year of over 90 F temperatures. Likewise, many have recorded 20 or more days per year below 0 F. The annual rainfall ranges as high as 60 inches per year to a low of 4 inches per year. The normal snow and sleet precipitation in some cities reach 88 inches per year. The recommended guidelines cover a broad range of conditions found in the United States and are adapted from the White Book specifications.

2.1.2 Weight

The weight of the lift should not adversely affect the legal axle loadings, the maneuverability, structural integrity, or the safe operation of the vehicle in which it is installed.

Rationale: For legal and safety reasons the weight of the lift should not adversely affect the vehicle. Since existing lifts reportedly meet these requirements, the weights of existing lifts are considered acceptable. The recommended upper limits are 1,000 pounds for lifts installed on standard transit vehicles and 400 pounds on small vans and other vehicles.

2.1.3 Operation Constraints

2.1.3.1 The lift should operate when the bus is on level ground and up to road grades up to seven (7) percent or four (4) degrees.

2.1.3.2 The lift should operate when the bus is on level ground and when the bus is at an angle of plus or minus 8.7 percent or five (5) degrees due to road crowns, depressions, or curb geographics.

Rationale: A lift will operate in a variety of different topographical conditions and must do so safely and reliably. A balance needs to be made between the topographical conditions to be accommodated by lift design and the conditions where a lift will not be required to operate.

A seven percent grade specification is currently used by Seattle Metro in its lift procurement. Since Seattle has a relatively hilly topography, using its limit for road grade seemed reasonable.

No specification reviewed during the development of these guidelines identified any requirements in terms of the roll of the bus. However, the VA sets a limit of 9 degrees in any direction for the operation of a powered wheelchair. Since a lift can tilt up to 3 degrees (Section 2.2.5), the 5 degree parameter was chosen in order to be below the 9 degree figure when the 3 degree tilt is considered.

2.1.4 Boarding Direction

A lift should be capable of handling a wheelchair in both an outward and inward facing position on the lift.

Rationale: To accommodate the passenger and for emergency or other special conditions, the lift needs to be able to accept and operate with a wheelchair facing either inward or outward. Discussion by the Advisory Panel considered outward facing to be preferred, but both directions need to be accommodated. Local operating policies may designate outward facing.

2.1.5 Location of Lift

The lift should be installed on the side of the vehicle opposite the driver's seat (recommended) or at the rear of the vehicle.

Rationale: An active lift usually requires a separate entry. For safety reasons the preferred location is the curb side of a vehicle. However, in some cases a rear entrance may be preferred (e.g., in order to better utilize interior space). A rear entrance was not recommended, by the Advisory Panel although they recognized that special situations exist. If a rear door lift is used, vehicle loadings and unloadings should occur at off-street locations.

2.1.6 Padding and Protective Covering

2.1.6.1 **Pinching movements, shear areas, or places where clothing or other objects could be caught or damaged should be covered or in other ways protected to prevent passenger injury when lift is in operation.**

2.1.6.2 **All exposed edges or other hazardous protrusions on the wheelchair lift or on the bus in an area associated with the wheelchair lift or securement device (except the platform) should be padded with energy absorbing material to minimize injury in normal use and in case of accident.**

Rationale: To ensure safer operations all potentially hazardous areas should be protected. This is especially true of lift operations where individuals with certain handicaps have limited control and/or feelings in parts of their body and may not sense a hazardous condition. When a hazardous area cannot be adequately protected, the lift manufacturer must use other means to ensure safety. One recommended alternative is a pressure sensing device that would automatically stop lift movement if an object were detected.

Tests have shown that edges and protrusions can be especially hazardous in accident situations. To reduce the potential danger, energy absorbing material should be used to protect these areas. The stowed platform should be protected on its edges. The Advisory Panel discussed having protection for the platform surface. When stowed the platform surface becomes a secondary "wall" inside the vehicle. A removable pad would provide additional protection, but was considered optional. California requires the pad but some states prohibit the pad because it reduces the field of vision.

2.1.7 Operation Counter (Optional)

The lift should have an operations or use counter that records each complete up and down cycle of the lift.

Rationale: A counter would provide data on lift use. The data would be especially useful in recording lift cycling, scheduling maintenance, and evaluating the performance of the lifts. The Advisory Panel considered this feature useful, but not required. Although a counter adds cost to the purchase price, the expense is considered to be offset by better maintenance and lower operating costs resulting from the use of the counter.

2.1.8 Power Source Interface

2.1.8.1 The lift should operate and meet all requirements of these guideline specifications while using the power sources on the transit vehicle.

2.1.8.2 For small transit and paratransit vehicles, wheelchair lifts may be powered by a heavy-duty alternator system or a dual battery system with batteries similar to that supplied by the manufacturer of the vehicle.

2.1.8.3 The lift should meet the requirements of these guideline specifications whenever the power sources are performing within their specified ranges. The lift should remain in a safe state during and following power source transients, including failure, that may be experienced on transit vehicles.

Rationale: The electrical interface between the vehicle and the lift is an important consideration in performance. This guideline is intended to ensure both proper interface consideration for normal operations and safe conditions in abnormal situations, including power source excursions and power failure. A heavy duty alternator or separate battery is recommended for small vehicles to provide for more reliable operations. While the requirement for safe lift operations during and following power source transients may be somewhat redundant with other sections of the guidelines, it serves to emphasize the importance of continued safe lift operations even during and following such power excursions.

2.1.9 Wheelchairs To Be Accommodated (Optional)

The contractor should identify the length, width, and height of the wheelchairs that can be accommodated by the lift.

Rationale: Platform size will limit the dimensions of wheelchairs that can use the lift. The contractor should indicate the characteristics of wheelchairs that can use the lift in order for the lift purchaser to understand clearly the limitations of the lift.

2.2 Platform

2.2.1 Dimensions

2.2.1.1 The lift platform should have a minimum clear width of 30 inches. It is desired to have a minimum clear width of 32 inches.

2.2.1.2 The minimum clear length of the lift platform as measured between the outer barrier and the inner edge or roll stop should be 40 inches. At a length two and one half inches above the platform, the clear length should be 44 inches. It is desired to have a clear length of 44 inches at platform level and 48 inches, two and one half inches above the surface.

2.2.1.3 The minimum height of the door opening at the wheelchair lift should be 56 inches.

Rationale: The VA lift specification is a 29 inch width; and it identified current platform widths of 26 to 40 inches with an average width of 32 inches. The VA length specification is 44 inches. The Canadian Standard Association specifies dimensions of 30 and 38 inches. However, these are just platform dimensions and do not correspond to the size of wheelchairs that can be accommodated.

Estimates of current wheelchair sizes were obtained from two manufacturers and more detailed information was found in a 1978 report, "A Requirements Analysis Document for Transit Vehicle Wheelchair Devices." The data are summarized in the following table:

Estimate of Wheelchair Dimensions

	Invacare		1986 Everest & Jennings		1977 Everest & Jennings(1)	
Percentile	Length	Width	Length	Width	Length	Width
100/99	48	30	77-1/2(2)	28-1/2	47	31-7/8
95			52/47-1/2(3)	26-1/2	43-1/2	26-1/4
90	44	26		26-1/2	42-1/2	26-1/4
85					42	26-1/4
80	44	24				

(1) "A Requirements Analysis Document for Transit Vehicle Wheelchair Lift Devices," Canyon Research Group, Inc., June 1978.
(2) 77-1/2 inches represents a partially reclined, recliner wheelchair.
(3) 52 inches represents a recliner wheelchair and 47-1/2 inches represents a regular wheelchair.

The dimensions of the lift are influenced by vehicle characteristics. For example, on small vans the ceiling height can limit platform length. Also, standard door openings on small vehicles can limit platform widths. Increased door openings are a possibility, but this could reduce the number of seats in a vehicle and increase vehicle cost.

The dimensions of wheelchairs, existing specifications, and potential vehicle limitations were all considered in the development of the platform size specifications. The minimum size requirements will accommodate 90 to 95 percent of the wheelchair population; and the desired sizes will accommodate 99 percent of the wheelchair population.

The area of most concern is the length requirement. Door height on many current vans limit the lengths of platforms, and buses with greater door height are more expensive. The guideline has specified a minimum clear length of 40 inches. This means that at a minimum the lift will accommodate wheelchairs of this length. Also, recognizing the characteristics of wheelchairs, roll stops, and barriers, a minimum clear distance of 44 inches at a two and one-half inch height is specified. This approach allows wheelchairs with footrests that would overhang the platform and have a length equal to or less than 44 inches to use the lift. The dimensions in these guideline specifications represent a realistic balance between the design limitations of current vehicles and the wheelchair population. One class of wheelchairs that may be a problem are the newer three-wheeled models, which are longer than most other wheelchairs. The desired length requirements would accommodate a larger population of wheelchairs but could exclude the consideration of certain vehicles.

The height requirements are based on anthropometric data. Human Dimension and Interior Space cited 1963 data showing that 97.5 percent of males in wheelchair had a seated height of 51.5 inches or lower. No more recent data were cited. However, Human Dimension and Interior Space cited 1979 data on the seating height normal--the vertical distance from the sitting surface to the top of the head for a person in a relaxed position. The 95th percentile male has a sitting height normal of 36.6 inches. Adding 19 inches for the seat height of wheelchair results in an overall height of 55.6 inches. The 56 inch height requirement accommodates this height and is compatible with most vehicles. Interior vehicle height should be greater to accommodate movement inside the vehicle.

2.2.2 Surface

The platform surface should be slip resistant under the conditions defined in Section 2.1.1.

Rationale: A slip resistant surface reduces the potential for accidents and provides traction for a wheelchair.

2.2.3 Protrusions and Openings

2.2.3.1 When a barrier is down, the platform should have no protrusions from the surface greater than 1/4 inch or smooth rise greater than 1/2 inch, except for the stationary edge guards, inner roll stops, or outer barriers.

2.2.3.2 The lift platform should not have any openings greater than 3/4 inch in width, except for a hand hold not exceeding 1-1/2 inch by 4-1/2 inches located midway between the edge barriers on semi-automatic lifts.

Rationale: When lift barriers are down, movement on and off the platform should be easy and not inhibited by protrusions. A 1/4 inch protrusion can easily be negotiated by wheelchairs and is currently specified in the California Administrative Code.

It must be noted that the language, "when the lift barrier is down," has been chosen to allow protrusions when the barrier is up. Lift manufacturers have indicated that mechanisms to hold a barrier in place may require protrusions through the lift platform when the barrier is up. These protrusions are allowable, but should not limit the size or type of wheelchairs that can use a lift.

As discussed in Section 2.2.10, a lift platform may not be solid. The VA specifications use the 3/4 inch limit on openings; and it has been adopted for these guideline specifications. The exception to this requirement allows a hand hold for semi-automatic lifts.

2.2.4 Gap Dimensions

When a lift is at the floor loading and unloading position, the gap between the vehicle floor and the lift platform should be at a minimum. In no case should a gap have a vertical distance exceeding 5/8 inch or a horizontal distance exceeding 1/2 inch.

Rationale: A series of subjective tests reported in the VA specifications established the 5/8 inch vertical gap as the highest that should be allowed. The 1/2 inch horizontal gap was chosen to limit the overall gap opening to approximately 3/4 inch. The preferred option is to have no gap.

2.2.5 Platform Deflection

The lift platform should not deflect more than 3 degrees in any direction when tested in accordance with Section 3.1.3.

Rationale: To reduce the ability of a wheelchair to gain additional speed and overcome the barrier or roll stop and to reduce the chance of a wheelchair tilting off the lift, a maximum deflection standard is established. The three (3) degree deflection is currently found in the California Administrative Code.

2.2.6 Edge Guards, Barriers, and Roll Stops

Use one of the following options. Option A should be used unless your operating procedures are in agreement with those described at the beginning of Option B.

Option A

2.2.6.1 Edge guards should extend the full length of the lift platform on both sides and shall have a minimum height of one and one-half (1-1/2) inch.

2.2.6.2 The lift should have an outer barrier or inherent design feature that retains a wheelchair on the platform when the platform is above the ground loading position.

2.2.6.3 The outer barrier or inherent design feature should be designed to meet the test requirements of Section 3.1.6.1.

2.2.6.4 The platform should have an inner roll stop or the design of the lift should use part of the vehicle as an inner roll stop. The inner roll stop or lift design should restrict the rolling movement of a wheelchair when the platform is in any operating position other than at the vehicle floor level position.

2.2.6.5 The inner roll stop should be designed to meet the test requirements of Section 3.1.6.3.

2.2.6.6 The contractor should identify and clearly emphasize in the operations and maintenance manuals any roll stop and barrier adjustments or maintenance actions that, if done improperly, could result in an unsafe condition.

Option B

When followed, operating procedures can reduce or eliminate potentially unsafe conditions. Recognizing that certain operating procedures can reduce certain risks and, therefore, change the safety requirements of a lift, this Option B is presented. Option B can be used when all of the operating procedures described in the following are adopted and mandated for use by a transit operator.

Operating Procedures

The objective of the following operating procedures is to eliminate the ability of a powered wheelchair to overcome a barrier and to provide safe lift operation. To accomplish this objective, the procedures are designed to disengage the power of a powered wheelchair and to require manual maneuvering of the wheelchair through the entire loading and unloading process, except when the lift is at the fully lowered position. The operating procedures are:

(A) With the lift platform in the lowered position, the wheelchair may be loaded by the passenger in the power mode or by the operator in a powered or unpowered mode. The wheelchair shall be loaded facing away from the vehicle with the operator on the ground either in front or to the side of the chair and platform.

(B) Before the lift is raised the operator shall:

(1) Ensure the power switch on the wheelchair is in the off position.
(2) Disengage all clutches on the wheelchair.
(3) Lock all wheelchair brakes, if possible.
(4) Ensure the passenger's hands and arms are resting in the passenger's lap or on the wheelchair arm rest away from the power control.

(C) The wheelchair shall be placed a sufficient distance in back of the barrier to allow unrestricted movement of the barrier to its locked position.

(D) The operator/driver shall physically check the barrier to make sure it is in a locked position:

1) After the lift platform has been raised a sufficient distance above the ground for its locking mechanism to engage.
2) Prior to loading a wheelchair on a lift platform when the lift platform is the raised position.

(E) During the raising or lowering of the lift platform, the operator/driver shall hold the wheelchair by an arm rest with his arm straight and elbow locked. The lift controls shall be operated with the other hand. The driver shall be standing on the ground with his feet apart when operating the lift.

(F) The operator/driver shall manually maneuver the wheelchair when it is onboard the vehicle.

(G) When loading the lift platform from the vehicle, the same operating procedures will be used. The wheelchair shall be placed a sufficient distance in back of the barrier to allow unrestricted movement of the barrier, the operator/driver shall physically check the barrier to make sure that it is in a locked position, and during the raising or lowering of the platform the operator/driver shall stand beside the platform with his feet apart and hold the wheelchair by an arm rest with his arm straight and the elbow locked.

(H) The operator/driver shall be familiar with the instructions provided by the manufacturer on the safe loading of powered wheelchairs.

2.2.6.1 Edge guards should extend the full length of the lift platform on both sides and shall have a minimum height of one and one-half (1-1/2) inch.

2.2.6.2 The lift should have an outer roll stop or inherent design feature that restricts the rolling movement of a wheelchair on the platform when the platform is above the ground loading position.

2.2.6.3 The outer roll stop should be designed to meet the test requirements of Section 3.1.6.2.

2.2.6.4 The platform should have an inner roll stop, or the design of the lift should use part of the vehicle as an inner roll stop. The inner roll stop or lift design should restrict the rolling movement of a wheelchair when the platform is in any operating position other than at the vehicle floor loading position.

2.2.6.5 The inner roll stop shall be designed to meet the test requirements of Section 3.1.6.3.

2.2.6.6 The contractor shall identify and clearly emphasize in the operations and maintenance manuals any roll stop adjustments or maintenance actions that if done improperly could result in an unsafe condition.

Rationale: Edge guards can prevent a wheelchair from accidentally sliding over the sides of the lift. Since side barriers are not in the direct path of a wheelchair using a lift, they do not need to be designed to retain a wheelchair in direct forward or reverse motion.

In 1985, Garrett Engineers, Inc. conducted tests for the Southern California Rapid Transit District (SCRTD). These tests showed that barriers on all existing passive wheelchair lifts could be overcome by common powered wheelchairs. The powered wheelchairs could ride over the barriers or push them down. SCRTD initiated these tests following an accident investigation that indicated a powered wheelchair had defeated a barrier. Although active lifts were not tested, their design does not indicate they could retain a powered wheelchair on the lift.

Under Option A, the specifications require that the lift have a barrier that meets Section 3.1.6.1, which requires the barrier to prevent a powered wheelchair from leaving the platform. This requirement is aimed at eliminating the unsafe condition of a wheelchair powering over or through a barrier.

Under Option B, operating procedures are presented that eliminate the unsafe condition that requires a barrier that meets the test requirements of Section 3.1.6.1. In other words, the power and drive mechanism on a powered wheelchair are disabled. Under this option the test requirements for a roll stop (rather than barrier) are used. The test described in Section 3.1.6.2 is similar to that required by the VA. The VA tests were designed to retain a wheelchair without power on a lift platform.

The ability of a lift to stop rolling movement on the inner portion of the platform is required by Section 2.2.6.4. The requirement can be met by a roll stop or by a lift design that uses part of the vehicle as the roll stop.

The Advisory Panel considered the accident scenarios involving the inner roll stop different from that with the outer barrier. For this reason different tests are recommended. An inner roll stop will not necessarily prevent an activated powered wheelchair from leaving the platform, but must meet the requirements of Section 3.1.6.3.

Section 2.2.6.6 under both options requires the contractor to identify any roll stop and barrier adjustments or maintenance actions that if done improperly could result in an unsafe condition. This requirement is added to enhance overall safe operation of the lift.

2.2.7 Handrails

2.2.7.1 **When the lift is fully deployed, the platform should be equipped with one handrail.**

2.2.7.2 **The top of the handrail should be 25 to 34 inches above the platform, should move with the platform, and should be at a minimum 24 inches in length.**

2.2.7 3 **The handrail should be capable of withstanding a horizontal force of 100 pounds concentrated at any point.**

2.2.7 4 **The handrails should be between 1-1/4 inches and 1-1/2 inches in diameter or width and should permit a full hand grip with no less than 1 inch of knuckle clearance.**

Rationale: Current active lifts primarily operate with one or no handrail. Although for unassisted passengers handrails on both sides are preferable, handrails can be a hinderance when assistance is being provided. Two handrails reduce clear space above a lift platform and can impair a driver from providing assistance both on and off the lift. Thus, handrails are recommended only for one side of the lift.

The handrail will provide support for passengers or a driver standing on the platform as well as for a person in a wheelchair. It should be noted that the Advisory Panel had differing opinions concerning persons not in a wheelchair being allowed on the lift. Some opposed standing on the lift, while others considered it an option.

Handrails that move with a lift provide more of a sense of security from a user's point of view than stationary handrails attached to the vehicle. Stationary handrails in effect move relative to the motion of the lift and are not as easy to grasp. Movable handrails are recommended by the Advisory Panel.

The vertical height dimensions and the 100-pound force requirement are adapted from the Canadian Standards Association standard. The handrail dimensions are the same as found in the White Book and in the Uniform Federal Accessibility Standards. Knuckle clearance in the UFAS is 1-1/2 inches. In the White Book it is 1 inch for door panels and 1-1/2 inches elsewhere. Although the 1-inch clearance has been chosen to coincide with door panel clearance of the White Book, such clearances must also meet the safety requirements of Section 2.1.6.1 concerning pinching movements and shear areas.

2.2.8 Platform Lighting

When the lift is in operation, the platform should have a minimum of one (1) foot-candle of illumination when deployed.

Rationale: Platform lighting provides for safer boardings when natural or other light is insufficient. The recommended level of illumination is adapted from the White Book specification. Nothing in this specification directs how the lighting is to be provided. The contractor has the option to make the lighting system part of the vehicle or part of the lift system.

2.2.9 Platform Markings (Optional)

2.2.9.1 The side edges, the outer edge, and the inner edge of the platform, or the inner edge of the floor of the bus adjacent to the lift should be clearly marked in a color different from the lift platform.

Rationale: This section is suggested. Members of the Advisory Panel differed on whether passengers should stand on a lift. However, it was agreed that these guidelines should not encourage the practice. Many transit operators provide wheelchairs for ambulatory passengers to use during boarding. The marking of the platform edges provides greater visibility and reduces the potential for accidents.

