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Wheelchair Securement Systems in Transit Vehicles:
A Summary Report

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TECHNOLOGY SHARING A PROGRAM OF THE UNITED STATES DEPARTMENT OF TRANSPORTATION

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INTRODUCTION

The origins of the National Workshop on Wheelchair Securement in Transit Vehicles can be traced to the operating experience of a large number of public and private transportation activities over the past 5 years. Initially, small urban and rural transportation programs as well as human service agency transportation programs frequently experienced problems associated with the safety, cost, and operational suitablility of wheelchair securement systems. In this setting, the majority of vehicles in use were vans or small buses and most operational patterns allowed for someone to assist the wheelchair passenger in using a securement system.

As the issue of public transit accessibility intensified and began to be felt at the operating level, the subject of wheelchair securement systems emerged as a particularly important area needing immediate attention.

Since most operating system experience with wheelchair securement systems has been with paratransit and human service special transportation units, experience with fixed-route, heavy transit buses and rail vehicles has been short-term and limited to those systems which are operating accessible fixed-route services.

Out of this mixed operating system experience a confused and sometimes contradictory knowledge base has emerged which has left manufacturers, system operators, users, and public officials little to work with in solving a number of problem areas which can have severe implications in safety and operating costs.

It became clear that a focused activity to establish a credible knowledge base, define issues, and establish potential solutions was badly needed. Towards this end, the National Workshop was planned and carried out.

The National Workshop on Wheelchair Securement in Transit Vehicles was held December 7th - 10th of 1980 to deal with this problem. The Transportation Systems Center's Office of Technology Sharing, in cooperation with the Urban Mass Transportation Administration's Office of Socio-Economic and Special Projects, sponsored and managed the Workshop. It was a cooperative effort involving the U.S. Department of Transportation (DOT), equipment manufacturers, state/local transportation units, and the R&D community.

Four objectives were set out for the Workshop participants to accomplish:

1. The immediate improvement of communications by bringing together individuals from groups representing the various sectors of activity and their knowledge and viewpoints.

2. The establishment of the state-of-the-art knowledge base, i.e., what activities have occurred in research, test and evaluation, product development, and utilization of wheelchair securements.

3. The definition of problems being encountered by the individual sectors of government, manufacturers, researchers, and users.

4. The determination of what needs to be done by which sector in order to overcome the problems and barriers that impede progress towards a solution.

These objectives were accomplished through in-depth working sessions.

This report is a summary of the workshop and is divided into two parts. The first part summarizes the discussion of the state-of-the-art and the problems which exist. The second part contains the recommendations of the group.

I. WORKSHOP DISCUSSION

This section highlights the major points made in the formal and informal presentations given at the workshop. It also summarizes the discussions of the sessions attended by all participants. The summary of the small group sessions is contained in the second section of this report in the form of a series of recommendations. Although the discussions reflected a wide range of ideas and opinions, the significant aspects of the current activities and problems in the research, development, and utilization of wheelchair securements are included here.

A. SECUREMENTS SYSTEMS - WHAT ARE THEY?

1. Basic Definition

The workshop participants used various terms to refer to the devices which were the focus of the workshop's discussions. Wheelchair securements, wheelchair restraints, and wheelchair tie-downs were terms used interchangeably. The term wheelchair securement system will be consistently used throughout this report.

According to the participants, a wheelchair securement system is a device, or combination of devices, which normally has two components:

- a wheelchair restraint, which secures the wheelchair within the vehicle against forces occurring from the front, back, or sides of the vehicle; and

- a passenger restraint, which secures the wheelchair passenger within the vehicle against forces occurring from the front, back, or sides of the vehicle.

The forces which occur in the vehicle may result from a sudden stop, sharp turn, or an impact into another object. In those situations, the securement system prevents the wheelchair from rolling, tipping, or flying within the vehicle, and keeps the wheelchair passenger in the wheelchair, in order to protect both the wheelchair passenger and other passengers.

Concern was expressed by some participants that wheelchair securement systems provide wheelchair passengers with greater protection than ambulatory passengers in public transportation. The response from other participants to this concern was twofold. First, there are Federal safety standards and specifications which protect seated passengers in transit. Basically, those standards require that seats be placed in such a fashion that seated passengers will impact a cushioned seat back and not impact on a hard object or fly around the vehicle. Wheelchair securements would provide comparable protection since a wheelchair passenger cannot sit in the regular seats. Second, a disabled person is more likely to be injured than an ambulatory person in the same kind of accident, because a disabled person may have brittle bones, or may not be able to grab hold of something or use his limbs to protect himself.