2.2.10 Line of Sight

When the platform is in a stowed position, it should not interfere with direct line of sight, especially between a passenger desiring to use the lift and the lift operator.

Rationale: The operational requirements of a lift may result in a lift operator and passenger being separated by the lift platform. The line of sight requirement means that in such a situation the platform should not impair sight contact. The operator should be able to see through or around the lift platform.

2.3 Structural

The structural elements of the wheelchair lift include those that support working loads and attach the lift to the bus. They do not include mechanical and hydraulic components associated with operation and control of the lift.

2.3.1 Lift Capacity

The wheelchair lift should have a lift capacity of 600 pounds uniform load.

Rationale: Discussion with wheelchair manufacturers indicated that the heavier, powered wheelchairs can weigh up to 250 pounds. The 99th percentile male weighs approximately 241 pounds. A combined weight is 491 pounds. Two 99th percentile males (one handicapped person and one attendant) combined with a heavy manual wheelchair would have a weight of approximately 540 pounds. The current wheelchair market would appear to be accommodated by a design load of 600 pounds. Moreover, although powered wheelchairs may change, it is anticipated that the weight will not increase substantially.

A combination of an attendant, a handicapped person and a powered wheelchair could yield loads up to 750 pounds. However, this combination is not considered an appropriate design standard. A heavy powered wheelchair could occupy most of the platform and not allow room for a person to stand on a lift. Also, a powered wheelchair provides independent movement and reduces the need for an attendant. Furthermore, some members of the Advisory Panel opposed anyone not in a wheelchair being on the lift.

2.3.2 Structural Safety Factor

The structural safety factor should be at least three (3) based on the ultimate strength of the construction material.

Rationale: In the "Safety Code for Elevators and Escalators," ANSI/ASME A17.1-1984, the design safety factor for structural components varies depending on the function of the loaded member. They range from as high as 7.8 for bolts to as low as 2.2 for parts which are not considered critical from a safety standpoint. These safety factors are for elevators traveling at speeds far above those of a wheelchair lift and allow for emergency stops and high acceleration forces.

Mark's Standard Handbook for Mechanical Engineers, Eighth Edition suggests that good design practice calls for factors of safety of 1.5 to 4.0 based on yield strength of the material. The materials specified in ANSI/ASME A17.1-1984 have yield strengths of about one-half based on the ultimate strength, so the Mark's safety factor can be reconciled with the "Safety Code for Elevators and Escalators."

Recognizing that wheelchair lifts on transit vehicles are very slow moving relative to elevators, a design factor of three (3) has been designated for the lift. This is the same factor found in the California Administrative Code.

2.3.3 Useful Life

When used and maintained in accordance with manufacturer recommended procedures, a wheelchair lift structure should be designed to have a useful life equal to the useful life of the vehicle on which it is used.

Rationale: Once installed the lift becomes part of the vehicle. As with other components of the vehicle, the lift with normal maintenance, including repair and replacement of parts, should be operable as long as the vehicle. Useful life of a transit bus is 12 years. Useful life of smaller vehicles is less, with vans having a useful life of 3 to 5 years.

2.3.4 Materials

Structural components shall be made of steel or other durable construction material.

2.3.4.1 Ferrous surfaces should be either plated with a protective coating or be cleaned and have a corrosion and abrasion-resistant flat protective finish.

2.3.4.2 Nonferrous and nonmetallic surfaces should be coated using a durable finish.

2.3.4.3 Stainless steel does not require coating or surface treatment.

Rationale: The structural components of the lift are to have a useful life equal to that of the vehicle upon which they are mounted. Materials and coatings identified in these guidelines are intended to ensure this useful life. The discussions of the Advisory Panel included using a salt spray test or paint thickness measurement to insure compliance. The VA standard includes both ferrous material coating and test methods. However, no specific tests or coating methods have been designated so that manufacturers can continue to use their preferred methods. Panel members considered placing any coatings or surface treatments on stainless steel unnecessary.

2.3.5 Interface with the Vehicle

2.3.5.1 Installation of the wheelchair lift should not reduce or in any way compromise the structural integrity of the vehicle and shall have a structural safety factor as specified in Section 2.3.2.

2.3.5.2 Attachment of the wheelchair lift, including any modification of the vehicle, should not cause an imbalance of the vehicle that will adversely affect vehicle handling characteristics.

2.3.5.3 No part of the installed and stowed lift should extend laterally beyond the normal width of the vehicle.

2.3.5.4 The lift should not contact the opened door and/or door frame during deployment and normal operation.

Rationale: The design of a wheelchair lift dictates the required space for installation. It should be the responsibility of the vehicle manufacturer to determine compatibility of his vehicle's structural design with the selected lift. These guideline specifications require that the interface with the vehicle should have the same design safety factor as the lift structure.

Interlocks that prevent lift operation unless a vehicle door is open are recommended. However, observations at public transportation operations indicated that door adjustments or improper lift installation can result in interference between the lift and the door. These specifications do not allow such operating conditions. Concurrently, these specifications encourage increased door clearances and/or more precision in lift operation. This specification does not prohibit the use of brushes or other devices that are designed to allow contact between the door and lift.

2.4 Mechanical and Hydraulic

Mechanical and hydraulic components include all parts of the lift drive or control systems that support the platform load during normal operation of the wheelchair lift.

2.4.1 Mechanical and Hydraulic Safety Factors

Mechanical and hydraulic components include all parts of the lift drive or control system that are subject to wear and degradation due to the operation of the lift.

2.4.1.1 The mechanical component safety factor should be at least six (6) based on the ultimate strength of the material.

2.4.1.2 Hydraulic components should comply with all applicable Society of Automotive Engineers Standards. These Standards include, but are not limited to the following.

SAE J 190 - Power Steering Pressure Hose - Wire Braided
SAE J 191 - Power Steering Pressure Hose - Low Volumetric
SAE J 514APR80 - Hydraulic Tubing Fittings
SAE J516JUN84 - Hydraulic Hose Fittings
SAE J517JUN85 - Hydraulic Hose

All other components that contain working fluid should have a minimum burst pressure of at least three (3) times normal design working pressure.

Rationale: The mechanical safety factor is in agreement with the California Administrative Code. Also, "Safety Standard for Manlifts," ANSI A90.1-1976 states that all parts of the machine shall have a safety factor of six (6) based on a full load. Although the wheelchair lift operates at a lower velocity and is subjected to less severe shock loads than a manlift, a safety factor of 6 is considered appropriate. The hydraulic system design guideline is structured to make use of applicable Society of Automotive Engineers Standards. Hydraulic components that are not the subject of SAE Standards should be burst pressure tested at least three times normal design working pressure to ensure the integrity of the complete hydraulic system.

2.4.2 Platform Free-Fall Limits

The platform loaded with the design load of 600 pounds should free-fall no faster than twice the normal descent rate in the event of any power or equipment failure during lift operation.

Rationale: Twice the normal decent rate stated in Section 2.5.10.1 is 12 inches per second. The California Administrative Code allows platform motion at up to 11.8 inches per second in normal operation and twice this speed in free-fall. Therefore, the free-fall speed specified here is approximately one half that of the California regulation. This reduced speed is still twice the normal speed of descent. The 12 inches per second was selected because this ratio seems achievable and safe. In addition, the Canadian Standards Association limits the free-fall rate of descent of the platform loaded to capacity (600 pounds) to 5 inches per second.

2.5 Control Systems

2.5.1 Control Unit

2.5.1.1 The control unit should be a console or box with a function switch, an operating switch, or a combination thereof. The control unit may also have a power switch.

2.5.1.2 The control unit location should allow the lift operator to have an unobstructed view of the platform during lift operation and should allow the lift operator to be on or off the vehicle during lift operation.

2.5.1.3 The control unit should be located in a position that minimizes its damage during use of the lift.

2.5.1.4 The control console should have simple instructions on or near it that directs the operator in the lift operating procedures.

Rationale: The control system should be simple. Operator error, a factor in lift accidents, can be reduced with simple control systems and instructions. Existing, popular active lift models do have easily understood controls that meet this requirement. Another safety factor is for the control unit to be located in a position that allows the lift operator constantly to monitor lift operations. Tethered or pendant-mounted control units are common in the industry but must be carefully positioned for both safe operation and long life. The position is especially important if a local operator uses the operating procedures in Section 2.2.6, Option B.

2.5.2 Control Power Switch

The lift controls should have a power switch with two positions--on and off. The "on" position enables lift operation. The "off" position prevents lift operation.

Rationale: The power switch must be on to operate the lift. This switch enables the function selection and the operating switches. This switch is considered important for the safe design of the control logic. The switch may be on the control unit. The switch may also be located elsewhere on the vehicle. For example, the switch may be activated by opening or closing the door that is used for the lift.

2.5.3 Control Functions

(Use one of the following optional sections)
Option A - Automatic Control
The complete wheelchair lift should be attendant operated, fully automatic, including folding and unfolding of the platform.

2.5.3.1 The lift control system should have at least four designated operating functions as defined:

(1) Up - raises a lift platform, while maintaining an operating position
(2) Down - lowers lift platform, while maintaining an operating position
(3) Fold - moves lift platform from an operating position to a stowed position
(4) Unfold - moves lift platform from a stowed position to an operating position.

2.5.3.2 The lift may have four additional optional functions as defined:

(1) Outer Barrier Up - raises outer barrier
(2) Outer Barrier Down - lowers outer barrier
(3) Inner Roll Stop Up - raises inner roll stop
(4) Inner Roll Stop Down - lowers inner roll stop.

Option B - Semi-Automatic Control

The complete wheelchair lift unit should be semiautomatic including a manual fold and unfold of the lift platform. The folding and unfolding of the lift from and to the stored position should be accomplished with not more than a 20-pound force.

2.5.3.1 The lift control system should have at least two designated operating functions as defined:

(1) Up - raises a lift platform, while maintaining an operating position
(2) Down - lowers lift platform, while maintaining an operating position.

2.5.3.2 The lift may have four additional optional functions as defined:

(1) Outer Barrier Up - raises outer barrier
(2) Outer Barrier Down - lowers outer barrier
(3) Inner Roll Stop Up - raises inner roll stop
(4) Inner Roll Stop Down - lowers inner roll stop.

Rationale: To help reduce driver error in fleets with different lifts, the operating terminology is standardized for both automatic and semi-automatic lifts. A distinction is made between recommended functions and optional functions. The recommended functions are considered the minimum acceptable for safe operation. Existing active lifts usually have an automatic barrier, and/or roll stop. The guideline allows an option for controlled barrier or roll stop operation.

It is important that durable markings identify the control functions. The durable markings help experienced operators and are vitally important when new or inexperienced operators are responsible for lift operation.

No nationally established standards for manual lifting exist. Ergonomists make judgements and recommendations for each type of manual lift that is encountered. The 20-pound force for folding and unfolding the semi-automatic lift platform is based on recognition that at and below this number the force is considered moderate. Ergonomists suggest engineering control, such as power assists, when a 20-pound lift force is exceeded.

2.5.4 Control Operating and Function Switches

2.5.4.1 The control system should consist of

(a) separate operating and function selection switches

or

(b) integrated operating and function switches.

2.5.4.2 The function selection switch or integrated switches should be labeled with the functions defined in Section 2.5.3.

2.5.4.3 The operating switch or integrated operating and function switches should require continuous force to operate the lift; and release of the switches shall stop lift motion.

2.5.4.4 The function selection switch or integrated operating and function switches should not allow the operation of more than one function at a time.

Rationale: The control system allows two approaches. The first is a function selection switch, which is used to designate a function, and an operating switch that activates the function. The second approach is separate integrated switches. Under this approach separate or combined switches (e.g. a single button "up" switch or a combined "up" and "down" toggle switch with a neutral position) control lift operation. Both approaches would be possible only by momentary switches that would stop lift movement when released. Also, for safety purposes the lift will only perform one function at a time.

2.5.5 Design Safety

The control system should be designed to be fail-safe for single failure modes that would negate the proper operations of the interlocks specified in Section 2.5.8. A complete failure modes and effects analysis (FMEA) should be provided that demonstrates that this design requirement has been met.

Rationale: Safe operation is a primary concern of the guideline specifications. The safety protection for some operator errors and equipment failures resides in the integrity of the interlocks and safety features of Section 2.5.8. The safety of the lift/vehicle system is enhanced by requiring that the interlocks remain in a known safe state under conditions of any single failure of the control system or loss of power to the control system. An FMEA is a frequently used method in safety analysis to demonstrate what a design will do under selected failure modes. There are many reports and papers explaining FMEA. Three reports are:

(1) Dussault, N. B., "The Evolution and Practical Applications of Failure Modes and Effects Analyses," RADC-TRC-83-72, March 1983.

(2) MIL-STD-7858, Sept. 15, 1980, "Reliability Program for Systems and Equipment Development and Production," Task 204, Failure Modes, Effects, and Criticality Analysis (FMECA).

(3) ARP 926 A, "Fault/Failure Analysis Procedure," SAE Aerospace Recommended Practice", Rev. 11-15-79.

The first reference is a report that discusses several methods. The second reference is a Military Standard that is used in many defense system developments. The third reference is an SAE Recommended Practice used in the aerospace industry.

2.5.6 Jacking Prevention

The control system or inherent lift design should prevent the operation of the lift from jacking the vehicle and causing damage to the vehicle or the lift.

Rationale: To prevent damage to the lift or vehicle, the control system or inherent lift design shall not allow jacking. In some cases the release of load on the vehicle suspension when the lift platform reaches the ground is mistakenly considered jacking.

2.5.7 Manual Operation

The lift should have a manual method of operation permitting an operator to lower the platform to ground level from any position in its cycle with a wheelchair occupant on the platform. The manual method should also allow an unoccupied platform to be raised; and it should be possible to fold the lift to a service transport position. Barriers should be operable when the lift is in the manual mode.

Rationale: In the event of a power failure the lift must have a manual backup system to take passengers off the vehicle. Also, the manual operation would allow the lift to be stowed in order for the vehicle to move. For safety reasons the barriers should be operable.

2.5.8 Interlocks and Safety Features

2.5.8.1 Interlocks may (1) prevent vehicle movement or (2) provide a driver warning light; unless the lift is up and folded.

2.5.8.2 Interlocks may prevent lift activation and operation unless the vehicle is stopped and inhibited from moving and the appropriate door is open.

2.5.8.3 An interlock or inherent design feature should prevent stowing of the lift when the platform is occupied.

2.5.8.4 An interlock or inherent design feature should not allow a lift to move up or down when the platform is more than three (3) inches above the ground unless the outer barrier is raised and functioning.

Rationale: The interlock and safety features are designed to prevent unsafe conditions. The first interlock is advisory with an option. Although the vehicle movement feature is recommended, providing such an interlock for small vehicles is technically difficult and, therefore, raises the cost. This interlock is easier for vehicles with air brakes. The Advisory Panel did consider a warning light as a desired option to help prevent vehicle movement if the lift is unfolded.

The second interlock prevents lift movement unless the vehicle is appropriately inhibited from moving, and the lift can be deployed through an open door. This interlock reduces unsafe passenger conditions and damage to the lift or vehicle. The Advisory Panel debated the use of this interlock since it could cause problems in accident situations. It has been made optional, and, if used, must be designed with allowance for possible lift operation in emergency situations by people not familiar with lift details.

A potential safety hazard is a lift folding while a passenger is on it. This condition should be prevented by an interlock or by design (e.g., some existing active lifts have electric motors for stowing that have limited lifting capacity preventing stowing of an occupied lift).

Barrier failure also can create a very hazardous condition. To prevent this condition the lift shall not be able to operate up or down unless the outer barrier is raised.

2.5.9 Wiring

Wiring should be in accordance with SAE Recommended Practice SAE J1292 OCT 81 and referenced Standards, except when good engineering practice dictates special conductor insulations.

Rationale: This SAE Recommended Practice, "Automobile, Truck, Truck-Tractor, Trailer, and Motor Coach Wiring," is accepted by the automotive industry and provides a baseline for design. The practice recognizes that unique design will require engineering practices that cannot be envisioned and incorporated into a recommended practice.

2.5.10 Lift Operational Requirements

2.5.10.1 The maximum speed of platform motion should be 6 inches per second. The operating time required to deploy the lift, lower or raise the platform, and stow the platform should not exceed 60 seconds.

2.5.10.2 The maximum platform horizontal and vertical acceleration should be 0.3g.

2.5.10.3 The maximum allowable jerk should be 0.3g/sec.

Rationale: Lift operating speeds and cycle times are set in the White Book as 5 seconds to deploy or stow and 15 seconds to raise or lower a passenger. Many transit operators consider this much too fast for the comfort and safety of the wheelchair occupant. The California Administrative Code allows platform motion at up to 11.8 inches per second. This rate was also considered fast by the Advisory Panel. The transit authority bid packages reviewed in developing these guidelines have specified speeds and velocities in a wide variety of ways. The speeds and operating times specified here are designed to be compatible with the existing conditions, be acceptable to the transit agencies and wheelchair occupant, and not place new design requirements on lift manufacturers.

"Safety Guidelines for Wheelchair Lifts on Public Transit Vehicles," UMTA-CA-06-0098-80-1 states that vertical and horizontal acceleration rates shall not exceed 0.3g and that jerk, the rate of change of acceleration, shall not exceed 0.3g/seconds throughout horizontal motion of the occupied lift platform. These rates are used in this guideline, but the Advisory Panel generally agreed that lower rates are desirable.

3.0 TESTING, CERTIFICATION, INSPECTION, AND WARRANTIES

3.1 Design Tests

The tests defined in Section 3.1 should be performed on one representative production unit of the wheelchair lift model purchased by this procurement. Unless otherwise specified, the lift should meet the requirements given in Section 2.0 when attached to a fixture that simulates a bus installation and when supplied by electric, hydraulic, air, or other power source of output equal to that normally available on the bus. Only one representative production unit is required to be tested for certification, with all tests of Section 3.1 conducted on the same unit without any repairs or maintenance during the test other than that permitted by Section 3.1.11.

3.1.1 Durability Tests

The following tests should be performed without failure in the order given.

3.1.1.1 Vertical Cycling Tests. The lift platform should be operated up and then down through its maximum vertical operating range for 15,600 cycles with a load of 600 pounds for the first 600 cycles and 400 pounds for the remainihg cycles. The ambient temperature for the first half of the cycles in each of these tests should be at least 110 F. The tests may be continuous or separated into groups of not less than 10 cycles with nonoperating periods of not more than one minute between each cycle in the group. The platform should raise and lower smoothly throughout the test with vertical and horizontal accelerations not exceeding 0.3g.

3.1.1.2 Deployment Cycling Test. The lift platform of an automatic lift should be folded and unfolded for 10,000 cycles. The ambient temperature for the first half of the cycles should be at least 110 F. The tests may be continuous or separated into groups and may have nonoperating periods between cycles as specified in Section 3.1.1.1.

3.1.1.3 Combination Vertical and Deployment Cycling Test. The tests in Sections 3.1.1.1 and 3.1.1.2 may be combined into a single test that meets the minimum requirements of both tests.

Rationale: The first two of the above tests are adapted from the California Administrative Code. Section 3.1.1.2 is only for automatic lifts. Since semi-automatic lifts do not have a power fold or unfold function, a durability test of fold and unfold is not necessary. Section 3.1.1.3 has been added to accommodate manufacturers equipped to conduct the tests simultaneously.

Note that the language in Section 3.1 does not mean that a manufacturer must perform these tests for each procurement. Once a production unit of a specific lift model and vehicle combination has been tested, the design tests apply to all procurements of that combination.

3.1.2 Low Temperature Operation Test

After 16 hours of exposure to a temperature not higher than 20 F, the wheelchair lift should be operated unloaded through 10 or more cycles of unfolding, lowering, raising, and folding (or lowering and raising for semiautomatic lifts) and through 10 or more cycles of raising and lowering with a 600-pound load. Each cycle should be separated by at least a 30-minute cooling period at a temperature not higher than 20 F. The lift should meet all performance requirements while operating at the exposure temperature.

Rationale: The above test is a modification of the low temperature test of the California Administrative Code. The major changes were to extend the soak time to correspond to an overnight storage at a low temperature, to add testing at the design load, and explicitly to require the lift to meet all performance requirements at the test temperature.

3.1.3 Platform Deflection Test

A static load of 400 pounds should be applied through the centroid of a test pallet placed at the centroid of the platform. The platform should be raised and lowered with this weight. During the lift operation the platform should not deflect more than three degrees in any direction from the loaded position and its unloaded position.

Rationale: Section 3.1.3 has been adapted from the California Administrative Code, which has a platform deflection requirement and from the VA specifications. For these guideline specifications, platform deflection has been defined in terms of test requirements.

3.1.4 Self-Damage Tests

The controls should be held in operating position for 5 seconds after the unloaded lift meets resistance to its travel under each control position with any limit switch disabled. The test should be performed twice at each lift position of unfold, fold, full up at floor level, and full down at ground level.

Rationale: Section 3.1.4 is adapted from the California Administrative Code.

3.1.5 Power and Equipment Failure Test

A failure of power, chain cable, hydraulic hose, or air hose that allows the lift to deploy or the platform to lower should be simulated. The wheelchair lift should comply with Section 2.4.2 during this test. An FMEA may be provided in lieu of conducting actual tests.

Rationale: Section 3.1.5 has also been adapted from the California Administrative Code. It has been modified by allowing an FMEA to be used in place of actual testing. Such an analysis examines the consequences of failures such as those specified for simulation.

3.1.6 Outer Barrier and Outer Barrier Roll Stop Tests

3.1.6.1 Outer Barrier Test (For Section 2.2.6, Option A)

The contractor should test the ability of the outer barrier to retain a powered wheelchair. Two of four wheelchairs are to be tested. The Everest and Jennings 3M Marathon or the Invacare Power Rolls Arrow Model 4M929E and the Everest and Jennings Modular Power Chair 61 or the Fortress Scientific 655 should be used. The two wheelchairs and secured load should not leave the platform and the outer barrier should not be defeated (driven through or climbed over) by the wheelchairs when tested under all of the following conditions:

(a) fully charged battery system
(b) equivalent occupant loads of both 110 and 250 pounds
(c) operated both forwards and backwards
(d) accelerated at full power from a starting position off of the lift platform and a minimum of 48 inches between the front edge of the foot rests or rim of the rear tires and the outer barrier
(e) a platform positioned with a 8 degree outward slope
(f) the lift platform in a raised position.

The Everest and Jennings 3M Marathon or Invacare Power Rolls Arrow Model should be equipped with a standard adult size seat, standard foot rests, 20-inch rear wheels, eight-inch front casters, and a standard upright back. The Everest and Jennings Explorer Modular Power Chair or the Fortress Scientific 655 should be equipped with all the above features except that the front and rear tires should be 10 inches in diameter and the seating option and batteries should result in a gross wheelchair weight at or exceeding 210 pounds.

3.1.6.2 Outer Roll Stop Test (For 2.2.6, Option B)

A static load of 1600 pounds should be applied at a height of three (3) inches above and parallel to the wheelchair ground plane, evenly distributed over the full width of the outer roll stop device. The load will be applied for at least five (5) seconds with the lift platform at the floor level and also will be applied as the wheelchair ground plane moves down (or up). A load of 600 pounds will be on the lift during the test if the wheelchair retaining operation is dependent on such a load for its proper operation.

3.1.6.3 Inner Roll Stop

The contractor should test the ability of the inner roll stop to prevent a wheelchair from inadvertently rolling off the platform. In its raised position the roll stop should withstand a total force of at least 300 pounds parallel to the platform surface in the unloading direction. The force should be applied at a minimum height of 2-1/2 inches above the top surface of the platform with 150 pounds at each of two points 11.8 inches on each side of the center of the roll stop. Inherent design features may preclude the need for an inner roll stop.

Rationale: The four wheelchair models represent current wheelchairs that are powered and could override barriers. They have been selected because they have been identified as representing those models that are currently available and produce high and possibly the highest amounts of force that could overcome a barrier.

Specific models of wheelchairs have been chosen to standardize this test and to make transit operators aware of the limits of the test. A transit operator faced with transporting wheelchairs more powerful than those mentioned (e.g., specially-adapted wheelchairs) will be faced with different safety and risk levels.

The wheelchairs are to be tested with two different weights. The 110-pound represents a 5th percentile woman. With this lighter load, a wheelchair would be more susceptible to climbing or bouncing over a barrier. The 250-pound load represents a 99th percentile male, the standard used in defining the design load. The heavier weight will test the ability of a wheelchair to be powered through a barrier.

The 48-inch distance is longer than the minimum allowable platform length and less than the combined platform length and interior clear distance found on the same bus models. The 48 inches is considered a reasonable test distance.

Section 3.1.6.1 (Option B) tests the outer roll stop under Option B of Section 2.2.6. The test is an adaption of the test required by the VA.

The inner roll stop test specified in Section 3.1.6.2 is adapted from that currently required for an outward barrier under the California Administrative Code. This test appears designed to prevent inadvertent rolling off of a platform. The 2-1/2-inch test height requires a minimum roll stop height of 2-1/2 inches. This is the same height required by the CSA. The California Administrative Code and the VA require minimum roll stop heights of 3 inches or more. VA tests showed that under simulated lift conditions, a wheelchair could roll over a 2-inch barrier but

National Workshop on Bus-Wheelchair Accessibility

Guideline Specifications for
Passive Wheelchair Lifts

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ACKNOWLEDGMENTS

These guideline specifications are the culmination of many hours of hard work by persons representing all facets of the accessible transit and paratransit industry. The Urban Mass Transportation Administration (UMTA) recognized that the technology associated with accessible transportation could be improved and sponsored an Advisory Panel in order to develop industry guideline specifications. Representing different viewpoints and different interests, the members of the Advisory Panel met, discussed issues, and developed these guideline specifications. It is a credit to the Advisory Panel and the dedication of its members that a formal vote never had to be taken and that the guideline specifications were developed on the basis of consensus.

Several people need to be acknowledged for the assistance they provided to the Advisory Panel in the development of these guidelines. George I. Izumi, the UMTA Project Manager, was responsible for planning and organizing the Advisory Panel, planning for the Workshop, and contributed greatly to the development of the guidelines. Vincent R. DeMarco, the UMTA Program Manager, was responsible for guiding the efforts of the Advisory Panel and for planning and conducting the Workshop. Two other persons from the U.S. Department of Transportation also provided assistance. Christina Chang of the Transportation Systems Center helped to organize and run the Workshop and prepare Workshop Proceedings. Scott York of the National Highway Traffic Safety Administration participated in the Advisory Panel meetings and assisted in clarifying certain safety issues. The Battelle project team of Gerald A. Francis (consultant), Martin Gombert (ATE Management and Service Company, Inc.), Rolland D. King, and David M. Norstrom was responsible for developing the draft guideline specifications and serving as a technical resource to the Advisory Panel. Special recognition is given to Mr. Norstrom who skillfully managed the guideline development process and led the discussions of the Advisory Panel meetings that obtained a general consensus of the Advisory Panel on each guideline subject. Finally, appreciation goes to each member of the Advisory Panel who gave of their time and contributed their expertise to the development of these industry guidelines.

PREFACE

On September 17, 1985, the Administrator, Ralph L. Stanley, of the Urban Mass Transportation Administration called together a meeting with representatives of transit agencies, handicapped organizations, rehabilitation specialists and manufacturers of buses and wheelchair lifts to hear first hand the problems and issues regarding transit bus wheelchair accessibility. As a result of this meeting, the Administrator requested that an UMTA Advisory Panel be formed to plan a National Bus Wheelchair Accessibility Workshop and to guide the development of a set of guideline specifications for the equipment required for transit bus and paratransit vehicle wheelchair accessibility. A contract was issued to Battelle to assist UMTA in this effort.

As a result of surveying the transit industry for input and meeting with the Advisory Panel, Battelle prepared a draft set of guideline specifications for wheelchair lifts, securement devices and ramps for presentation and discussion at the National Bus Wheelchair Accessibility Workshop held in Seattle, Washington, on May 7 through 9, 1986. Using the inputs developed during the Workshop and the written comments submitted following the Workshop, the Advisory Panel prepared these final guideline specifications.

These guideline specifications are advisory in nature. The intention of the guideline specifications is to provide transit agencies with a model that they could use, as appropriate, in the development of their specifications for wheelchair accessibility. In the guideline specifications, where the word "should" is used, the recommendation of the Advisory Panel is that the suggested item or value be included in a general specification. Where the word "may" is used, the Advisory Panel recommends that the item or choice of value be considered for inclusion based upon local operating conditions. The Advisory Panel has developed these guidelines for use throughout the United States. It recognizes that unique local conditions could make an item suggested for inclusion inappropriate and a local public transportation provider would be required to make the appropriate changes (e.g. to accommodate extreme environmental conditions).

This guideline specification is one of four specifications developed by the Advisory Panel, which developed separate guideline specifications for passive wheelchair lifts (those used primarily on transit buses), active wheelchair lifts (those used primarily on paratransit vehicles), ramps and securement devices. Members of the Advisory Panel participated actively in the development of each individual guideline specification based upon their experience and interest. Although the Advisory Panel discussed many related accessibility issues, these guideline specifications focus only on the technical requirements of a specific piece of equipment. They have been prepared to assist in the purchase of such equipment either separately or as part of an overall vehicle procurement.

ADVISORY PANEL

The following individuals participated in the Advisory Panel for the development of the draft guideline specifications of passive wheelchair lifts, active wheelchair lifts, ramps, and wheelchair securement devices.

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Mr. Dennis Cannon, Architectural and Transportation Barriers Compliance Board, Washington, D.C.

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Mr. Mike Kurtz, Washington Metropolitan Area Transit Authority, Washington, D.C.

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1.0 GENERAL

1.1 Scope

These guideline specifications relate to passive lifts that are used by handicapped individuals to assist in boarding public transportation vehicles. A passive lift is defined as a lift that when stowed allows the unimpeded use of the vehicle door in which the lift is located. These guidelines specifications have been developed with special concern for the safety of passengers using a lift and reliability of lift operations.

1.2 Definitions

The following definitions apply for this document.

Accessible Vehicle - A vehicle that has been equipped to allow boarding by passengers who by reason of handicap are physically unable to board the vehicle that has not been so equipped.

Active Lift - An active lift is one that when stowed may interfere with the use of the vehicle entrance where the vehicle is located and that when being raised or lowered operates primarily outside the body of the vehicle.

Arc Lift - This term denotes the type of lift that has an arcing motion during operation as differentiated from elevator lift.

dBA - This term denotes decibels with reference to 0.0002 microbar as measured on the "A" scale.

Deploy - The term used to denote the operation of a lift from a stowed position to an operating position.

Design Load - The maximum weight capacity a lift is designed to raise or lower.

Drifting - The unintended movement of a lift from a stowed position.

Elevator Lift - This term denotes the type of lift that has a vertical up and down movement as differentiated from an arc lift.

Factor of Safety (Design Safety Factor) - The factor of safety is the ultimate strength of a material divided by the working stress. A structure fails or breaks when loaded to its ultimate strength. A structure deforms or takes set when loaded to its yield strength.

Fail-safe - A characteristic of a system and its elements whereby any malfunctions affecting safety will cause the system to revert to a known safe state.

Interlock - The arrangement in which the operation or position of one mechanism automatically allows or prevents the operation of another.

Lift or Wheelchair Lift - A level change device used to assist those with limited mobility in the use of transit and paratransit services. The term lift and wheelchair lift are used interchangeably in this document.

Maintenance Personnel Skill Levels - Maintenance personnel skills used in this document are defined in accordance with the White Book specifications as follows:

5M: Specialist Mechanic or Class A Mechanic Leader
4M: Journeyman or Class A Mechanic
3M: Service Mechanic or Class B Serviceman
2M: Mechanic Helper or Coach Serviceman
1M: Cleaner, Fueler, Oiler, Hostler, or Shifter.

May - This term shall be construed as permissive.

Mechanical and Hydraulic Components - Mechanical and hydraulic components include all parts of the lift drive or control system that are subject to wear and degradation due to the operation of the lift.

Paratransit Operation - Paratransit operation refers to a public transportation operation (service, vehicles, facilities, etc.) that is not a transit operation.

Passive Lift - A passive lift is one that when stowed allows the unimpeded use of the vehicle door in which the lift is located.

Pinching Point - A location where two closely spaced parts of machinery can move together to create a human hazard.

Shear Area - A hazardous condition or location where a moving part approaches or crosses a fixed part.

Should - The term is to be construed as recommended by the Advisory Panel.

Slip Resistant - A characteristic of a surface of a material that reduces unintended relative motion with respect to another surface with which it has contact.

Structural Elements - The structural elements of the wheelchair lift include those that support working loads and attach the lift to the vehicle. They do not include mechanical and hydraulic components associated with operation and control of the lift.

Stow - This term denotes the movement of a lift from an operating position to a position where the lift is stored and does not interfere with passenger use of entrance.

Transit Operation - Transit operation refers to a public transportation operation (service, vehicles, facilities, etc.) that operates with fixed routes and fixed schedules.

White Book - This term is the common name for "Baseline Advance Design Transit Coach Specifications." Originally published by UMTA on April 4, 1977, it is now available from the American Public Transit Association.

Wheelchair - A seating arrangement that is positioned on wheels, may be powered or unpowered, and can be used to assist mobility limited individuals.

Wheelchair Securement Device - A device anchored to a vehicle and used to limit the movement of a wheelchair when the vehicle is in motion.

1.3 Abbreviations

The following abbreviations may be found in the guideline.

ANSI --- American National Standards Institute

ASME --- American Society of Mechanical Engineers

ASTM --- American Society for Testing and Materials

CSA --- Canadian Standards Association

FMEA --- Failure Modes and Effect Analysis

FMVSS --- Federal Motor Vehicle Safety Standard

NHTSA --- National Highway Traffic Safety Administration

SAE --- Society of Automotive Engineers

SCRTD --- Southern California Rapid Transit District

UFAS --- Uniform Federal Accessibility Standards

UMTA --- Urban Mass Transportation Administration

VA --- Veterans Administration

1.4 Reference Documents

(1) American National Standards Institute
1430 Broadway, New York, N.Y. 10018

ANSI A17-1983
Elevator and Escalator Committee Interpretations
ANSI/ASME A17.1-1984
Safety Code for Elevators and Escalators
ANSI A90.1-1976
Safety Standards for Manlifts

(2) American Public Transit Association. "Baseline Advanced Design Transit Coach Specifications," includes Addendums 1 through 20 that were made to the April 1977 issue of "Baseline Advanced Design Transit Coach Specifications," published by Urban Mass Transportation Administration. (Commonly known as The White Book.) American Public Transit Association. April 1983.

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(4) California Administrative Code, Title 13, Chapter 2, Subchapter 4, Article 15. Wheelchair Lifts.

(5) Canadian Standards Association. "Motor Vehicles for the Transportation of Physically Disabled Persons," CAN3-D409-M84. Ontario, Canada: Rexdale. April 1984.

(6) Canyon Research Group, Inc. "A Requirements Analysis Document for Transit Vehicle Wheelchair Lift Devices." Prepared for Urban Mass Transportation Administration, Westlake Village, California. June 1978.

(7) "Federal Motor Vehicle Safety Standard," Code of Federal Regulations, Title 49, Part 571 No. 207, Seating Systems, and No. 210, Seat Belt Assembly Anchorages.

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(10) Panero, Julius and Zelnik, Martin. Human Dimensions and Interior Space. New York: Whitney Library of Design. 1979.

(11) Society of Automotive Engineers. Standards, Recommended Practices, Information Reports.

(12) Stewart, Carl F. and Reinl, Herbert G. "Safety Guidelines for Wheelchair Lifts on Public Transit Vehicles." Prepared for Urban Mass Transportation Administration (UMTA-CA-06-0098-80-1). California Department of Transportation. July 1, 1980.

(13) "Uniform Federal Accessibility Standards." Federal Register (49 FR 31528). August 7, 1984.

(14) "Veterans Administration Wheelchair Lift Systems: VA Standard Design and Test Criteria for Safety and Quality of Automatic Wheelchair Lift System for Passenger Motor Vehicles." Federal Register (49 FR 21390). May 17, 1978.

2.0 TECHNICAL REQUIREMENTS

2.1 General Requirements

The wheelchair lift should meet the technical requirements given in Section 2.0.

2.1.1 Operating Environment

The lift should operate in temperature ranges of -10 F to 115 F, at relative humidities between 5 percent and 100 percent, and at altitudes up to 5,000 feet above sea level. Degradation of performance due to atmospheric conditions should be minimized at temperatures below -10 F, above 115 F, or at altitudes above 5,000 feet.

Special procedures, hydraulic fluids, and/or lubricants may be used to operate the lift for the low and/or high temperature operating conditions.

Rationale: The urban areas of the United States have broad ranges of climatic conditions. Weather data indicate that many cities have recorded 100 days or more per year of over 90 F temperatures. Likewise, many have recorded 20 or more days per year below 0 F. The annual rainfall ranges as high as 60 inches per year to a low of 4 inches per year. The normal snow and sleet precipitation in some cities reach 88 inches per year. The recommended guidelines cover a broad range of conditions found in the United States and are adapted from the White Book specifications.

2.1.2 Weight

The weight of the lift should not adversely affect the legal axle loadings, the maneuverability, structural integrity, or the safe operation of the vehicle in which it is installed.

Rationale: For legal and safety reasons the weight of the lift should not adversely affect the bus. Since existing lifts reportedly meet these requirements, the weights of existing lifts are considered acceptable. The recommended upper limit is 3,000 pounds, which does not exclude any existing model.

2.1.3 Operation Constraints

2.1.3.1 The lift should operate when the lift platform is level and on any angle up to five (5) degrees or 8.7 percent in both the longitudinal and transverse direction.

2.1.3.2 The lift should be deployable when the curb levels are at least three and one-half (3-1/2) inches below the first step of the vehicle, the vehicle is on level ground, and and the vehicle is at the manufacturer's specified ride height.

Rationale: A lift will operate in a variety of different topographical conditions and must do so safely and reliably. This specification identifies a balance between the topographical conditions to be accommodated by the lift design and the conditions where a lift will not be required to operate. In this latter case a bus stop zone would be considered inaccessible unless changes were made (e.g. a platform or pad installed at the bus stop zone) that allowed lift operation.

No specification reviewed during the development of these guidelines identified any requirements in terms of the roll of the bus. The VA sets an operational limit of 9 degrees in any direction of tilt for the maneuvering of a powered wheelchair. A seven (7) percent grade specification is currently used by Seattle Metro in its lift procurement. Since a fully loaded lift can tilt up to 3 degrees (see Section 2.2.5), the 5 degree parameter was chosen in order to be less than the 9 degree limit when the 3 degree tilt is considered. The three and one-half (3-1/2) inch distance above a curb in Section 2.1.3.2 can be met by existing lifts.

This section is advisory. It has been included to provide a design guide for manufacturers. Concurrently, it can be used by transit operators to help define inaccessible bus stops. These guidelines do not assume the wheelchair lift will operate in all topographical conditions. Some current stops of a transit operator may be inaccessible. The transit operator would have to change the topography of the stop or change its location to provide accessibility.

2.1.4 Boarding Direction

A lift should be capable of handling a wheelchair in both an inward and outward facing position on the lift.

Rationale: The Advisory Panel considered outward facing to be the recommended position. However, emergency or other factors may require inward facing. For example, the ability to maneuver inside the bus or at a bus stop may require a person in a wheelchair to use a lift in either direction. To accommodate the passenger, the lift needs to be able to accept and operate with a wheelchair facing either inward or outward.

2.1.5 Location of Lift (Use one of the following options)

(Option A) The lift should be installed in the front door of the bus.
(Option B) The lift should be installed in the rear door of the bus.
(Option C) The lift should be installed in either the front or rear door of the bus.

Rationale: The issue of lift location generated many comments from advocates of either front door or rear door lifts. The location of the lift is a local decision based on local conditions. No location is universally agreed to be better than another. A transit operation should assess several factors before specifying a lift location, since doing so can exclude certain bus manufacturers from bidding. If a clear preference is not evident, the location should be optional.

Among the factors to be considered are the following:

Accident Data - Accident data from different sources supported both front door and rear door locations. A transit operation should assess its own accident history in terms of accidents involving front or rear door operation.

Bus Stop Topography - Positioning a lift for use is affected by bus stop topography. Vehicle maneuverability requirements at a bus stop differ between front and rear door lifts.

Operating Policies - A driver must leave his seat to operate current rear door lifts. Current operating policies or labor rules may prohibit such actions and would need to be changed.

Communication with Driver - Better communication between the driver and the mobility limited passenger is possible when the wheelchair securement is located near the front of the vehicle.

Interior Maneuverability - On some vehicles wheelchair maneuverability in the front of a vehicle can be restricted by fare boxes or other items. Rear door entry is normally not as restricted.