2. Types of Restraints in Use

A formal presentation by one of the participants which discussed the securement systems currently in service described the three primary methods of wheelchair restraint:

- Wheel anchor - this method anchors the rim of the wheel(s) to the wall or floor of the vehicle. The restraint device is usually a clamp, or a rod or pin placed between U-shaped brackets.

- Frame anchor - Restraints using this method usually are joined to the floor and attach onto some part of the wheelchair frame, such as the crossmember bars. These devices consist of belts, chains, clamps, or T-bars.

- Through the passenger - This method wraps a belt, which is attached to the wall or floor of the vehicle, around the passenger. In doing so, both the chair and the passenger are secured.

Existing passenger restraint also has three major forms:

- Nothing - Nothing is considered a major form, because it is common practice that only the wheelchair and not the passenger is secured.

- Belt to chair - This form involves the securement of the passenger to the wheelchair with a belt. The belt is usually wrapped around the back of the wheelchair and around the passenger's upper chest and stomach.

- Belt to vehicle - In this form a belt is attached to the vehicle floor or wall and wraps around the passenger over the armrests of the wheelchair.

3. Manufacturing

Most of the manufacturers at the workshop indicated that wheelchair securement system devices are relatively low cost and low volume items. Very little, if any, profit is realized from their sale. Therefore, securements are generally a minor item in a manufacturer's product line.

Yet, across the country there are a number of manufacturers who produce securements. (See Appendix B for a listing.) Most of these manufacturers are in the business of modifying and customizing vehicles for disabled passengers or drivers.

4. Regulations

Based upon discussions at the workshop, the participants concluded that currently there are no Federal regulations specifically governing wheelchair securement systems. However, it was pointed out that there is a series of Federal Motor Vehicle Safety Standards (FMVSS) which require occupant crash protection in vehicles. These standards specify performance requirements and test procedures for passenger seat belts, seat structure, and seat to vehicle anchorage: FMVSS Nos. 207, 208, 209, 210, 222. Also brought to the group's attention by some participants are the mandated specifications for the

Advanced Design transit buses, or ADB's (Baseline Advanced Transit Coach Specifications - UMTA), which include standards for passenger seat design and construction. In the case of the FMVSS 222 and the ADB standards, passenger crash protection is provided in school buses (FMVSS 222) and transit buses, by containing seated passengers in their seats. This is accomplished by the placement of a seat in front of them. In an accident passengers should strike the forward seat, which is designed to absorb some energy from the impact, and should not strike other, more hazardous objects in the vehicle.

The participants involved in research said that all of these standards have provided them with the initial concepts upon which they tested wheelchair securement systems. However, given the difference in construction between a wheelchair and a vehicle seat, the special physical characteristics of disabled passengers, and the lack of space to place a wheelchair behind the vehicle seat, most of the researchers agreed that safety standards or guidelines specifically for wheelchair passengers are necessary.

Participants noted that despite the lack of Federal standards, some states have instituted their own standards. Both California and Minnesota have standards for attaching securements in public transit vehicles. Minnesota, in addition, has performance standards for wheelchair securements. The main intent of the standards is to keep wheelchairs from moving while the vehicle is in motion. The standards do not provide for protection in the event of a crash. Minnesota requires manufacturers to have their devices certified by the Highway Patrol. Appendix D contains a copy of the regulation. A few participants also noted that some states have regulations for securements used in school buses transporting disabled children.

B. FACTORS WHICH AFFECT SECUREMENT DESIGN

1. Transportation Modes

In discussing securement design requirements, the participants reached a consensus that one securement design would not be appropriate for all transportation modes. Thus, they categorized the design parameters by transit mode. The chart below summarizes the major characteristics which they identified as determining securement design parameters, which include vehicle type, service type, and driver role.

a. Vehicle Type

- Larger vehicles have more maneuvering space and thus can contain a larger securement system.

- Larger, heavier vehicles tend to absorb more of the energy resulting from an impact, transfering less energy to the passengers. Thus, these vehicles do not need securements as strong as those in smaller vehicles. (The section below on the research test results discusses impact energy levels in more detail).

b. Service Type

- Services which must adhere to fixed schedules do not allow the vehicle to dwell at a stop for very long. A boarding survey of wheelchair passengers conducted by the California Department of Transportation (Caltrans) found that of the 2 to 4 minutes it took wheelchair passengers to board before the bus could move, most of the time was spent maneuvering inside the vehicle and operating the securement.

- Vehicles travel at different speeds depending upon the service type. Vehicles traveling at higher speeds require more protective securements.