Dwell Time - The dwell time at a bus stop can be affected by the location of a lift. As noted above, a driver must leave his seat to operate current rear door lifts. However, the location and type of securement device and the interior maneueverability can also affect dwell time. Properly positioned securement devices may require less time when associated with a rear door lift. Thus, in terms of dwell time the lift location must be considered with regard to other factors.

Lift Dimensions - Some buses can accommodate larger lifts in the rear door. Specifying wider lifts may force some manufacturers to offer a rear door lift.

<u>Fare Collection</u> - The fare box on a transit vehicle is almost always in the front. Rear door boarding requires different fare collection procedures.

<u>Current Lift Location</u> - If a transit property currently has front or rear door lifts, it may find it advantageous to procure more of the same. For example, if a transit operator has invested in pads or made other bus stop improvements based on current lift location, procuring vehicles with a different lift location might require more bus stop improvements. Mixed lift locations also put extra demands on passengers and drivers.

2.1.6 Warning Signals

2.1.6.1 When the lift is being deployed, the lift should have an audible warning signal of 85 dBA (as measured five feet outside the door of the vehicle).

2.1.6.2 When the lift is being deployed, operated, or stored, the four-way flasher, hazard lights on the vehicle should be operating automatically.

Rationale: Transit operators report that lift accidents involve both persons using and not using the lift. The audible warning will signal passengers at a bus stop that the lift is being deployed. The 85 dBA level is a frequently used level for annunciators. A person can be exposed to this sound level for long periods of time without hearing damage; and the level is loud enough that it can be heard above normal background noise.

The four-way flasher, hazard lights will serve as a visual signal that the lift is being deployed. Since lift operation adds to the dwell time at a bus stop, the visual signal will alert motorists that the bus will be stopped for a longer than usual period. Although this requirement adds costs that could be avoided with an operational policy that drivers activate the hazard signals, to avoid human error the guidelines specifications require automatic warning lights.

2.1.7 Maximum Noise Level

The operating noise level of the lift should not exceed 75 dBA inside the vehicle or on the lift platform, except for the audible warning signal as specified in Section 2.1.6.1.

Rationale: The lift operation should not audibly disrupt the transit operations nor should it obscure the warning signal. The 75 dBA level has been used by the San Diego Transit Corporation in its lift specifications and has been adopted for use in these guidelines.

2.1.8 Protective Covering

2.1.8.1 Pinching movements, shear areas or places where clothing or other objects could be caught or damaged should be covered or in other ways protected to prevent passenger injury.

2.1.8.2 All exposed edges or other hazardous protrusions on the wheelchair lift should be protected to minimize injury during lift operation and in case of accident.

Rationale: To ensure safer operations, potentially hazardous areas should be protected. This is especially true of lift operations where individuals with certain handicaps have limited control of or feelings in parts of their body and may not sense a hazardous condition. When a hazardous area cannot be adequately covered or padded, the lift manufacturer must use other means to ensure safety. One alternative is a pressure sensing device that would automatically stop lift movement if an object is detected.

2.1.9 Operation Counter (Optional)

The lift may have an operations or use counter that records each complete cycle of the lift.

Rationale: A counter can provide data on lift use. The data would be especially useful in recording lift cycling, scheduling maintenance, and evaluating the performance of the lifts. The Advisory Panel considered this feature useful but not required. Local operating practices would determine whether it should be an option. The additional cost of this item may be offset by lower operating costs resulting from more timely maintenance.

2.1.10 Power Source Interface

The lift should operate and meet all requirements of these specifications while using the electrical and/or hydraulic power sources normally used on public transportation vehicles. The lift should meet these requirements whenever those power sources are performing within their specified ranges. The lift should continue to meet the requirements of Sections 2.4.2, 2.5.5, 2.5.8, and 2.5.11 during and following power source transients, including failure, that may be experienced on transit vehicles.

Rationale: The electrical and hydraulic interface between the vehicle and the lift is an important consideration in lift performance. This guideline is intended to ensure both proper interface consideration for normal operations and safe lift conditions in abnormal situations.

The guideline specifications have been developed for passive lifts and diesel buses. Although much of the guideline specifications could be used for other modes of transit, not all sections would apply. This is especially true for this section relative to trolley buses. The power source of a trolley bus places special requirements on the power source interface between the lift and the vehicle. A transit property planning to purchase lifts for use in trolley buses may have to add other power source interface requirements.

2.2 Platform

2.2.1 Dimensions

2.2.1.1 The lift platform should have a minimum clear width of 28-1/2 inches. It is desired to have a minimum clear width of 32 inches.

2.2.1.2 The minimum clear width between any handrails at the height of 14 inches or more above the platform surface should be 31 inches. It is desired to have a minimum clear width of 35 inches.

2.2.1.3 The minimum clear length of the lift platform as measured between the outer barrier and the inner roll stop should be 40 inches. At a distance two and one half inches above the platform, the clear distance should be 44 inches. It is desired to have a minimum clear distance of 44 inches at platform level and 48 inches, two and one half inches above the surface.

Rationale: Current passive lifts have overall widths of 30 to 42 inches and lengths of 40 to 47 inches. Barriers, roll stops, and handrails, can reduce the effective clearance below these dimensions.

The effective length of wheelchairs includes the length added by footrests, which means wheelchairs are shorter at ground level than at footrest level. Section 2.2.1.3 recognizes this fact by specifying a minimum platform length and a minimum clear width at a distance of 2-1/2 inches above the platform.

Estimates on current wheelchair sizes were obtained from two manufacturers and more detailed information was found in a 1978 report, "A Requirements Analysis Document for Transit Vehicle Wheelchair Devices."

The data are summarized in the following table:

Estimate of Wheelchair Dimensions

Percentile	Invacare Length	Invacare Width	1986 Everest & Jennings Length	1986 Everest & Jennings Width	1987 Everest & Jennings(1) Length	1987 Everest & Jennings(1) Width
100/99	48	30	77-1/2(2)	28-1/2	47	31-7/8
99			52/47-1/2(3)	26-1/2	43-1/2	26-1/4
90	44	26		26-1/2	42-1/2	26-1/4
85					42	
80	44	24				

(1) "A Requirements Analysis Document for Transit Vehicle Wheelchair Lift Devices," Canyon Research Group, Inc., June 1978.

(2) 77-1/2 inches represents a partially reclined, recliner wheelchair.

(3) 52 inches represents a recliner wheelchair and 47-1/2 inches represents a regular wheelchair.

The dimensions of the lift are influenced by the width of the vehicle doors and the floor height. The following table presents examples of these dimensions found on buses sold in the United States:

Door and Floor Height Dimensions for Selected U.S. Standard Size Buses

Examples of Typical U.S. Standard Size Buses	Door Width(1) Front Door	Door Width(1) Rear Door	Floor Height Front Door	Floor Height Rear Door
Flxible Corporation-Metro	36 in.	30 in.	30 in.	34.9 in.
General Motors Corp.-RTS 04	30 in.	44 in.	32 in.	35.75 in.
Neoplan- T-Drive ADB	34.5 in.	34.5 in.	31 in.	37 in.
Scania-CN112	48 in.	26 in.	31 in.	34 in.

(1) Door width is metal to metal. Clear widths would be less allowing for handrails and other elements.

Although the vehicle dimensions affect the size of the lift, within the specified minimum dimensions 90 to 95 percent of the wheelchair population can be accommodated. The dimensions in this guideline represents a realistic balance between the design limitations of current bus equipment and the wheelchair population. One class of wheelchairs that may be a problem are the newer three-wheeled models, which are longer than most other wheelchairs.

The recommended dimensions assume adequate interior maneuverability within the vehicle. Limited maneuverability on the vehicle could require a wider lift to allow acceptable access.

"Desired" dimensions are included in these guideline specifications. A user of these guidelines could provide cost offsets or other considerations for bidders providing lifts that meet or exceed the "desired" dimensions. The "desired" dimensions also represent the consensus of the Advisory Panel in terms of the desired direction for the industry. In the future, lifts should have minimum widths of 32 inches and minimum lengths of 44 and 48 inches.

The clear width between handrails is designed for the maximum width of wheelchair and allowance for a person to have clearance for hands on the rims of a wheelchair.

2.2.2 Surface

The platform surface should be slip resistant under the conditions defined in Section 2.1.1.

Rationale: A slip resistant surface reduces the potential for accidents for people standing on the lift and provides traction for a wheelchair.

2.2.3 Protrusions

When the lift barrier or roll stop is down, the platform should have no protrusions from the surface greater than 1/4 inch vertical rise or 1/2 inch smooth transition rise (slope no greater than 1:2).

Rationale: When lift barrier or roll stop is down, movement on and off the platform should be easy and not inhibited by protrusions greater than 1/4 inch vertical rise or 1/2 inch smooth transition rise from the surface. These dimensions are adapted from the UFAS.

It must be noted that the language, "when lift barrier or roll stop is down," has been chosen to allow protrusions when the barrier or roll stop is up. Lift manufacturers have indicated that mechanisms to hold the required outer barrier in place may require protrusions through the lift platform when the barrier is up. Such protrusions are allowable, but should not limit the size or type of wheelchairs that can use a lift

2.2.4 Gap Dimensions

When a lift is in the loading position at the vehicle floor height, the gap between the lift platform and the vehicle floor should be at a minimum. In no case should the vertical distance exceed 5/8 inch and the horizontal distance exceed 1/2 inch.

Rationale: A series of subjective tests reported in the VA specifications established the 5/8 inch vertical gap as the highest that should be allowed. The 1/2 inch horizontal gap was chosen to limit the overall gap opening to approximately 3/4 inch. The preferred option is to have virtually no gap.

2.2.5 Platform Deflection

The lift platform should not deflect more than three (3) degrees in any direction when tested in accordance with Section 3.1.3.

Rationale: To reduce the ability of a wheelchair to gain additional speed and overcome the barrier or roll stop and to reduce the chance of a wheelchair tilting off the lift, a maximum deflection standard is established. The three (3) degree deflection is currently found in the California Administration Code.

2.2.6 Edge Guards, Outer Barrier and Inner Roll Stop

2.2.6.1 Edge guards should extend the length of the platform that operates outside of the vehicle. These edge guards should have a minimum height of one inch.

2.2.6.2 The lift should have an outer barrier that retains a wheelchair on the platform when the platform is above the ground loading position.

2.2.6.3 The outer barrier should be designed to meet the test requirements of Section 3.1.6.1.

2.2.6.4 The platform should have an inner roll stop; or the design of the lift should use a part of the vehicle as an inner roll stop. The inner roll stop should restrict the rolling movement of a wheelchair when the platform is in any operating position other than at the vehicle floor loading position.

2.2.6.5 The inner roll stop should be designed to meet the test requirements of Section 3.1.6.2.

2.2.6.6 The contractor should identify and clearly emphasize in the operations and maintenance manuals any barrier or roll stop adjustment or maintenance action that if done improperly could result in an unsafe condition.

Rationale: Edge guards can prevent a wheelchair from accidentally sliding over the sides of the lift. Since edge guards are not in the direct path of a wheelchair using a lift, they are not designed to retain a wheelchair in direct forward or reverse motion but are designed to deflect tire direction. The one-inch height corresponds to that found in the California Administrative Code.

In 1985, Garrett Engineers, Inc. conducted tests for the Southern California Rapid Transit District (SCRTD). These tests showed that outer barriers on all existing passive wheelchair lifts could be overcome by commonly available powered wheelchairs. The powered wheelchairs could ride over the outer barriers or push them down. SCRTD initiated these tests following an accident investigation that indicated a powered wheelchair had defeated an outer barrier.

The unsafe condition of an outer barrier not retaining a wheelchair on the platform is unacceptable. This guideline is intended to eliminate this unsafe condition. The tests described in Section 3.1.6.1 establish the limits for barrier operation.

The Advisory Panel considered having the same requirements for an inner barrier. However, transit operators reported no problems with the existing inner roll stop. Also, the accident scenarios involving running over the inner roll stop or off the inside of a lift appeared to involve less risk of serious injury. Given these conditions, the Advisory Panel considered the requirements of a inner "barrier" to be different from an outer barrier. The inner roll stop is designed to stop inadvertent rolling of a wheelchair and provide an acceptable margin of safety.

It is recognized that certain lift designs may obviate the need for a separate inner roll stop by using a solid part of the vehicle structure as the inner roll stop. In such a case, the vehicle structure will function as the inner roll stop.

2.2.7 Handrails

2.2.7.1 When the lift if fully deployed, the platform should be equipped with a handrail on each side of the lift.

2.2.7.2 The handrails should be 25 to 34 inches above the platform and should be a minimum 12 inches in length.

2.2.7.3 The handrails should be capable of withstanding a horizontal force of 100 pounds concentrated at any point without permanent visible deformation.

2.2.7.4 The handrails should be between 1-1/4 and 1-1/2 inches in diameter or width and should permit a full hand grip with no less than 1-1/2 inches of knuckle clearance.

2.2.7.5 For wheelchair lifts that move in a arc motion, handrails should move with the lift. For wheelchair lifts that are of an elevator type, the handrails should be stationary or move with the lift.

Rationale: For a person with mobility only on one side, two handrails allow boarding in either direction. Handrails on both sides of a lift also limit lateral wheelchair movement.

Handrails that move with a lift provide more of a sense of security from a user's point of view than stationary handrails attached to the vehicle. Stationary handrails in effect move relative to the motion of the lift and are not as easy to grasp. However, stationary handrails currently in use have not been reported to be a major problem. The Advisory Panel considered movable handrails preferable for arc lifts. For elevator lifts stationary or movable handrails were considered acceptable.

The vertical height dimensions and the 100-pound force requirement are adapted from the Canadian Standards Association standard.

2.2.8 Platform Lighting

When the lift is in operation, the platform should have a minimum of one (1) foot-candle of illumination.

Rationale: Platform lighting provides for safer boardings when natural or other light is insufficient. The recommended level of illumination is adapted from the White Book.

2.2.9 Platform Markings

2.2.9.1 The side edges, the outer edge, and the inner edge of the platform, or the inner edge of the floor of the bus adjacent to the lift should be clearly marked in a color different from the lift platform.

2.2.9.2 The lift may have a designated standing area for lift passengers who are not in a wheelchair.

Rationale: The marking of the platform edges will provide greater visibility and reduce the potential for accidents. When standees are allowed on a lift, a designated standing area may be desirable. This standing area would be designated in a location to provide the passenger enhanced safety when using the lift.

2.2.10 Platform Seating (Optional)

Mobility limited passengers who are not in a wheelchair should be provided a seat that enables them to be in a seated position when using the lift. The seat when not in use will not interfere with normal lift operations or decrease the available clear space below the minimum identified in Section 2.2.1. The seat should be capable of holding a 95th percentile male and the force required to position the seat should not exceed five (5) pounds.

Rationale: The option allows transit operators to provide extra comfort and safety for a person not in a wheelchair who is using the lift. When using the seat, a passenger will have better head clearance and better stability on the lift. The Advisory Panel considered that this seat was optional and that the need for a seat was influenced by the type of lift. With the movement of an arc lift, a seat may provide a passenger with more of a sense of safety. On an elevator type lift, the lift movement reduces the need for a seat to provide perceived safety.

2.3 Structural

The structural elements of the wheelchair lift include those that support working loads and attach the lift to the vehicle. They do not include mechanical and hydraulic components associated with operation and control of the lift.

2.3.1 Lift Capacity

The wheelchair lift should have a lift capacity of 600 pounds uniform load.

Rationale: Discussion with wheelchair manufacturers indicated that the heavier, powered wheelchairs can weigh up to 250 pounds. The 99th percentile male weights approximately 241 pounds. A combined weight is 491 pounds. Two 99th percentile males (one handicapped person and one attendant) combined with a heavy manual wheelchair would have a weight of approximately 540 pounds. The current wheelchair market would appear to be accommodated by a design load of 600 pounds. Moreover, although powered wheelchairs may change, it is anticipated that the weight will not increase substantially.

A combination of an attendant, a handicapped person and a powered wheelchair could yield loads approaching 750 pounds. However, this combination is not considered an appropriate design standard. A heavy powered wheelchair could occupy most of the platform and not allow room for a person to stand on a lift. Also, a powered wheelchair provides independent movement and reduces the need for an attendant.

2.3.2 Structural Safety Factor

The structural safety factor should be at least three (3) based on the ultimate strength of the construction material.

Rationale: In the "Safety Code for Elevators and Escalators," ANSI/ASME A17.1-1984, the design safety factor for structural components varies depending on the function of the loaded member. They range from as high as 7.8 for bolts to as low as 2.2 for parts that are not considered critical from a safety standpoint. These safety factors are for elevators traveling at speeds far above those of a wheelchair lift and allow for emergency stops and high acceleration forces.

Mark's Standard Handbook for Mechanical Engineers, Eighth Edition suggests that good design practice calls for factors of safety of 1.5 to 4.0 based on yield strength of the material. The materials specified in ANSI/ASME A17.1-1984 have yield strengths of about one-half based on the ultimate strength, so the Mark's safety factor can be reconciled with the "Safety Code for Elevators and Escalators."

Recognizing that wheelchair lifts on transit vehicles are very slow moving relative to elevators, a design factor of three (3) has been selected. This is the same factor found in the California Administrative Code.

2.3.3 Useful Life

When used and maintained in accordance with manufacturer recommended procedures, a wheelchair lift structure should be designed to have a useful life equal to the useful life of the vehicle on which it is used.

Rationale: Once installed the lift becomes a part of the vehicle. As with other components of the vehicle, the lift with manufacturer recommended maintenance, including repair and replacement of parts, should be operable as long as the vehicle. Useful life of a standard size transit bus is 12 years.

2.3.4 Materials

Structural components should be made of steel or other durable construction material.

2.3.4.1 Ferrous surfaces should be either plated with a protective coating or be cleaned, primed, and have a corrosion and abrasion resistant flat finish.

2.3.4.2 Nonferrous and nonmetallic surfaces should be coated using a durable flat or matte finish.

2.3.4.3 Stainless steel does not require coating or surface treatment.

Rationale: The structural components of the lift should have a useful life equal to that of the vehicle upon which it is mounted. The materials and coatings identified in these guidelines are intended to ensure the useful life. Discussions of the Advisory Panel included using a salt spray test or paint thickness measure to ensure compliance. No specific tests have been designated in order to allow manufacturers flexibility, recognizing that the overall goal is to have materials lasting the useful life of the vehicle.

2.3.5 Interface with the Vehicle

2.3.5.1 The interface with the vehicle should have the structural strength required for in situ static loading of the lift platform to 1,800 pounds (three times the lift capacity).

2.3.5.2 Installation of the wheelchair lift should not reduce or in any way compromise the structural integrity of the vehicle.

2.3.5.3 Attachment of the wheelchair lift, including any modification of the vehicle, should not cause an imbalance of the vehicle that will adversely affect vehicle handling characteristics.

2.3.5.4 No part of the installed and stowed lift should extend into the stepwell, laterally beyond the normal side contour of the vehicle, or in any way violate the specified approach or breakover angle of the vehicle.

2.3.5.5 The stowed lift should not inhibit the operation of the vehicle door; and there should be no contact or rubbing between the opened door and/or the door frame that would damage the door or the lift during deployment and normal operation of the lift.

Rationale: The structural safety factor of the lift is three (3) and the designated lift capacity is 600 pounds. This section requires that the lift interface with the bus have the same design safety factor as the lift structure.

The design of a wheelchair lift dictates the required space for installation. The bus manufacturer has the responsibility to determine compatibility of the bus structural design and the selected lift.

Protrusions both inside and outside the bus pose potential hazards for passengers. The potential of damage to the lift is also increased when parts of the lift protrude outside the bus. Section 2.3.5.4 prohibits protrusions in the stepwell or on the sides of the bus. Also, the lift should not protrude from underneath the bus and adversely affect the approach or breakover angles. This requirement includes protrusions that result from the drifting of the lift. Drifting should be prevented through lift design, mechanical lock or detent.

Interlocks that prevent lift operation unless a vehicle door is open are included in these guideline specifications. Observations at public transportation operations indicated that door adjustments or improper lift installation can result in interference between the lift and the door. This guideline specification does not allow such an operating condition. Concurrently, it encourages increased door clearances and/or more precision in the lift operation. The specification does not prohibit the use of brushes or other devices that are designed to allow contact between the door and lift.

2.4 Mechanical and Hydraulic

Mechanical and hydraulic components include all parts of the lift drive or control system that are subject to wear and degradation due to the operation of the lift.

2.4.1 Mechanical and Hydraulic Safety Factors

2.4.1.1 The mechanical component safety factor should be at least six (6) based on the ultimate strength of the material.

2.4.1.2 All hydraulic hoses should comply with SAE Standards J190 (Power Steering Pressure Hose--Wire Braided) and J191 (Power Steering Pressure Hose--Low Volumetric Expansion Type).

2.4.1.3. All components that contain hydraulic fluid should have a minimum burst pressure of five (5) times normal design working pressure.

Rationale: The mechanical safety factor is in agreement with the California Administrative Code. Also, "Safety Standards for Manlifts," ANSI A90.1-1976 states that all parts of the machine shall have a safety factor of six (6) based on a full load. Although the wheelchair lift operates at a lower velocity and it should be subjected to less severe shock loads than a manlift, a safety factor of 6 is considered appropriate.

The hydraulic safety factors are based on SAE standards for hose and ANSI/ASME A17.1-1984, Safety Code for Elevators and Escalators, Part III Hydraulic Elevators. Part III requires safety factors of 5 on hydraulic cylinders, piping, and valves.

2.4.2 Platform Free Fall Limits

The platform loaded with the design load should free-fall no faster than twice the normal descent rate, as specified in Section 2.5.11.1, in the event of any power or equipment failure during lift operation.

Rationale: Twice the normal descent rate stated in Section 2.5.11.1 is 12 inches per second. The California Administrative Code allows platform motion at up to 11.8 inches per second in normal operation and twice this speed in free-fall. Therefore, the free-fall speed specified here is approximately one half that of the California regulation.

2.4.3 Hydraulic Power Source (use one of the following options)

(Option A) The hydraulic power source for the lift should be the vehicle power steering pump or another existing hydraulic power source on the vehicle.

(Option B) The lift hydraulic system shall be independent and shall operate the lift ---(*)--- percent of design speeds at a minimum temperature of ---(*)--- F.

* To be completed by Procuring Agency.

Rationale: Cold weather affects the operation of the hydraulic systems on current lifts. Where cold weather is not a problem, Option A can be used in lift specifications. When cold weather conditions are expected to affect the operation of the lift, Option B can be used to specify an independent hydraulic system that will function in cold weather. This separate system could be driven by the power steering pump.

2.5 Control Systems

2.5.1 Control Console

2.5.1.1 The lift controls should be located on a console and shall consist of a power switch, a function selection switch, and an operating switch.

2.5.1.2 The control console should be located in a position where the lift operator (driver) has a direct unobstructed view of the platform during lift operation and should be secure from operation or tampering by unauthorized individuals.

2.5.1.3 The control console should have simple instructions on or near it that directs the operator in the lift operating procedures.

2.5.1.4 The switches on the control console should by their location or by other means prohibit simultaneous, one-handed operation of more than one switch.

Rationale: Discussions with public transportation operators indicated that lift operator error contributes to a significant proportion of lift accidents and cause maintenance and reliability problems. Several factors contribute to lift operator error--infrequent use of the lift, different controls for different lifts, and lack of follow-up training. One means to reduce operator error is to make lift control systems functionally standard and simple. These guideline specifications seek to do this.

The first step is to have the lift operation controlled by three switches, which operate as described in Sections 2.5.2 to 2.5.4. For safety reasons the operator must have a clear view of the movement of the lift when it is in operation. This requirement means that the console for a rear door lift must be located near the rear door and be secure from unauthorized access. To assist in reducing operator error, simple instructions for the lift operator should be available.

Simultaneous, one-handed operation has been identified as a source of operator error. Proper positioning of the switches or other means can eliminate this source of driver error.

2.5.2 Power Switch

The lift controls should have a power switch with two positions--on and off. The "on" position enables lift operation and should be designated by a lighted indicator. The "off" position prevents lift movement.

Rationale: The power switch must be "on" to operate the lift. This switch enables the function selection and the operating switches. This switch is considered important for the safe design of the control logic, especially since it can also act as a back-up, emergency "off" switch. The requirement for a lighted indicator is to allow the driver to discern the status of the power switch.

2.5.3 Control Function Selection Switch

2.5.3.1 The lift controls should have a function selection switch to designate the desired lift function. The switch shall have at least five designated functions (as defined) in the following order:

(1) Off - no function can be activated
(2) Deploy - lift is operated from a stowed position to a platform position
(3) Down - lowers lift platform
(4) Up - raises lift platform

(5) Stow - lift is operated from a platform position to a stowed position.

2.5.3.2 The lift may have four optional functions--outer barrier down, outer barrier up, roll stop down, and roll stop up. If any one or more of these functions are included, their order on the function switch shall be as follows:

(1) Off
(2) Deploy
(3) Down
(4) Outer Barrier Down - lowers outer barrier
(5) Outer Barrier Up - raises outer barrier
(6) Up
(7) Roll Stop Down - lower inner roll stop
(8) Roll Stop Up - raises inner roll stop
(9) Stow

2.5.3.3 The function selection switch should not allow the selection of more than one function at one time.

Rationale: The control selection switch specification identifies functions for a lift and defines these functions. Existing lifts designate functions with various terms. This specification identifies the terms that should appear on lifts produced by any manufacturer.

A distinction is made between recommended functions and optional functions. The recommended functions are considered the minimum acceptable for operation. Existing lifts have barriers or roll stops controlled either automatically or by driver action. The specification allows both options. The minimum designated functions assume roll stop automatic barrier functions.

The sequence for listing the mandatory and optional functions has been chosen to provide more standardization. The switch itself may be different (e.g., rotary, lever, or pushbutton); but the order of the functions remains the same. A lift operator can expect identical functional relationships, although the control switches may be different. Section 2.5.3.3 provides for increased safety and reliability in the lift operation by having only one function selected at a time.

The Advisory Panel also discussed having an interlock that would prevent the function selection switch from being changed when the operating switch is activated. Some members considered this option expensive and redundant with other safety features in the specifications. For these reasons such an interlock was not included.

2.5.4 Control Operating Switch

2.5.4.1 The lift controls should have an operating switch labeled "Operate" that will activate the designated function for the lift.

2.5.4.2 The operating switch should require continuous force to perform the selected function.

2.5.4.3 Release of the operating switch should stop the lift motion.

Rationale: The third type of switch on the control console is an operating switch. This switch will allow the lift to perform the designated function. For safety reasons, it is a momentary-type switch that requires continuous force for operation. If a driver is disabled or wants to stop the lift immediately, the only required action is the release of the switch. The lift operator should be able to stop and change to any control function in order to adjust to operating conditions, safety hazards, or passenger requests. The momentary nature of the operating switch in combination with the function switch provides this control capability.

2.5.5 Design Safety

The control system should be designed to be fail-safe for single failure modes that would negate the proper operations of the interlocks specified in Section 2.5.8. A complete failure modes and effects analysis (FMEA) that demonstrates these design requirements have been met should be provided.

Rationale: Safe operation is a primary concern of the guideline specifications. The safety protection for some operator errors and equipment failures resides in the integrity of the Interlocks and Safety Features of Section 2.5.8. The safety of the lift/vehicle system is enhanced by requiring that the interlocks remain in a known safe state under conditions of any single failure of the control system or loss of power to the control system.

An FMEA is a frequently used method in safety analysis to demonstrate what a design will do under selected failure modes. There are many reports and papers explaining FMEA. Three such reports are:

(1) Dussault, N. B. "The Evolution and Practical Applications of Failure Modes and Effects Analyses," RADC-TR-83-72. March 1983.

(2) MIL-STD-7858, Sept. 15, 1980, "Reliability Program for Systems and Equipment Development and Production," Task 204, Failure Modes, Effects, and Criticality Analysis (FMECA).

(3) ARP 926 A, "Fault/Failure Analysis Procedure," SAE Aerospace Recommended Practice," Rev. 11-15-79.

The first reference is a report that discusses several methods. The second reference is a Military standard that is used in many defense system developments. The third reference is a SAE Recommended Practice used in the aerospace industry.

2.5.6 Jacking Prevention

The control system or inherent lift design should prevent the operation of the lift from jacking the bus and causing damage to the bus or the lift.

Rationale: Jacking is the support or lifting of the bus by the wheelchair lift when the platform is power driven into the ground. The release of load from the bus when the occupied platform contacts the ground is sometimes mistakenly considered jacking. Early models of some passive lifts did result in jacking and damaging to the lift or bus. To prevent such damage the control system or inherent lift design should not allow jacking.

2.5.7 Manual Operation

The lift should have a manual method of operation permitting an operator to lower the platform to ground level from any position in its cycle with a wheelchair occupant. It should also be possible to raise an unoccupied platform, and to stow the lift. The outer barrier and inner roll stop should be functional and controllable when the lift is in the manual mode.

Rationale: In the event of a power failure the lift must have a manual backup system. To accommodate passengers the manual system will be able to be used to take passengers off the vehicle. Also, the manual operation will allow the lift to be stowed in order for the vehicle to move. For safety reasons, the barriers and inner roll stop would be operable.

2.5.8 Interlocks and Safety Features

2.5.8.1 Interlocks should prevent vehicle movement unless the lift is stowed.

2.5.8.2 Interlocks should prevent lift activation and operation unless the vehicle is stopped and inhibited from moving and the appropriate door is open.

2.5.8.3 An interlock or inherent design feature should prevent stowing of the lift when the platform is occupied.

2.5.8.4 An interlock or inherent design feature should not allow a lift to move up or down unless the inner roll stop and outer barrier are raised and operational.

2.5.8.5 An interlock or inherent design feature should not allow the outer barrier to be lowered unless the lift platform is at an unloading surface below the vehicle floor level.

Rationale: The interlocks and safety features are designed to prevent unsafe conditions. The first interlock guideline prevents vehicle movement when a passenger is on a lift or when the lift extends beyond the normal width of the vehicle. The second interlock prevents lift movement unless the vehicle is appropriately inhibited from moving and the lift can be deployed through an open door. This interlock reduces unsafe passenger conditions and damage to the lift or vehicle.

One safety hazard identified with lift operations is going into a stow position when a lift is occupied. The control system or the inherent design of the lift would prevent this condition.

Barrier or roll stop failure can create a hazardous condition. To prevent this condition the lift should not be able to operate up or down unless the inner roll stop and outer barrier are up and working properly.

Similarly, the lift operator cannot inadvertently lower the outer barrier unless the platform is at an unloading surface. This feature means the platform would have to be at ground level or on a surface that allows safe boarding and a lighting.

2.5.9 Maintenance Controls (Optional)

The lift should have a separate maintenance control that allows complete lift operation, is inaccessible during normal vehicle operation, and is located in a functional position for maintenance of the lift. The design of the maintenance controls should ensure all safety features of lift operations when the maintenance controls are not in use.

Rationale: The control requirements for normal operation and maintenance are different depending on console location and maintenance access. To assist in the maintenance of the lift, it is suggested that separate maintenance controls be provided. However, this requirement is optional. An operator will have to decide whether the initial cost for such controls will be offset by reduced maintenance costs.

2.5.10 Wiring

Wiring should be in accordance with SAE Recommended Practice SAE J1292 OCT 81 and referenced Standards, except when good engineering practice dictates special conductor insulations.

Rationale: The SAE Recommended Practice, "Automobile, Truck, Truck-Tractor, Trailer, and Motor Coach Wiring," is accepted by the automotive industry and provides a baseline for design. The practice recognizes that unique design will require engineering practices that cannot be envisioned and incorporated into a recommended practice.

2.5.11 Lift Operational Requirements

2.5.11.1 The maximum speed of platform motion should be 6 inches per second. The operating time required to fully cycle the lift (deploy, down, up, and slow with barrier operation) should not exceed 45 seconds at 20 F and not exceed 65 seconds at -10 F.

2.5.11.2 The maximum platform horizontal and vertical acceleration shall be 0.2g.

Rationale: Lift operating speeds and cycle times are set in the White Book as 5 seconds to deploy or stow and 15 seconds to raise or lower a passenger. Many transit operators consider this much too fast for the comfort and safety of the wheelchair occupant. The California Administrative Code allows platform motion at up to 11.8 inches per second. This rate was considered fast by the Advisory Panel. The transit authority bid packages reviewed have specified speeds and velocities in a wide variety of ways. The speeds and operating times specified here are designed to be compatible with existing condition, acceptable to the wheelchair occupant, and should not place new design requirements on the lift manufacturer.

"Safety Guidelines for Wheelchair Lifts on Public Transit Vehicles" states that vertical and horizontal acceleration rates shall not exceed 0.3g. The specified value of acceleration permitted in this section is lower and provides more desirable conditions for the lift user with very little increase in operating cycle time.

The above referenced report also recommends that the rate for jerk, the rate of change of acceleration, not exceed 0.3g/second throughout the horizontal motion of the occupied lift platform. The Advisory Panel discussed the rate of jerk. However, little data could be identified that would guide the establishment of a rate for jerk. Both 0.2g/second and 0.3g/second were discussed. Given the lack of data, the Advisory Panel made no recommendation in this area.

3.0 TESTING, CERTIFICATION, AND INSPECTION

3.1 Design Tests

The tests defined in Section 3.1 shall be performed on a representative production unit of the wheelchair lift model purchased by this procurement.

Unless otherwise specified, the lift should meet the requirements given in Section 2.0 when attached to a fixture that simulates a vehicle installation and when supplied by electric, hydraulic, air, or other power source of output equal to that normally available on the vehicle. Only one representative production unit is required to be tested for certification for design tests 3.1.1 through 3.1.7. Design tests 3.1.1 through 3.1.5 should be conducted on the same unit, without failure, in the order given, and without any repairs or maintenance other than that permitted by Section 3.1.11. The contractor may elect to conduct the tests specified in Section 3.1.6 with the lift installed in a vehicle. Design tests 3.1.8 and 3.1.9 require a lift model and vehicle model combination. For certification these tests need only be conducted once for each lift and vehicle model combination.

3.1.1 Durability Tests

3.1.1.1 Vertical Cycling Test. The lift platform should be operated up and then down through its maximum vertical operating range for 15,600 cycles with a load of 600 pounds for the first 600 cycles and 400 pounds for the remaining cycles. The ambient temperature for the first half of the cycles in each of these tests should be at least 110 F. The tests may be continuous or separated into groups or not less than 10 cycles with nonoperating periods of not more than one minute between each cycle in the group. The platform should raise and lower smoothly throughout the test with vertical and horizontal accelerations not exceeding 0.2g.

3.1.1.2 Deployment Cycling Test. The lift platform should be deployed and stowed for 10,000 cycles. The ambient temperature for the first half of the cycles should be at least 110 F. The tests may be continuous or separated into groups and may have nonoperating periods between cycles as specified in Section 3.1.1.1.

3.1.1.3 Combination Vertical and Deployment Cycling Test. The tests in Sections 3.1.1.1 and 3.1.1.2 may be combined into a single test that meets the requirements or both tests.

Rationale: The tests in Section 3.1.1.1 and 3.1.1.2 are adapted from those required by the California Administrative Code. Section 3.1.1.3 has been added to accommodate manufacturers equipped to conduct the tests simultaneously.

Note that the language in Section 3.1 does not mean that a manufacturer must perform these tests for each procurement. Once a production unit of a specific lift model and vehicle combination has been tested, the design tests apply to all procurements of that combination.

3.1.2 Low Temperature Operation Test

After 16 hours of exposure to a temperature not higher than 20 F, the wheelchair lift should be operated unloaded through 10 cycles of deploying, lowering, raising, and stowing and through 10 cycles of raising and lowering with a 600-pound load. Each cycle should be separated by at least a 30-minute cooling period at a temperature not higher than 20 F. The lift should meet all performance requirements while operating at exposure temperatures.

Rationale: The above test is a modification of the low temperature test of the California Administrative Code. The major changes were to extend the soak time to correspond to an overnight storage at a low temperature, to increase the test weight to the 600 pound limit contained in these specifications, explicitly to require the lift to meet all performance requirements at the test temperature, and to change the cycling to avoid loading and unloading the lift during the test.

3.1.3 Platform Deflection Test

A static load of 600 pounds should be applied through the centroid of a test pallet 24 inches by 24 inches placed at the centroid of the platform. The platform should be raised and lowered with this weight. During the lift operation the platform should not deflect more than three degrees in any direction between the loaded position and its unloaded position.

Rationale: The California Administrative Code has a platform deflection requirement. For the guideline specifications platform deflection has been defined in terms of test requirements. The test requirement have been developed based on the design load and the platform deflection requirement in the California Administrative Code.

3.1.4 Self-Damage Tests

The controls should be held in operating position for five (5) seconds after the unloaded lift meets resistance to its travel under each control position with any limit switch disabled. The test should be performed twice at each lift position of deploy, stow, full up at floor level, and full down at ground level.

Rationale: Section 3.1.4 is adapted from the California Administrative Code.

3.1.5 Power and Equipment Failure Test

A failure of power, chain, cable, hydraulic hose, or air hose that allows the lift to deploy or the platform to lower should be simulated. The wheelchair lift should comply with Section 2.4.2 during this test. An FMEA may be provided in lieu of conducting actual tests.

Rationale: Section 3.1.5 is adapted from the California Administrative Code. It allows an FMEA to be used in place of actual testing. Such an analysis examines the consequences of failures such as those specified for simulation.

3.1.6 Barrier and Roll Stop Tests

3.1.6.1 The contractor should test the ability of the outer barrier to retain a powered wheelchair. Two of four wheelchairs are to be tested. The Everest and Jennings 3M Marathon or the Invacare Power Rolls Arrow Model 4M929E and the Everest and Jennings Explorer Modular Power Chair, or the Fortress Scientific 655 should be used. The two wheelchairs and secured load should not leave the platform and the outer barrier should not be defeated (driven through or climbed over) by the wheelchairs when tested under all of the following conditions:

(a) fully charged battery system
(b) equivalent occupant loads of both 110 and 250 pounds
(c) operated both forwards and backwards
(d) accelerated at full power from a starting position off of the lift platform and a minimum of 48 inches between the front edge of the foot rests or rim of the rear tires and the outer barrier
(e) a platform positioned with an 8 degree outward slope
(f) the lift platform in a raised position.

The Everest and Jennings 3M Marathon or the Invacare Power Rolls Arrow Model should be equipped with a standard adult size seat, standard foot rests, 20-inch rear wheels, eight-inch front castors, and a standard upright back. The Everest and Jennings Explorer Modular Power Chair or the Fortress Scientific 655 should be equipped with all the above features, except that the front and rear tires should be 10 inches in diameter and the seating option and batteries should result in a gross wheelchair weight at or exceeding 210 pounds.

3.1.6.2 The contractor should test the ability of the inner roll stop to prevent a wheelchair from inadvertently rolling off the platform. In its raised position the roll stop should withstand a total force of at least 300 pounds parallel to the platform surface in the unloading direction. The force should be applied at a minimum height of 2-1/2 inches above the top surface of the platform with 150 pounds at each of two points 11.8 inches on each side of the center of the roll stop.

Rationale: As discussed in the rationale for Section 2.2.6, existing barriers have failed in tests using powered wheelchairs. This test of the outer barrier is designed to ensure that barriers do not fail under the test conditions and that a wheelchair and secured occupant could remain on the platform.

The four models represent two types of current wheelchairs that are powered and could override barriers. They have been selected because they have been identified as representing those wheelchair models that are currently available and produce high and possibly the highest amounts of force that could overcome a barrier.

Specific models of wheelchairs have been chosen to standardize this test and to make transit operators aware of the limits of the test. A transit operator faced with transporting wheelchairs more powerful than those mentioned (e.g. specially designed wheelchairs) will be faced with different safety and risk levels.

The wheelchairs are to be tested with two different weights. The 110 pound represents a 5th percentile woman. With this lighter load, a wheelchair would be more susceptible to climbing or bouncing over a barrier. The 250 pound load represents a 99th percentile male, the standard used in defining the design load. The heavier weight will test the ability of a wheelchair to be powered through a barrier.

The 48 inch distance is longer than the maximum allowable platform length and less than the combined platform length and interior clear distance found on the same bus models. The 48 inches is considered a reasonable test distance.

The test in Section 3.1.6.1 is recommended as an interim test by the Advisory Panel. The Advisory Panel also recommends that more precise test requirements be developed that identify specific forces, angles, and other factors to be tested. These requirements would simulate conditions described in Section 3.1.6.1 and provide a more definitive test procedure and guideline.