MODAL CHARACTERISTICS INFLUENCING SECUREMENT DESIGN

MODE	CHARACTERISTICS		
	Vehicle Type	Service Type	Driver Role
Rail	Heavy and Light Rail Vehicles	Fixed-Route Intra-city Intercity	Driver not permitted to leave seat to assist passenger. Driver (conductor) may be permitted to leave seat.
Transit Bus (Standard)	Heavy Vehicles	Fixed-Route Normally Slow Operating Speeds	Driver not permitted to leave seat.
Paratransit and School Bus	Light Vehicles (vans, body on chassis)	Demand Responsive Subscription Type Regular Clientele Moderate Speeds	Driver is trained to see that passengers are loaded into the vehicle and secured properly.
Private	Light Vehicles (vans)	Personal Transportation Highway Speeds (accident exposure similar to automobiles)	Driver may be the wheelchair occupant.

- Fixed-route services do not always have a regular clientele, so a securement has to be designed to accept all wheelchairs and passengers.

c. Driver's Role

The driver's role determines how a securement must be operated. The participants divided securement operation into two categories: hands-off and hands-on. Some of the securements can be attached and released by the wheelchair passenger himself/herself. These are called hands-off systems. The systems which require the vehicle driver to assist the passenger are called hands-on systems. Hands-on systems are generally manually operated, while hands-off systems are semi or fully automatic. The automatic systems are often activated by spring-loaded mechansims or by electrical power. However, currently in most cases, the passenger must be able to press a button or handle a lever to operate the automatic system. In addition, hands-off securements are expected to be much more expensive than hands-on securements. In general, (as shown in the chart above):

- hands-off securements are appropriate for rail service, fixed-route transit bus service, and privately owned vans.

- hands-on securements are appropriate for paratransit and school bus service modes.

d. Existing Securements

Given the securement design requirements for fixed-route bus and rail service modes, the participants generally believed that none of the existing securements are fully adequate for those modes. Most securements in use have been designed for private vans and paratransit services. Although most of the participants agreed that a securement system should be used in fixed-route bus service, a consensus was not reached regarding the need for securements in rail service.

2. Variability in Wheelchairs

Most participants concurred that the various sizes and shapes of wheelchairs make it difficult to develop wheelchair restraints which will function for most wheelchairs.

In one of the formal presentations, a participant gave a brief overview of wheelchairs. He explained that a wheelchair is a substitute for ambulation for the user and is necessary for the user's basic existence. Since people who use wheelchairs come in all shapes and sizes, wheelchairs are customized devices for the particular needs of the user. About 75 percent of the wheelchairs expected to be used out of the home fall into two categories. First, there are the lightweight, foldable manual wheelchairs. They are basically chairs with large spoked driving wheels and small spoked caster turning wheels. The second category is the electrically powered version of the manual chair. The main difference is that the wheels are smaller in diameter and it has a battery pack with drive motors to power the chair and a control system to maneuver the chair. The other 25 percent of the wheelchairs are usually power driven and nonfoldable. They have small solid wheels and range greatly in size.

Other participants pointed out that new wheelchair designs and modification are developed without taking into consideration the fact that the chairs are being used as seats in a variety of transportation systems and will continue to be used as seats at an increasing level. On the other hand, it was noted that securements are designed without taking into consideration new designs in wheelchair construction.

3. Consumer Preference

Participants recognized at the workshop that the physical strength and dexterity of disabled individuals vary greatly. In addition, their personal preferences differ regarding the method in which the securement attaches to the chair, the extent of securement, and the direction to face while traveling. The workshop participants agreed that most passengers want to avoid having their chair damaged by a securement and they want to be treated similarly to ambulatory passengers.

C. RESEARCH

1. Overview

A number of formal and informal presentations were given by those involved in research activities. According to the researchers, the primary objectives of the research and testing in the area of securement systems have been the determination of the magnitude of the forces a secured wheelchair and passenger would be expected to experience during impacts, and how securement systems perform when subjected to these forces. Some research has also involved the development of prototype securement designs and the analysis of accident data.

To test securement performance in accidents, static and dynamic testing are being used by the researchers. In static testing, a specified force (a weighted load) is applied to a stationary and secured wheelchair in order to evaluate the resulting movement and/or deformation of the securement device. Static testing primarily tests the strength of the material of the securement.