The roll stop test specified in Section 3.1.6.2 is adapted from that currently required for an outward barrier under the California Administrative Code. This test appears designed to prevent inadvertent rolling off of a platform. The 2-1/2 inch test height requires a minimum roll stop height of 2-1/2 inches. This is the same height required by the CSA. The California Administrative code and the VA require minimum roll stop heights of three inches or more. VA tests showed that under simulated lift conditions, a wheelchair could roll over a 2-inch barrier but be stopped by a 3-inch barrier. The 2-1/2-inch barrier is accepted by

CSA and corresponds to the height at which clear length is measured (see Section 2.2.1.3).

3.1.7 Static Load Test

A static load of 1800 pounds should be applied through the centroid of a test pallet placed at the centroid of the platform when the platform is positioned at its raised position. The length and width dimensions of the test pallet should be 24 inches by 24 inches to correspond to the approximate outer dimensions of a wheelchair "footprint." The load should remain on the platform not less than two (2) minutes. After the load is removed, an inspection should be made to determine if fractures have occurred.

Rationale: The test given in Section 3.1.7 is adapted from the California Administrative Code. Section 3.1.7 was modified to specify a time period for the test. The two-minute period is the same as that specified by the VA.

3.1.8 Vehicle Interface Test

This test should be conducted on a lift installed in an actual vehicle of the same model as being purchased through this procurement. A static load of 900 pounds should be applied through the centroid of a test pallet placed at the centroid of the platform when the platform is positioned at its raised position. The length and width dimensions of the test pallet should be 24 inches by 24 inches. The load should remain on the platform not less than two (2) minutes.

Rationale: Section 3.1.8 has been developed for these guideline specifications and tests the structural interface between the vehicle and the lift.

3.1.9 Interlock Safety Tests

The Contractor should submit a test plan for approval by the Procuring Agency or certification of tests that demonstrate that the lift model, when installed in the vehicle model, meets the safety related interlocks as given in Section 2.5.8.

Rationale: This test will demonstrate the level of safety provided by the lift interlocks.

3.1.10 Visual Inspection

At the conclusion of any test described in Section 3.1--except Sections 3.1.6 and 3.1.7--with all loads removed, the parts of the wheelchair lift should show no condition of fracture, permanent deformation, wear that would exceed manufacturer's tolerances, perceptible impairment, or other deterioration that would be dangerous.

Rationale: Section 3.1.10 is adapted from the California Administrative Code. The visual inspection is a means to determine if the tests have been passed.

3.1.11 Maintenance During Tests

During the Durability Tests of Section 3.1.1, the inspection, lubrication, maintenance, and replacement of parts (other than bulbs and fuses) may be performed only as specified in the contractor's maintenance manual for the lift and at intervals no more frequent than specified in the manual. Maintenance specified for certain time intervals should be performed during the vertical cycling and deployment cycling tests at a number of cycles that is in the same proportion to the total cycles as the maintenance period is to 36 months.

Rationale: Section 3.1.11 is taken from the California Administrative Code. Scheduled maintenance is permitted during the tests, and parts scheduled for replacement can be replaced. However, if replacement or other parts fail during the tests, the test would have to be repeated.

3.1.12 Certification

The contractor should provide written certification of compliance of the tests specified in Section 3.1, Design Tests.

Rationale: This is a standard practice in design testing.

3.2 Acceptance Tests (Optional)

The contractor should submit for approval to the Procuring Agency a test plan to demonstrate that the lifts purchased by this procurement meet the requirements given in Section 2.0, unless otherwise tested in Section 3.1. The Procuring Agency may witness any or all of these acceptance tests. A mutually agreed upon notification time prior to the conduct of a test should be made between the two parties. The test results should be recorded, witnessed, and submitted to the Procuring Agency as proof of meeting the acceptance criteria of the approved test plan.

Rationale: This section is optional since most lifts would be purchased as a part of a vehicle procurement and any lift acceptance testing would be included in the vehicle acceptance testing. Acceptance testing needs to be considered as a separate price item in the lift procurement. The more comprehensive the acceptance tests, the more expensive this option can be to the Procuring Agency. The successful completion of acceptance tests is the time at which the warranty period normally begins.

3.3 Environmental Tests

The contractor should provide the Procuring Agency with (1) certified documentation to lift performance in revenue service in transit environments similar to those that will be encountered or (2) certified documentation of tests that demonstrate that the lift should function reliably in the transit operating environment.

Rationale: Tests described in Sections 3.1 and 3.2 are conducted in laboratory or test conditions that do not attempt to simulate a revenue service, transit environment. The Advisory Panel concluded that a lift should not be put into regular revenue service until it has been tested to determine the effects of dirt, water, salt, ice, road conditions, and other in-service environmental factors on reliability and service life.

COMMENTS SHEET

These guideline specifications are an industry document developed by professionals familiar with accessible transportation. The document is considered to be an important step in the evolution of accessible transportation. However, it is not the final step. It is anticipated that operational experiences and technology advancements will indicate areas where these guidelines can be improved. Your comments and suggested changes are solicited. Please use this comments sheet to forward your comments to:

Mr. George Izumi
Department of Transportation
Urban Mass Transportation Administration
Office of Bus and Paratransit Systems/URT-20
400 7th Street, S.W., Room 6424
Washington, D.C. 20590

Comments: (When referring to specific sections of the guideline specifications, please identify the section number and title.)

National Workshop on Bus-Wheelchair Accessibility

Guideline Specifications for
Wheelchair Ramps

May 7-9, 1986
Seattle, Washington

Prepared by
Battelle Columbus Division
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Columbus, Ohio 43201

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Washington, D.C. 20590

ACKNOWLEDGMENTS

These guideline specifications are the culmination of many hours of hard work by persons representing all facets of the accessible transit and paratransit industry. The Urban Mass Transportation Administration (UMTA) recognized that the technology associated with accessible transportation could be improved and sponsored an Advisory Panel in order to develop industry guideline specifications. Representing different viewpoints and different interests, the members of the Advisory Panel met, discussed issues, and developed these guideline specifications. It is a credit to the Advisory Panel and the dedication of its members that a formal vote never had to be taken and that the guideline specifications were developed on the basis of consensus.

Several people need to be acknowledged for the assistance they provided to the Advisory Panel in the development of these guidelines. George I. Izumi, the UMTA Project Manager, was responsible for planning and organizing the Advisory Panel, planning for the Workshop, and contributed greatly to the development of the guidelines. Vincent R. DeMarco, the UMTA Program Manager, was responsible for guiding the efforts of the Advisory Panel and for planning and conducting the Workshop. Two other persons from the U.S. Department of Transportation also provided assistance. Christina Chang of the Transportation Systems Center helped to organize and run the Workshop and prepare Workshop Proceedings. Scott York of the National Highway Traffic Safety Administration participated in the Advisory Panel meetings and assisted in clarifying certain safety issues. The Battelle project team of Gerald A. Francis (consultant), Martin Gombert (ATE Management and Service Company, Inc.), Rolland D. King, and David [illegible]. Norstrom was responsible for developing the draft guideline specifications and serving as a technical resource to the Advisory Panel. Special recognition is given to Mr. Norstrom who skillfully managed the guideline development process and led the discussions of the Advisory Panel meetings that obtained a general consensus of the Advisory Panel on each guideline subject. Finally, appreciation goes to each member of the Advisory Panel who gave of their time and contributed their expertise to the development of these industry guidelines.

PREFACE

On September 17, 1985, the Administrator, Ralph L. Stanley, of the Urban Mass Transportation Administration called together a meeting with representatives of transit agencies, handicapped organizations, rehabilitation specialists and manufacturers of buses and wheelchair lifts to hear first hand the problems and issues regarding transit bus wheelchair accessibility. As a result of this meeting, the Administrator requested that an UMTA Advisory Panel be formed to plan a National Bus Wheelchair Accessibility Workshop and to guide the development of a set of guideline specifications for the equipment required for transit bus and paratransit vehicle wheelchair accessibility. A contract was issued to Battelle to assist UMTA in this effort.

As a result of surveying the transit industry for input and meeting with the Advisory Panel, Battelle prepared a draft set of guideline specifications for wheelchair lifts, securement devices and ramps for presentation and discussion at the National Bus Wheelchair Accessibility Workshop held in Seattle, Washington, on May 7 through 9, 1986. Using the inputs developed during the Workshop and the written comments submitted following the Workshop, the Advisory Panel prepared these final guideline specifications.

These guideline specifications are advisory in nature. The intention of the guideline specifications is to provide transit agencies with a model that they could use, as appropriate, in the development of their specifications for wheelchair accessibility. In the guideline specifications, where the word "should" is used, the recommendation of the Advisory Panel is that the suggested item or value be included in a general specification. Where the word "may" is used, the Advisory Panel recommends that the item or choice of values be considered for inclusion based upon local operating conditions. The Advisory Panel has developed these guidelines for use throughout the United States. It recognizes that unique local conditions could make an item suggested for inclusion inappropriate and a local public transportation provider would be required to make the appropriate changes (e.g. to accommodate extreme environmental conditions).

This guideline specification is one of four specifications developed by the Advisory Panel, which developed separate guideline specifications for passive wheelchair lifts (those used primarily on transit buses), active wheelchair lifts (those used primarily on paratransit vehicles), ramps and securement devices. Members of the Advisory Panel participated actively in the development of each individual guideline specification based upon their experience and interest. Although the Advisory Panel discussed many related accessibility issues, these guideline specifications focus only on the technical requirements of a specific piece of equipment. They have been prepared to assist in the purchase of such equipment either separately or as part of an overall vehicle procurement.

ADVISORY PANEL

The following individuals participated in the Advisory Panel for the development of the draft guideline specifications of passive wheelchair lifts, active wheelchair lifts, ramps, and wheelchair securement devices.

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Mr. James Burton, Municipality of Metropolitan Seattle, Seattle, Washington

Mr. Dennis Cannon, Architectural and Transportation Barriers Compliance Board, Washington, D.C.

Mr. Richard Daubert, Collins Special Products, Hutchinson, Kansas

Ms. Mary Lou Daily, Metropolitan Boston Transit Authority, Boston, Massachusetts

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Ms. Pat Flinchbaugh, York Transportation Club, York, Pennsylvania

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TABLE OF CONTENTS

1.0 GENERAL

1.1 Scope

These guideline specifications relate to powered and manual ramps that are used by mobility limited persons to assist in boarding public transportation vehicles. The safety of passengers using the ramp and reliability of operations are of primary concern in these guideline specifications.

1.2 Definitions

The following definitions apply for this document.

Accessible Vehicle - A vehicle that has been equipped to allow boarding by passengers who by reason of handicap are physically unable to board a vehicle that has not been so equipped.

dBA - This term denotes decibels with reference to 0.0002 microbar as measured on the "A" scale.

Deploy - The term used to denote the operation of a ramp from a stowed position to a position for use.

Design Load - The maximum weight capacity a ramp is designed to support.

Elevator Lift - This term denotes the type of lift that has a vertical up and down movement as differentiated from an arc lift.

Factor of Safety (Design Safety Factor) - The factor of safety is the ultimate strength of a material divided by the working stress. A structure fails or breaks when loaded to its ultimate strength. A structure deforms or takes set when loaded to its yield strength.

Fail-safe - A characteristic of a system and its elements whereby any malfunctions affecting safety will cause the system to revert to a known safe state.

Interlock - The arrangement in which the operation or position of one mechanism automatically allows or prevents the operation of another.

Maintenance Personnel Skill Levels - Maintenance personnel skills used in this document are defined in accordance with the White Book specifications as follows:

- 5M: Specialist Mechanic or Class A Mechanical Leader
- 4M: Journeyman or Class A Mechanic
- 3M: Service Mechanic or Class B Serviceman
- 2M: Mechanic Helper or Coach Serviceman
- 1M: Cleaner, Fueler, Oiler, Hostler, or Shifter

May - This term is to be construed as permissive.

Paratransit Operation - Paratransit operation refers to a public transportation operation (service, vehicles, facilities, etc.) that is not a transit operation.

Should - The term is to be construed as recommended or strongly recommended by the Advisory Panel.

Slip Resistant - A characteristic of a surface of a material that reduces unintended relative motion with respect to another surface with which it has contact.

Stow - This term denotes the movement of a ramp from a position of use to a position where the ramp is stored and does not interfere with passenger movement.

Structural Components - The structural elements of the ramp include those that support working loads and attach the lift to the vehicle. They do not include mechanical and hydraulic components associated with operation and control of the ramp.

Transit Operation - Transit operations refers to a public transportation operation (service, vehicles, facilities, etc.) that operates with fixed routes and schedules.

White Book - This term is the common name for the "Baseline Advanced Design Transit Coach Specifications;" originally published by UMTA on April 4, 1977, it is now available from the American Public Transit Association.

Wheelchair - A seating arrangement that is positioned on wheels, may be powered or unpowered, and can be used to assist mobility limited individuals.

1.3 Abbreviations

The following abbreviations may be found in this document.

ANSI --- American National Standards Institute

ASME --- American Society of Mechanical Engineers

ASTM --- American Society of Testing and Materials

CSA --- Canadian Standards Association

FMVSS --- Federal Motor Vehicle Safety Standards

NHTSA --- National Highway Traffic Safety Administration

SAE --- Society of Automotive Engineers

UMTA --- Urban Mass Transportation Administration

VA --- Veterans Administration

1.4 Reference Documents

(1) American Public Transit Association. "Baseline Advanced Design Transit Coach Specifications," includes Addendums 1 through 20 that were made to the April 1977 issue of "Baseline Advanced Design Transit Coach Specifications," published by Urban Mass Transportation Administration. (Commonly known as The White Book). American Pubic Transit Association. April 1983.

(2) Booz, Allen and Hamilton Inc. Boarding Ramps for Transit Buses. Prepared for Urban Mass Transportation Administration. Washington, D.C. May 1977.

(3) California Administrative Code, Title 13, Chapter 2, Subchapter 4, Article 15. Wheelchair Lifts.

(4) Canadian Standards Association. "Motor Vehicles for the Transportation of Physically Disabled Persons," CAN3-D409-M84. Ontario, Canada: Rexdale. April 1984.

(5) Henderson, William H., Dabney, Raymond L., and Thomas, David D. Passenger Assistance Techniques: A Training Manual For Vehicle Operators of Systems Transporting the Elderly and Handicapped, Third Edition. Fort Worth, Texas: Transportation Management Associates. 1984.

(6) James D. I. "A Broader Look at Pedestrian Friction." Rubber Chemistry and Technology, Vol. 53, pp. 512-541.

(7) Society of Automotive Engineers. Standards, Recommended Practices, Information Reports.

(8) "Veterans Administration Wheelchair Lift Systems: VA Standard Design and Test Criteria for Safety and Quality of Automatic Wheelchair Lift System for Passenger Motor Vehicles." Federal Register (43 FR 21390). May 17, 1978.

2.0 TECHNICAL REQUIREMENTS

The ramp shall meet the technical requirements given in Section 2.0.

2.1 General Requirements

2.1.1 Operating Environment

The ramp should operate in a temperature range of -10 F to 115 F, at relative humidities between 5 percent and 100 percent, and at altitudes up to 5,000 feet above sea level. Degradation of performance due to atmospheric conditions should be minimized at temperatures below -10 F, above 115 F, or at altitudes above 5,000 feet.

Rationale: The urban areas of the United States have broad ranges of climatic conditions. Weather data indicate that many cities have recorded 100 days or more per year of over 90 F temperatures. Likewise, many have recorded 20 or more days per year below 0 F. The annual rainfall ranges as high as 60 inches per year to a low of 4 inches per year. The normal snow and sleet precipitation in some cities reach 88 inches per year. The above guidelines cover a broad range of conditions found in the United States and are taken from the White Book specifications.

2.1.2 Operation Constraints

The ramp should operate when the vehicle is on level ground and up to road grades of seven (7) percent or four (4) degrees.

Rationale: A ramp will be required to operate under a variety of different topographic conditions. A balance needs to be made between the topographical conditions to be accommodated by a ramp and the conditions where a ramp will not be required to operate. A seven percent grade specification is currently used by Seattle Metro in its lift procurements. Since Seattle has a relatively hilly topography, using its limits for road grade seemed reasonable.

By its very nature a ramp will be able to accommodate different roll attitudes of a vehicle. The result will be an increased or decreased ramp slope. Section 2.1.7 identifies the maximum ramp slope; and from this section local operating policies concerning ramp slope can be developed to accommodate vehicle roll.

2.1.3 Boarding Direction

A ramp should be capable of handling a wheelchair with the occupant facing toward or away from the vehicle.

Rationale: The ability to maneuver inside the vehicle or at a vehicle stop may require a person in a wheelchair to use a ramp in either direction. However, the Advisory Panel recommends that under normal operating conditions the wheelchair passenger face the vehicle with the attendant or driver back of the wheelchair.

2.1.4 Location of Ramp

The ramp should be installed on the side of the vehicle opposite the driver's seat (recommended) at the rear of the vehicle; or on both sides of the vehicle.

Rationale: A ramp could be used in a regular vehicle door or in a separate entrance. For safety reasons, the preferred location is the curbside of the vehicle. However, in some cases, a rear entrance may be preferred. If a rear entrance is used, vehicle loading and unloading should occur at off-street locations. In urban environments with one-way streets, having openings on both sides of a vehicle may be convenient.

2.1.5 Useful Life

When used and maintained in accordance with manufacturer's recommended procedures, the ramp structure should be designed to have a useful service life at least equal to that of the vehicle in which it is installed.

Rationale: Once installed the ramp becomes a part of the vehicle. As with other subsystems of the vehicle, the ramp with recommended maintenance (including repair and replacement of mechanical parts) should be operable as long as the vehicle. The service life of a standard transit bus is 12 to 15 years. The service life of a smaller bus is normally less, in the range of 7 to 10 years, with a van having a service life typically from 3 to 5 years.

2.1.6 Weight

2.1.6.1 The weight of the ramp should not adversely affect the legal axle loadings, the maneuverability, or the safe operation of the vehicle.

2.1.6.2 The ramp should be able to be deployed and stowed by one person.

Rationale: For legal and safety reasons the weight of the ramp should not adversely affect the vehicle on which it is used. Most transit operations have one operator per vehicle. Whether the ramp is powered or manual, it should be safely handled by one person. The use of counter balances to assist in manual operation may be necessary.

2.1.7 Ramp Slope

The maximum slope of a ramp for unassisted wheelchair operations or ambulatory passengers should be 1 in 12. For assisted operations slopes up to 1 in 3 are allowable.

Rationale: The Canadian Standards Association recommends a maximum gradient of 1 in 4. The Booz, Allen and Hamilton report indicated that the 1 in 4 slope would be difficult for unassisted wheelchair entry and may require assistance for exit. The ANSI architectural standards for longer building ramps are slopes no greater than 1 in 12. Assisted operations can allow greater slopes. Local operating policies will determine what the operable slopes should be. Roof height can limit ramp length and make it necessary to use slopes up to 1 in 3.

2.1.8 Ramp Width

The ramp should have a minimum usable width of 28-1/2 inches. It is desired to have a width of 32 inches.

Rationale: The 28-1/2-inch width does not preclude existing ramp manufacturers and accommodates approximately 95 percent of the existing wheelchair population. The wider ramp would facilitate entry, provide more maneuvering room, and accommodate a larger wheelchair population.

2.1.9 Ramp Surface

2.1.9.1 Slip Resistant

The surface of the ramp should be slip resistant for the operating environment conditions defined in Section 2.1.1.

2.1.9.2 Cleats (Optional)

The ramp may have cleats located to assist an attendant using a lift.

2.1.9.3 Protrusions

The ramp should have no protrusions and from the surface greater than 1/4 inch above the load bearing surface in the wheel tracks when deployed for use, except when cleats are chosen as an option.

2.1.9.4 Openings and Gaps

When the ramp is positioned horizontally any opening or gap in the ramp should reject a 3/4-inch diameter metal ball.

Rationale: The ramp must provide a non-slip surface under wet and winter conditions so that the wheelchair wheels will not slip during entry or exit. Also, the surface must provide a slip-resistant surface for persons walking on the ramp. Cleats for attendant assistance are optional and should not inhibit the movement of a wheelchair. However, it is recognized that cleats could interfere with a three-wheeled mobility aid.

Movement on and off the ramp should be easy and not inhibited by protrusions. The 1/4-inch dimension is consistent with the protrusion limits specified in the California Administrative Code.

It is desirable to minimize the gaps or openings in a ramp. The VA specifications, which require wheelchair lift platforms to have openings that meet the 1/4-inch guideline, have been adapted for these guideline specifications.

2.1.10 Ramp Threshold

The entryways of a ramp should have a vertical rise (bump) of 5/8 inch or less.