In dynamic testing, a secured wheelchair and dummy are accelerated or decelerated. Acceleration, or deceleration, is the rate of change of velocity (the change in velocity per unit of time). Acceleration and deceleration are measured in terms of g. For instance, as shown in the chart below*, a vehicle traveling at 21.82 mph which decelerates to 0 mph within 1 second will

*For general reference, a comparison between acceleration in miles per hour per second (mphps) and "g" is shown below:

mphps	g	mphps	g	mphps	g	mphps	g
1.7	0.08	3.0	0.14	4.1	0.19	21.82	1.0
2.5	0.11	3.2	0.15	4.75	0.22	109.0	5.0
2.75	0.13	3.5	0.16	6.5	0.30	218.0	10.0
				6.8	0.31		

experience 1 g. The force an object experiences upon deceleration is a product of the amount of deceleration (number of g's) and the object's weight (mass).

Most dynamic tests consist of a sled, upon which a wheelchair and dummy are secured, that travels at a specified speed. The speed is then suddenly changed; the sled is either accelerated or decelerated. This test method simulates a moving vehicle impacting a barrier.

The researchers indicated that a number of organizations have sponsored research of securement systems. (The reports which discuss the research in detail are listed in Appendix E.) Their activities were summarized by the participants as follows.

a. <u>The Swedish Institute of Traffic Safety and Goteborg University</u>

In 1974, these two organizations dynamically tested five types of securements for manual wheelchairs that were used in paratransit vehicles. They tested at acceleration levels of 5 g's, 10 g's, and 20 g's.

b. <u>Wayne State University</u>

A securement system was designed at the University to be used in their minibuses. The wheelchair was positioned so that it faced the rear of the vehicle and the securement was designed to provide protection during a frontal impact. It was an elaborate system consisting of a padded back and head support mounted on energy absorbing posts. However, it was never marketed commercially and the University has decided to purchase commercially available securements in the future.

c. <u>U.S. Veterans Administration (VA)</u>

The VA has sponsored both static testing, conducted by Texas A&M University, and dynamic testing, performed by the Southwest Research Institute. Dynamic testing was done at 20 mph, 20 g's. The intent of the testing was to evaluate the commercially available securements which the VA currently has installed in vans owned by their clients. The results of the tests have been for internal use in the consideration of the VA's securement purchases.

d. National Highway Traffic Safety Administration (NHTSA) and the Urban Mass Transportation Administration (UMTA)

Minicars, Inc. recently conducted the NHTSA/UMTA sponsored program evaluating crash protection systems for handicapped school bus passengers and transit bus passengers. Minicars surveyed the securement systems currently in use, and examined accident and injury data to identify what causes injuries in accidents. They also conducted a program of crashing buses to determine the forces involved in accidents. Small school buses were crashed at 30 mph, large school buses were crashed at 21 mph, and transit buses were crashed at 21 mph. Their future research will consist of a series of dynamic tests to investigate the influence of certain parameters, such as bus size and passenger size, on the crash protection available to disabled passengers.

e. Wisconsin Department of Public Instruction

In 1975, the Universtiy of Michigan's Highway Safety Research Institute (HSRI)* conducted 16 dynamic tests at 20 mph, 16 g's, to evaluate securements used to transport disabled school children.

f. Massachusetts Rehabilitation Commission

In 1980, HSRI, under contract to the Massachusetts Rehabilitation Commission, tested securements used by individuals in powered wheelchairs, principally drivers of vans. The securements were tested at 20 mph, 16 g's. Some securements were tested at 30 mph, 20 g's.

*HSRI also has conducted tests for manufacturers who are developing new securement systems. In addition, HSRI has conducted a series of tests through the University of Michigan Rehabilitation Engineering Center.

g. Transport Canada's Transportation Development Center

The Canadian federal government contracted with Douglas Ball, Ltd. to design and develop a securement system for intercity rail service. It will be introduced into the Canadian VIA intercity rail service. Douglas Ball also designed a similar prototype for use in buses and paratransit vehicles. The prototypes have been statically tested and also have been evaluated while being used in service. Dynamic testing of second generation prototypes will be conducted in the future.

h. Urban Mass Transportation Administration (UMTA)

UMTA has sponsored the evaluation of 12 securement systems, conducted by the California Department of Transportation (Caltrans). The securement systems were dynamically tested at 20 mph, 10 g's and at 20 mph, 5 g's. The study focused on the performance of the securements' design concepts rather than the performance of securements bought "off the shelf".

i. California Department of Transportation (Caltrans)

Caltrans has begun a project funded by the state to design a securement system which is appropriate for fixed-route bus services, and which can accommodate most wheelchairs.