Rationale: A series of subjective tests by the VA identified 5/8 inch as a maximum allowable vertical distance.

2.1.11 Ramp Barriers

Each side of a ramp should have an edge barrier no less than one and one-half (1-1/2) inches. A 2-inch barrier is desired.

Rationale: The Booz, Allen and Hamilton report recommended 1-1/2-inch barriers, and the Canadian Standard Association requires a 1- to 2-inch height. The 1-1/2-inch height is the recommended minimum for lifts in unassisted operation. The 2-inch height is suggested for all ramps in keeping with the upper limit of CSA.

2.1.12 Ramp Passenger Assists (Optional)

Ramps should have handrails to assist wheelchair passengers in the use of the ramp. When provided, handrails should be on both sides of the ramp, 25 to 34 inches above the surface of the ramp, 1-1/4 to 1-1/2 inches in diameter or width, and positioned to permit a full hand grip with no less than 1-1/2 inches of knuckle clearance. The handrails should be capable of withstanding a horizontal force of 100 pounds concentrated at any point.

Rationale: This section is optional. The Advisory Panel felt handrails should not be recommended when passenger assistance is provided. Handrails can interfere when driver or attendant assistance is provided. The Advisory Panel also does not recommend that ambulatory passengers be permitted to use a ramp. However, if a local operator desires to allow ambulatory passengers, handrails should be used. The Booz, Allen and Hamilton report recommended the use of handrails. The height and 100-pound force requirements are found in the Canadian Standards Association document.

2.1.13 Padding and Protective Covering (Optional)

All exposed edges or other hazardous protrusions on the stowed ramp or on vehicle areas associated with the ramp should be padded with energy absorbing material to minimize injury to passengers.

Rationale: To ensure safer operations all potentially hazardous areas should be protected. Tests have shown that edges and protrusions can be especially hazardous in accident situations. To reduce the potential danger, energy absorbing material should be used to protect these areas. This guideline is optional because some operators consider the obstruction of vision a greater hazard than exposed edges.

2.1.14 Securement

If the ramp is stowed in the passenger compartment, it should be secured to the vehicle so that it can withstand a horizontal force resulting from a 20 g deceleration in any direction.

Rationale: The Canadian Standards Association document contains this requirement. Ramps are frequently used on small vehicles, such as vans. Crash tests have shown that peak decelerations of 21 to 25 g's can be experienced in small vehicles.

2.2 Structural Requirements

2.2.1 Capacity

The ramp should be designed for a load of 400 pounds distributed evenly over a length of 48 inches and the full width of the ramp halfway up the ramp.

Rationale: The Advisory Panel adopted a 400-pound capacity based on the capacity of existing ramps. The market for ramps is very small. Manufacturers indicated that the existing capacity met the market need and there were no objections by the paratransit and transit operators on the Advisory Panel.

2.2.2 Structural Safety Factor

The structural safety factor should be at least three (3) based on the ultimate strength of the construction material.

Rationale: This safety factor is in agreement with that used in the California Administrative Code for wheelchair lifts and with good engineering practices. With this safety factor there should be no bending that could produce permanent deformation of the ramp at rated load capacity.

2.2.3 Materials

Ramp structural components should be made of steel or other durable construction material.

2.2.3.1 Ferrous surfaces should be either plated with a protective coating or be cleaned and have a corrosion and abrasion resistant flat protective finish.

2.2.3.2 Nonferrous and nonmetallic surfaces should be coated using a durable flat or matte finish.

2.2.3.3 Stainless steel does not require coating or surface treatment.

Rationale: The ramp is to have a useful life equal to that of the vehicle upon which it is mounted. Materials and coatings identified in these guidelines are intended to ensure this useful life. The discussions of the Advisory Panel with regard to materials included using a salt spray test or paint thickness measurement to ensure compliance. No specific tests or coating methods have been designated so that manufacturers can continue to use their preferred methods. Panel members considered placing any coatings or surface treatments on stainless steel unnecessary

2.2.4 Interface With Vehicle

Installation of the ramp should not reduce or in any way compromise the structural integrity of the vehicle nor cause an imbalance of the vehicle that would adversely affect vehicle handling characteristics.

Rationale: The installation of a ramp in a vehicle may require some modification. It is the responsibility of the vehicle manufacturer to determine compatibility of his vehicle's structural design with the selected ramp.

2.3 Power Ramp Requirements (The following guidelines are for power ramps)

2.3.1 Warning Signals

2.3.1.1 Sound
When the ramp is being deployed or stored, an audible warning signal of 85 dBA, as measured 5 feet outside the door of the vehicle, should be sounded.

2.3.1.2 Lights
When the ramp is being deployed or used, the four-way flasher, hazard lights on the vehicle should be automatically operating.

Rationale: The audible warning will signal passengers at a bus stop that a powered ramp is being deployed. The 85 dBA level is a frequently used level for annunciators. A person can be exposed to this sound level for long periods of time without hearing damage: and the level is loud enough that it can be heard above normal background noise.

The four-way flasher, hazard lights will serve as a visual signal that the ramp is being deployed or used. Since ramp operation adds to the dwell time at a bus stop, the visual signal will alert motorists that the bus will be stopped for a longer than usual period.

2.3.2 Controls

2.3.2.1 Ramp Control Terminology
The following ramp control terminology should be used:

Ramp Authorized or Ramp Power -- enables the ramp to deploy or stow
Ramp Out -- ramp is commanded to a deployed position
Ramp In -- ramp is commanded to a stowed position

2.3.2.2 Ramp Authorized or Ramp Power Switch
The ramp authorized or power switch should have two positions, on and off. When in the "on" position, the ramp is enabled to deploy or stow. When in the "off" position, ramp operation is prevented.

2.3.2.3 Function Switch
The function switch or switches for ramp movement should be of the momentary type for the ramp out and ramp in commands so that ramp movement requires constant pressure on the switch. The ramp should stop moving when the "ramp out" or "ramp in" switch is released. It should not be possible to command both the "ramp out" and "ramp in" simultaneously.

2.3.2.4 Control Location
The control should be on a pendant or mounted on the vehicle. The control location shall be such that the operator can observe the ramp while using the control. Provision shall be made for storage of a pendant control unit when not being used by the operator.

Rationale: The intent is to have a simple control so as to reduce the potential of operator error and reduce cost. The general control terminology and approach is patterned after existing ramps currently supplied by a small bus manufacturer.

The ramp power switch may be a key type to prevent use of the ramp by unauthorized persons. The function switch could be a 3-position toggle switch, spring loaded to return to the center position when released or it could be done with two push button switches or other suitable implementation.

2.3.2.5 Interlocks

2.3.2.5.1 Interlocks may prevent vehicle movement or provide a driver warning light unless the ramp is stowed and the power is off.

2.3.2.5.2 Interlocks may prevent operation of the ramp unless the vehicle is stopped and inhibited from moving and the appropriate door is open.

2.3.2.5.3 Interlocks or inherent design features should prevent stowing when ramp is occupied.

Rationale: Interlocks are designed to prevent unsafe conditions and damage to the ramp or vehicle. The first interlock has two options. Although preventing vehicle movement is recommended, providing an interlock to prevent movement for small vehicles is technically difficult and, therefore, raises the cost. This interlock is easier for vehicles with air brakes. At a minimum, a driver warning light is recommended.

The second interlock is advisory. Some Advisory Panel members felt that this interlock could cause problems in an accident situation. It has been made optional, and if used, must be designed with allowance for possible lift operation in emergency situations by people not familiar with lift details.

The third interlock is recommended. A ramp that cannot be stowed when occupied provides for increased safety in ramp operations.

2.3.2.6 Manual Operation
The power ramp should be equipped with a manual override to enable the operator to deploy and stow the ramp in case of power failure.

Rationale: In the event of power failure a ramp must be available to unload passengers. Also, the manual operation should allow a ramp to be stowed in order to continue vehicle operations.

2.3.2.7 Wiring
Wiring should be in accordance with SAE Recommended Practice SAE J1292 OCT 81 and referenced Standards, except when good engineering practice dictates special conductor insulations.

Rationale: This SAE Recommended Practice, "Automobile, Truck, Truck Tractor Trailer, and Motor Coach Wiring," is accepted by the automotive industry and provides a baseline for design. The practice recognizes that unique design will require engineering practices that cannot be envisioned and incorporated into a recommended practice.

3.0 TESTING, CERTIFICATION, INSPECTION, AND WARRANTIES

3.1 Design Tests

The tests defined in Section 3.1 should be performed on a representative production model of the ramp procured under this specification. The ramp should meet the requirements given in Section 2.0 when attached to a fixture that simulates the vehicle installation and when supplied by a power source typically available on the vehicle. Only one representative production unit is required to be tested for certification, with all tests of Section 3.1 conducted on the same unit without repairs or maintenance during the tests, other than that permitted by Section 3.1.2.4.

3.1.1 Static Load Test (All Ramps)

A static load of 1200 pounds shall be applied through the centroid of a test pallet placed in the center of the ramp when the ramp is positioned horizontally at its deployed position. The length and width dimensions of the test pallet should be 48 inches in length and the full width of the ramp. The load should remain on the ramp not less than two (2) minutes. After the load is removed, an inspection should be made to determine if fractures have occurred.

Rationale: Since the design capacity of the ramp is 400 pounds, the proof test load was selected to demonstrate that the ramp meets the safety factor of three that is required. This test could produce permanent deformation or set of the ramp. The test in Section 3.1.1 is an adaptation of the VA Wheelchair Lift Static Load Test.

3.1.2 Power Operated Ramp Tests

The tests of Section 3.1.2 should be performed on power operated ramps.

3.1.2.1 Durability Tests

For a power operated ramp, the ramp should be deployed and stowed for 15,600 cycles. The ambient temperature for the first half of the cycles should be at least 110 F. The tests may be continuous or separated into groups of not less than 10 cycles and may have nonoperating periods of not more than one minute between each cycle in the group.

Rationale: The above test is an adaptation of the tests required for wheelchair lifts in the California Administrative Code. The test is intended to give an indication of the expected service life of a ramp.

3.1.2.2 Self Damage Tests

The controls should be held in the operating position for five (5) seconds after the ramp meets resistance to its travel under each control position with any limit switch disabled. The tests should be performed twice at each a ramp position of deploy and stow.

Rationale: The test is designed to show that the ramp will not damage itself or the vehicle when operated with any of the limit switches failed. The test is an adaptation of the tests for wheelchair lifts found in the California Administrative Code.

3.1.2.3 Visual Inspection
At the conclusion of the tests of powered ramps described in Sections 3.1.2.1 and 3.1.2.2, with all loads removed, the parts of the ramp should show no condition of fracture, permanent deformation, wear that would exceed manufacturer's tolerances, perceptible impairment, or other deterioration that would be hazardous.

3.1.2.4 Maintenance During Tests
During the Durability Test of Section 3.1.2.1, the inspection, lubrication, maintenance, and replacement of parts (other than bulbs and fuses) may be performed only as specified in the contractor's maintenance manual for the ramp.

Rationale: The guidelines given in Sections 3.1.2.3 and 3.1.2.4 are an adaptation of those found in the California Administrative Code.

3.1.3 Certification

The contractor should provide certification that the ramp procured under this specification has been tested as required by Section 3.1 and has met all requirements.

Rationale: This is a standard practice in design testing.

3.2 Acceptance Tests (Optional)

The contractor should submit for approval to the Procuring Agency an acceptance test plan to demonstrate that the ramps procured by this specification meet the requirements given in Section 2.0. This acceptance test plan, at a minimum, should contain tests that demonstrate that the ramp meets the safety interlock requirements as given in Section 2.3.2.5. The Procuring Agency may witness any or all of these tests. A mutually agreed upon notification time prior to the start of a test should be made between the two parties. The test results should be recorded, witnessed, and submitted to the Procuring Agency as proof of meeting the acceptance criteria contained in the approved test plan.

Rationale: This section is optional since ramps would normally be purchased as part of a vehicle procurement and ramp acceptance testing would be included in the vehicle acceptance testing.

THE WARRANTY PROVISIONS AND MAINTENANCE AND SERVICE GUIDELINES THAT FOLLOW ARE ADAPTED FROM THE WHITE BOOK SPECIFICATIONS. IF THE RAMP IS PROCURED AS A PART OF A VEHICLE SPECIFICATION, THESE SECTIONS MAY NOT BE REQUIRED.

3.3 Ramp Warranty

The ramp should be warranted and guaranteed to be free from defects for one (1) year beginning on the date of acceptance of each ramp. The warranty should not apply to any part or component of the ramp that has been subjected to misuse, negligence, accident, or that has been repaired or altered in any way so as to affect adversely its performance or reliability, except insofar as such repairs were in accordance with recognized standards of the industry. The warranty should not apply to scheduled maintenance items, and items damaged as a result of normal wear and tear in service such as floor coverings and paint.

4.0 MAINTENANCE AND SERVICE

4.1 Documents

The contractor should provide ---(*)--- current maintenance manual(s), ---(*)--- current parts manual(s), and ---(*)--- current operator's manuals, or ---(*)--- combination manuals thereof as part of this contract. The contractor should keep maintenance manuals available for a period of 3 years after the date of acceptance of the ramp procured under this contract.

(*) Procuring Agency to fill in pertinent information.

4.2 Maintenance and Inspection

Scheduled maintenance or inspection tasks, as specified by the contractor, shall require a skill level of 3M or less. Scheduled maintenance tasks should be related and should be grouped in maximum vehicle mileage intervals. Routine scheduled maintenance actions should not be required at intervals of less than 6,000 vehicle miles.

4.3 Service

4.3.1 Engineering

The contractor should, at its own expense, have a competent engineering representative(s) available on request to assist the Procuring Agency's staff in the solution of engineering or design problems within the scope of these specifications that may arise during the warranty period. This does not relieve the contractor of responsibilities under Section 3.6 Warranty Provisions.

4.3.2 Replacement Parts

The contractor should guarantee the availability of replacement parts for ramps procured under this contract for at least a ---(*)--- year(s) period after the date of acceptance. Spare parts should be interchangeable with the original equipment and should be manufactured in accordance with the same quality assurance as the original part.

(*) Pertinent information to be filled in by Procuring Agency.

COMMENTS SHEET

These guideline specifications are an industry document developed by professionals familiar with accessible transportation. The document is considered to be an important step in the evolution of accessible transportation. However, it is not the final step. It is anticipated that operational experiences and technology advancements will indicate areas where these guidelines can be improved. Your comments and suggested changes are solicited. Please use this comments sheet to forward your comments to:

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Department of Transportation
Urban Mass Transportation Administration
Office of Bus and Paratransit Systems/URT-20
400 7th Street, S.W., Room 6424
Washington, D.C. 20590

Comments: (When referring to specific sections of the guideline specifications, please identify the section number and title.)

National Workshop on Bus-Wheelchair Accessibility

Guideline Specifications for
Wheelchair Securement Devices

May 7-9, 1986
Seattle, Washington

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ACKNOWLEDGMENTS

These guideline specifications are the culmination of many hours of hard work by persons representing all facets of the accessible transit and paratransit industry. The Urban Mass Transportation Administration (UMTA) recognized that the technology associated with accessible transportation could be improved and sponsored an Advisory Panel in order to develop industry guideline specifications. Representing different viewpoints and different interests, the members of the Advisory Panel met, discussed issues, and developed these guideline specifications. It is a credit to the Advisory Panel and the dedication of its members that a formal vote never had to be taken and that the guideline specifications were developed on the basis of consensus.

Several people need to be acknowledged for the assistance they provided to the Advisory Panel in the development of these guidelines. George I. Izumi, the UMTA Project Manager, was responsible for planning and organizing the Advisory Panel, planning for the Workshop, and contributed greatly to the development of the guidelines. Vincent R. DeMarco, the UMTA Program Manager, was responsible for guiding the efforts of the Advisory Panel and for planning and conducting the Workshop. Two other persons from the U.S. Department of Transportation also provided assistance. Christina Chang of the Transportation Systems Center helped to organize and run the Workshop and prepare Workshop Proceedings. Scott York of the National Highway Traffic Safety Administration participated in the Advisory Panel meetings and assisted in clarifying certain safety issues. The Battelle project team of Gerald A. Francis (consultant), Martin Gombert (ATE Management and Service Company, Inc.), Rolland D. King, and David M. Norstrom was responsible for developing the draft guideline specifications and serving as a technical resource to the Advisory Panel. Special recognition is given to Mr. Norstrom who skillfully managed the guideline development process and led the discussions of the Advisory Panel meetings that obtained a general consensus of the Advisory Panel on each guideline subject. Finally, appreciation goes to each member of the Advisory Panel who gave of their time and contributed their expertise to the development of these industry guidelines.

PREFACE

On September 17, 1985, the Administrator, Ralph L. Stanley, of the Urban Mass Transportation Administration called together a meeting with representatives of transit agencies, handicapped organizations, rehabilitation specialists and manufacturers of buses and wheelchair lifts to hear first hand the problems and issues regarding transit bus wheelchair accessibility. As a result of this meeting, the Administrator requested that an UMTA Advisory Panel be formed to plan a National Bus Wheelchair Accessibility Workshop and to guide the development of a set of guideline specifications for the equipment required for transit bus and paratransit vehicle wheelchair accessibility. A contract was issued to Battelle to assist UMTA in this effort.

As a result of surveying the transit industry for input and meeting with the Advisory Panel, Battelle prepared a draft set of guideline specifications for wheelchair lifts, securement devices and ramps for presentation and discussion at the National Bus Wheelchair Accessibility Workshop held in Seattle, Washington, on May 7 through 9, 1986. Using the inputs developed during the Workshop and the written comments submitted following the Workshop, the Advisory Panel prepared these final guideline specifications.

These guideline specifications are advisory in nature. The intention of the guideline specifications is to provide transit agencies with a model that they could use, as appropriate, in the development of their specifications for wheelchair accessibility. In the guideline specifications, where the word "should" is used, the recommendation of the Advisory Panel is that the suggested item or value be included in a general specification. Where the word "may" is used, the Advisory Panel recommends that the item or choice of values be considered for inclusion based upon local operating conditions. The Advisory Panel has developed these guidelines for use throughout the United States. It recognizes that unique local conditions could make an item suggested for inclusion inappropriate and a local public transportation provider would be required to make the appropriate changes (e.g. to accommodate extreme environmental conditions).

This guideline specification is one of four specifications developed by the Advisory Panel, which developed separate guideline specifications for passive wheelchair lifts (those used primarily on transit buses), active wheelchair lifts (those used primarily on paratransit vehicles), ramps and securement devices. Members of the Advisory Panel participated actively in the development of each individual guideline specification based upon their experience and interest. Although the Advisory Panel discussed many related accessibility issues, these guideline specifications focus only on the technical requirements of a specific piece of equipment. They have been prepared to assist in the purchase of such equipment either separately or as part of an overall vehicle procurement.

ADVISORY PANEL

The following individuals participated in the Advisory Panel for the development of the draft guideline specifications of passive wheelchair lifts, active wheelchair lifts, ramps, and wheelchair securement devices.

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TABLE OF CONTENTS

1.0 GENERAL

1.1 Scope

These guideline specifications relate to wheelchair securement devices that are used on public transportation vehicles. The securement devices are designed to accommodate wheelchairs that do not exceed 250 pounds in weight. Maximum safety all for passengers and reliable securement device operation are of primary concern in these guideline specifications.

1.2 Definitions

The following definitions apply for this document.

Accessible Vehicle - A vehicle that has been equipped to allow boarding by passengers who by reason of handicap are physically unable to board the vehicle that has not been so equipped.

Active Lift - An active lift is one that when stowed may interfere with the use of the vehicle entrance where the lift is located and that when being raised or lowered operates primarily outside the body of the vehicle.

Fail-safe - A characteristic of a system and its elements whereby any malfunction affecting safety will cause the system to revert to a known safe state.

Interlock - The arrangement in which the operation or position of one mechanism automatically allows or prevents the operation of another.

Lift or Wheelchair Lift - A level change device used to assist those with limited mobility in the use of transit and paratransit services. The term lift and wheelchair lift are used interchangeably in this document.

Maintenance Personnel Skill Levels - Maintenance personnel skills used in this document are defined in accordance with the White Book specifications as follows:

5M: Specialist Mechanic or Class A Mechanic Leader
4M: Journeyman or Class A Mechanic
3M: Service Mechanic or Class B Serviceman
2M: Mechanic Helper or Coach Serviceman
1M: Cleaner, Fueler, Oiler, Hostler, or Shifter.

May - This term is to be construed as permissive.

Paratransit Operation - Paratransit operation refers to a public transportation operation (service, vehicles, facilities, etc.) that is not a transit operation.

Should - The term is to be construed as recommended by the Advisory Panel.

Transit Operation - Transit operation refers to a public transportation operation (service, vehicles, facilities, etc.) that operates with fixed routes and schedules.

White Book - This term is the common name for "Baseline Advance Design Transit Coach Specifications," originally published by UMTA on April 4, 1977. It is now available from the American Public Transit Association.

Wheelchair - A seating arrangement that is positioned on wheels, may be powered or unpowered, and can be used to assist mobility limited individuals.

Wheelchair Securement Device - A device anchored to a vehicle and used to limit the movement of a wheelchair when the vehicle is in motion.

1.3 Abbreviations

The following abbreviations may be found in the guidelines.

ANSI --- American National Standards Institute

ASME --- American Society of Mechanical Engineers

CSA --- Canadian Standards Association

FMVSS --- Federal Motor Vehicle Safety Standard

GVWR --- Gross Vehicle Weight Rating

NHTSA --- National Highway Traffic Safety Administration

SAE --- Society of Automotive Engineers

UFAS --- Uniform Federal Accessibility Standards

UMTA --- Urban Mass Transportation Administration

VA --- Veterans Administration

1.4 Reference Documents

(1) American Public Transit Association. "Baseline Advanced Design Transit Coach Specifications," includes Addendums 1 through 20 that were made to the April 1977 issue of "Baseline Advanced Design Transit Coach Specifications," published by Urban Mass Transportation Administration. (Commonly known as The White Book.) American Public Transit Association. April 1983.

(2) California Administrative Code, Title 13, Chapter 2, Subchapter 4, Article 15. Wheelchair Lifts.

(3) Canadian Standards Association. "Motor vehicles for the Transportation of Physically Disabled Persons," CAN3-D409-M84. Ontario, Canada: Rexdale. April 1984.

(4) Canyon Research Group, Inc. "A Requirements Analysis Document for Transit Vehicle Wheelchair Lift Devices." Prepared for Urban Mass Transportation Administration, Westlake Village, California. June 1978.

(5) Doag, Virginia S. and Smith, Robert M. (California Department of Transportation). Wheelchair Securement on Bus and Paratransit Vehicles. Prepared for Urban Mass Transportation Administration, Sacramento, California. July 1981.

(6) "Federal Motor Vehicle Safety Standard," Code of Federal Regulations, Title 49, Part 571 No. 207, Seating Systems, and No. 210, Seat Belt Assembly Anchorages.

(7) Henderson, William H., Dabney, Raymond L., and Thomas, David D. Passenger Assistance Techniques: A Training Manual For Vehicle Operators of Systems Transporting the Elderly and Handicapped, Third Edition. Fort Worth, Texas: Transportation Management Associates. 1984.

(8) "Uniform Federal Accessibility Standards." Federal Register (49FR31528). August 7, 1984.

(9) "Veterans Administration Wheelchair Lift Systems: VA Standard Design and Test Criteria for Safety and Quality of Automatic Wheelchair Lift System for Passenger Motor Vehicles." Federal Register (43FR21390). May 17, 1978.

(10) "Wheelchair Securement Systems in Transit Vehicles: A Summary Report." Summary proceedings of the National Workshop on Wheelchair Securement in Transit Vehicles of December 7-10, 1980.

2.0 TECHNICAL REQUIREMENTS

2.1 General Requirements

2.1.1 Useful Life

When used and maintained in accordance with manufacturer recommended procedures, a wheelchair securement device should be designed to have a useful life equal to the useful life of the vehicle on which it is used.

Rationale: The securement system may be belts, clamps, lock-pin devices, or a combination thereof. Once installed the system becomes a part of the vehicle. As with other components of the vehicle, with normal maintenance, including repair and replacement of parts, and proper use, the securement device should last as long as the vehicle. Normal maintenance should include replacement of belts and other parts subject to wear and damage (e.g., the severe stretching of belts in an accident), and should be replaced as recommended by manufacturers.

Useful life of a standard size transit bus is 12 years. Smaller vehicles have shorter useful lives. For example, a converted van used for public transportation typically has a useful life of 3 to 5 years.

2.1.2 Wheelchair to be Accommodated

The contractor should provide information on the dimensions and characteristics of wheelchairs that can be accommodated by the securement system.

Rationale: Existing securement systems have a trade-off between the time and convenience of securement and the wheelchairs that can be accommodated. The contractor should identify the wheelchair characteristics and dimensions that can be secured in order for the system operator to design appropriate operating policies. (For example, wheelchairs with small, solid tires may not be accommodated by a clamp system.)

2.1.3 Wheelchair Orientation

The selection of wheelchair orientation in a transit vehicle involves the consideration of safety, capacity, ride comfort, and vehicle interior factors. The order of preference for wheelchair orientation for passenger safety in transit vehicles is:

(1) Rearward facing with padded head and back support
(2) Forward facing
(3) Rearward facing without support
(4) Side facing of the wheelchair with padded support to prevent motion toward the front of the vehicle
(5) Side facing without support

The procuring agency should specify wheelchair orientation based on their consideration of the above factors.

Rationale: Tests simulating a frontal crash have indicated that the safest orientation is rearward facing coupled with padded head and back support. The next safest is forward facing. Less safe is rear facing without support and side facing with a barrier next to the wheelchair. Least safe is side facing with no barrier.

The Advisory Panel was able to reach consensus as to recommended wheelchair orientation for standard size transit vehicles (Gross Vehicle Weight Rating [GVWR] greater than 30,000 pounds). For those class of vehicles the forward facing was preferred with a rearward facing as a second choice.

The Advisory Panel was not able to reach consensus as to recommended wheelchair orientation for smaller size transit vehicles. However, they were in agreement as to the rank with respect to safety.

In smaller vehicles, limiting wheelchair securement to a forward or rearward facing position poses problems in terms of reducing the capacity of the vehicle to accommodate wheelchairs. Discussions among the Advisory Panel showed a divergence of opinion between safety and capacity considerations. Accident data indicate that approximately 60 percent of occupant injury accidents are frontal. Forward facing or rearward facing with barriers are safer orientations than side facing in frontal accidents. With 40 percent of the occupant injury accidents being side, rear, or other impact locations and with side facing orientation providing more wheelchair loading capacity, operators face a trade-off between capacity and potential accident impact. For operators of small vehicles, a local decision will need to be made concerning orientation and capacity. By analyzing its needs and its accident history, a local operator should choose an orientation that best meets the local conditions and needs.

2.1.4 Storage

When not being used for securement, the securement devices should be located or stored in a manner that does not interfere with passenger movement; does not present protrusions, obstacles, or other conditions that would be hazardous in normal operations or a crash environment; is reasonably protected from vandalism; and can be readily accessed when needed for use.

Rationale: A securement system should not introduce any hazardous conditions into a vehicle. By ensuring that the securement system is located or stored in a manner that will not interfere with passenger movement, hazardous conditions are minimized.

Transit systems report that vandalism is a problem that impairs the operation of a securement system. Although vandalism cannot be totally prevented, the securement system should be designed and located in a manner that will minimize vandalism. This guideline also applies when occupant restraint belts are specified.

2.2 Securement Process

2.2.1 Engaging and Releasing Wheelchair

The wheelchair securement device should secure a wheelchair when it is properly positioned. The securement device should be 1) activated by a mechanism of the securement device when contacted by a wheelchair and released by either passenger or second party action, and/or (2) conveniently engaged and released by a person familiar with the operation of the securement device.

2.2.2 Time for Securement

The securement should be able to be engaged or released by a person familiar with the use of the securement device in no more than ---(*)--- minutes.

(*) To be completed by Procuring Agency.

Rationale: The securement system might be mechanical devices, belts, or a combination of the two. Existing securement devices can be activated in the positioning process (e.g., certain clamp devices), require assistance in engaging and releasing (e.g., lock-pin devices), or are combination systems requiring both (e.g. a combination clamp and belt system).

In Section 2.2.1 the first activation process may require involvement by more than a wheelchair passenger in the process while the second process will require second party involvement.

In discussing the securement process, the Advisory Panel debated the role of the driver. For paratransit services the driver should be involved in the securement process and verify securement. For fixed route operations, opinions varied. Some members considered that the driver should be involved in the securement process and verify securement. Others considered the driver role to be passive. Proper securement would be left to the passenger. The role of the driver is a local operating policy decision; and the specification allows an optional driver role. As noted above, a device that can be "conveniently engaged and released by a person familiar with the operation of the securement device" may require driver or a third party familiar with the securement device operation.

The time of securement is a specification that is to be completed by the local operator based on the characteristics of the service being provided. For fixed route service, the Advisory Panel considered the securement engaging or release process should take a minimum amount of time. Less than 1 minute and less than 2 minutes were both discussed. In no case should the time exceed 5 minutes. For paratransit service no consensus could be reached on a desirable time. The time of securement is dependent on the type of device used, operating conditions, and the type of wheelchair being secured. When using this specification the operator may wish to designate the wheelchair types to be secured within the specified time or establish an upper time limit.

2.3 Wheelchair Restraint Requirements

2.3.1 Force To Be Restrained

2.3.1.1 The wheelchair securement system used on vehicles with GVWRs of 30,000 pounds or above should be designed to withstand a force in a forward longitudinal direction of up to 2,000 pounds per tiedown leg or clamping mechanism and a minimum of 4,000 pounds total for each wheelchair.

2.3.1.2 The wheelchair securement system used on vehicles with GVWRs of up to 30,000 pounds should restrain up to 2,500 pounds per tiedown leg or clamping mechanism and a minimum of 5,000 pounds total for each wheelchair.

Rationale: Crash tests have shown the following:

(a) Small school buses crashed at 30 mph experienced peak decelerations of 21-25g's
(b) Large school buses crashed at 21 mph experienced peak decelerations of 12-15g's
(c) Transit buses crashed at 21 mph experienced peak decelerations of 8-10g's.

The force values given in this guideline section were selected by the Advisory Panel on the basis of the test data and recognition that paratransit vehicles are small relative to standard transit buses and can be expected to operate at a higher average speed.

The requirement of lower wheelchair restraining forces for vehicles with GVWRs of 30,000 pounds or more is based on recognition that virtually all advanced design transit bases over 30 feet in length have GVWRs over 30,000 pounds. The higher wheelchair restraining forces were considered appropriate to all vehicles with lower GVWRs.

2.3.2 Attachment to Vehicle

2.3.2.1 On vehicles with a rated GVWRs of 30,000 pounds or more, the attachments to the vehicle should restrain a force in the forward longitudinal direction of up to 2,000 pounds per attachment point and a minimum of 4,000 pounds total for wheelchair securement system.

2.3.2.2 On vehicles with GVWRs of less than 30,000 pounds, the attachments to the vehicle should restrain a force in the forward longitudinal direction up to 2,500 pounds per attachment point and a minimum of 5,000 pounds total for the wheelchair securement system.

Rationale: The force to be restrained by the attachment to the vehicle is designated the same as the force to be restrained by the wheelchair securement system (Section 2.3.1) in order to ensure overall integrity in the system.

2.3.3 Nominal Movement in Normal Operations

Each securement location within a vehicle should be designed to limit movement of an occupied wheelchair when the vehicle is in normal operation and should meet the requirements of Section 4.1.2.

Rationale: Limiting wheelchair movement during normal operation provides a more comfortable ride for the wheelchair passenger and reduces the risk of a moving wheelchair injuring another passenger. Note that nominal movement will most likely require self-locking securement for belts and prohibit the use of inertial securement on belts.

3.0 OCCUPANT BELT REQUIREMENTS (Optional)

3.1 Occupant Belts

Separate from the wheelchair securement system, an occupant securement system consisting of (1) a lap belt <u>or</u> (2) a lap and shoulder belt should be provided. The lap belt should be a minimum of 86 inches in length. For lap and shoulder belt combination, the shoulder belt should be a minimum 86 inches in length and the second belt should be a minimum 43 inches in length. The occupant belt system should comply with Section 2.1.4.

Rationale: The question of occupant securement generated divergent opinions among the Advisory Panel. Occupant securement is not required on public transportation vehicles. Some thought that no special consideration should be made for those in wheelchairs. Yet, the Southern California Rapid Transit District has documented that wheelchair patrons have an accident rate over 350 times greater than ambulatory passengers.

As described earlier in the rationale of Section 2.3.1, the forces present in a crash vary by type of vehicle. Operators of small vehicles generally favored occupant securement. Belt systems are often used in paratransit operations; and occupant securement belts would not add significantly to the time of boarding. Given the divergence, the Advisory Panel considered occupant securement a local issue and made this section optional.

Differences of opinion also existed in terms of only a lap belt or a lap and shoulder belt combination. Again, the differences partially related to vehicle size. On larger transit buses, finding attachment points for shoulder belts is difficult. On smaller vehicles, especially vans, the problem of attachment is not considered as difficult.

Although self-locking securement for belts for wheelchairs may result from the nominal movement requirements, inertial locking systems should be acceptable for passenger use. Such belts could allow passenger movement in a wheelchair. The 86-inch length is currently in use in the industry. Longer lengths have caused both procurement and certification problems.

3.2 Force to be Restrained

The occupant securement system and anchorages should comply with FMVSS 209 and FMVSS 210, respectively.

Rationale: Both the belt assembly and anchorage should be designed and tested to FMVSS. These standards for seat belts are accepted in the automotive industry. Since FMVSS is to be met, no additional test procedures are described in Section 4.0.

4.0 TESTING, CERTIFICATION, AND WARRANTIES

4.1 Design Tests

The tests defined in Section 4.1 should be performed on a representative production unit of the securement device model procured under this specification. The securement device should meet the requirements given in Section 2.0 when attached to a fixture that simulates a bus installation. Only one representative production unit is required to be tested for certification.

4.1.1 Wheelchair Securement Device and Attachment Restraint Test

Once engaged the securement device and attachment to the vehicle should not fail when the device is subjected to the loads described in Sections 2.3.1 and 2.3.2 for 10 seconds under the following conditions:

(1) For clamps and similar systems:
The force is applied at the height at which the securement device is mounted or attached to a wheelchair.

(2) For belt systems:
The force is applied horizontally at the end of the belt when belts are in conformance with the manufacturer's recommended installation and securement procedures.

Permanent deformation or rupture of the restraint or anchorage is not considered a failure if the required force is sustained for 10 seconds.

Rationale: This test is designed based on the requirements of Sections 2.3.1 and 2.3.2, and concurrently tests both restraint and the attachment to the vehicle. It recognizes the difference between the clamp and belt systems. The clamp systems will be tested at their height of mounting or when the clamp is adjustable at the height of attachment to a wheelchair (usually 10 inches to 18 inches above the floor). The belt systems will be tested when belts are in conformance with the manufacturer's recommended installation and securement procedures. The definition of failure used in this guideline is similar to that used in FMVSS 210.

Note that the language in Section 4.1 does not mean that a manufacturer must perform these tests for each procurement. Once a securement device model and vehicle model combination have been tested, the design test applies to all procurements of this combination of models.

4.1.2 Nominal Movement Test

The contractor should test the ability of the securement device to maintain nominal movement. One or more of the following wheelchairs should be used in this test:

- a standard manual wheelchair (e.g., an Everest and Jennings Traveller model or equivalent)
- a standard powered wheelchair (e.g., an Invacare Power Rolls Arrow Model 4M929E or equivalent)
- a modular powered wheelchair (e.g., a Fortress Scientific 655 or equivalent).

When the wheelchair is loaded with a restrained weight of 110 and 250 pounds, it should not move more than 4 inches in any direction at any point of contact with the floor when the vehicle is being operated under the following conditions:

(a) Full throttle acceleration on dry pavement from a standstill to 25 mph with the vehicle at its curb weight plus one occupied wheelchair.
(b) Maximum braking from 22 mph to a standstill on dry pavement with the vehicle at its curb weight plus one occupied wheelchair.
(c) Driving both clockwise and counterclockwise with the outer front wheel around one of the following:

  (i) 50 ft diameter circle at a minimum steady speed of 12 mph
  (ii) 75 ft diameter circle at a minimum steady speed of 14 mph
  (iii) 100 ft diameter circle at a minimum steady speed of 16 mph.

Use of the securement device during normal bus operation should not cause damage to the wheelchair being transported.

Rationale: This section is adapted from the Canadian Standards Association. The 4-inch movement was recommended by the Advisory Panel, which considered the CSA 3/8-inch standard too restrictive, especially with regard to clamp systems. The vehicle circular operating tests all generate 0.35 to 0.39 gs of lateral force. The circle to be operated will depend on the size and manueverability of the vehicle.

4.1.3 Visual Inspection

At the conclusion of the tests described in Section 4.1.2, the securement device and components for attachment to the vehicle should show no condition of fracture, wear that would exceed manufacturer's tolerances, perceptible impairment, or other deterioration.

Rationale: The tests in Section 4.1.2 involve loads well below those applied in Section 4.1.1 and these tests should not reduce the capacity of the system to restrain loads.

4.1.4 Certification

The contractor should provide written certification of compliance of the tests in Section 4.1.

Rationale: Section 4.1.4 is standard practice in design testing.

4.2 Acceptance Tests (Optional)

The contractor should submit for approval to the Procuring Agency a test plan to demonstrate that the securement devices purchased by this procurement meet the requirements in Section 2.0. The Procuring Agency may witness any or all of these acceptance tests. A mutually agreed upon notification time prior to the conduct of a test should be made between the two parties. The test results should be recorded, witnessed (i.e., signed), and submitted to the Procuring Agency as proof of meeting the acceptance criteria of the approved test plan.

Rationale: Acceptance tests are standard industry practice in vehicle procurement. It is anticipated that acceptance testing will primarily concern the requirements of Sections 2.2 and 2.3.2. For small procurements the Procuring Agency could choose to accept test data from other procurements of the same vehicle and securement device. For this reason the acceptance test requirement is optional based on the size of the procurement.

4.3 Warranty

A statement of warranty should be provided with each securement device assuring the quality of materials and workmanship of the product for at least one (1) year from the date of delivery to the final consumer.

Rationale: When securing accessible equipment, the above is standard practice in the industry.

THE MAINTENANCE, TRAINING, AND SERVICE GUIDELINES THAT FOLLOW ARE ADAPTED FROM WHITE BOOK SPECIFICATIONS. IF WHEELCHAIR SECUREMENT DEVICES ARE PROCURED AS A PART OF A VEHICLE SPECIFICATION, THESE SECTIONS MAY NOT BE REQUIRED.

5.0 MAINTENANCE, TRAINING, AND SERVICE

5.1 Documents

The contractor should provide ---(*)--- current maintenance manual(s), ---(*)--- current parts manual(s), and ---(*)--- operator's manual(s) or ---(*)--- combination manuals thereof as part of this contract. The contractor should keep maintenance manuals available for a period of 3 years after the date of acceptance of the securement device procured under this contract.

(*) Procuring Agency to fill in pertinent information.

5.2 Maintenance and Inspection

Scheduled maintenance or inspection tasks as specified by the contractor should require a skill level of 3M or less. Scheduled maintenance tasks should be related and should be grouped in maximum bus mileage or time intervals.

5.3 Replacement Parts

The contractor should guarantee the availability of replacement parts for securement devices procured under this contract for at least the useful life of the securement device. Spare parts should be interchangeable with the original equipment and should be manufactured in accordance with the quality assurance provisions of this contract.

5.4 Training (Optional)

The contractor should have at least one qualified instructor who should be available at the Procuring Agency's property for ---(*)---calendar days between the hours of ---(*)--- and ---(*)--- after acceptance of the first securement device. Instructor(s) should conduct classes and advise the personnel of the Procuring Agency on the proper operation and maintenance of the securement device. The contractor should also provide visual and other teaching aids for use by the Procuring Agency's own training staff.

(*) Procuring Agency to fill in pertinent information.

Rationale: For small procurements this type of training would be expensive and excessive. This section is, therefore, optional. For small procurements the contractor should be requested to provide brief instructions on securement device use at the time of vehicle delivery, and to be available for consultation on an as-needed basis.

COMMENTS SHEET

These guideline specifications are an industry document developed by professionals familiar with accessible transportation. The document is considered to be an important step in the evolution of accessible transportation. However, it is not the final step. It is anticipated that operational experiences and technology advancements will indicate areas where these guidelines can be improved. Your comments and suggested changes are solicited. Please use this comments sheet to forward your comments to:

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Comments: (When referring to specific sections of the guideline specifications, please identify the section number and title.)