2. Test Procedures and Results

During and after the presentations, there was a great deal of disscussion concerning the test procedures and results. For many participants, this was their first review of the test results.

a. Dynamic vs Static Testing

The researchers at the workshop generally agreed that dynamic testing of securements is preferable to static testing. They acknowledged that static testing can provide useful information about the strength of materials, but they believe dynamic testing is the only method that can evaluate how a system may perform in the real world. Static testing can not simulate how a force (load) is transmitted to the chair and restraints. In addition, they explained that the human body, which is simulated through crash dummies, has a very complex response in a dynamic situation, which static loading can not simulate.

Dynamic testing generally has used crash dummies which represent the 50th perentile male; in other words, a man 30 years old weighing 160 pounds. (HSRI and Minicars, Inc., in doing tests for school buses, used dummies weighing 48 pounds to represent 6 year olds, and dummies weighing 100 pounds to represent 14 year olds.) Most of the researchers claim that the design of standards based upon the 50th percentile male makes the erroneous assumption that if protection is provided for this limited case, then everyone else is protected by the same securement system. Thus, they recommended that the full range of person sizes in the population be accommodated in the test procedures.

Most dynamic testing simulates frontal impacts because, as some participants explained, of all serious impacts, frontal impacts are more common than side or rear impacts. A recent survey by Minicars of fatal school bus accidents across the country in 1975, 1976, 1977, and 1978 found that 38 percent involved frontal impacts, 19 percent were side impacts, 15 percent were rear impacts, and the remainder were rollovers.

b. Accident Force Levels

Some of the participants involved in research pointed out that a minimum level of crash forces against which a securement will protect has to be established. The test force levels chosen by the researchers were based on several factors: the average speed at which a vehicle would most likely be traveling in a particular transit mode, and the size and weight of that vehicle. It was reasoned that impacts at higher speeds produce more energy and that lighter vehicles, such as vans, do not abosorb as much of the energy produced in an impact before that energy reaches the passenger. Since most testing had been based upon estimated force levels, the recent Minicar's bus crash tests were conducted to provide actual data. The bus crash tests found the following forces to occur as a result of impacts:

- Small school buses crashed at 30 mph experienced peak decelerations of 21-25 g's;

- Large school buses crashed at 21 mph experienced peak decelerations of 12-15 g's; and

- Transit buses crashed at 21 mph experienced peak decelerations of 8-10 g's.

The workshop participants recommended that force levels similar to those found in the Minicar's tests be used in setting performance standards. These recommendations are contained in Section II of this report.

Vans were thought by some participants to have accidents at levels similar to those of automobiles. NHTSA tests automotive passenger securements at 30 mph, 20 g's, but some researchers estimated that a typical van crash at 30 mph would result in a 35 g deceleration due to the different kind of crush a van has. Some researchers noted that while they were conducting the tests, they discovered that the significant factor in determining the ability of a securement system to withstand an impact is the velocity at which the vehicle is traveling when it hits a barrier. It was explained that since the wheelchair and dummy are not totally rigid with the test platform, due to looseness between the securement system and the wheelchair and passenger, the wheelchair and passenger behave differently than the test platform during the impact. Thus, they will experience different g levels. This was referred to as the decoupling effect. Often, the g levels are expected to be higher for the wheelchair and dummy, since they can be forced to decelerate in less time and distance than the test sled. Similarly, due to the looseness between the restraint and the passenger, a complex interaction between the mass segments of the passenger's body takes place. For example, a whipping motion of the body can result in what a participant called acceleration amplification factors. This implies that if there is an impact of 16 g's, some parts of the body may experience, for example, 60 g's.

c. Securement Performance

Evaluation Criteria - To determine the performance of a securement, the researchers looked at the containment and the excursion of the wheelchair and passenger. Containment means that some limitation is placed on the movement of the wheelchair and passenger inside the vehicle. This applies to secondary impacts as well as initial impacts. The researchers found that some of the devices that were tested performed well for the initial stop of the sled. However, in a vehicle accident frequently there is a rebound and secondary pulses occur. They indicated that if the device releases right after the inital impact, this containment is lost. They noted that some of the devices did release during testing. It was pointed out that a single modification to the securement could prevent that from happening. It happened primarily because there was some deformation that occurred in the wheelchair frame, or such, that allowed the securement to fall off after that deformation occurred.

The other performance criterion some researchers referred to is excursion. This is the distance traveled by the wheelchair (and passenger) after an impact and it is particularly important if the passenger strikes another object in the vehicle. One index used in some of the tests to judge injury is a standard that the NHTSA uses in evaluating vehicular accidents for ambulatory passengers: the head injury criteria (HIC), which is calculated from g levels experienced by the head. One researcher noted that there has to be a head impact for this to be a valid measurement, but it was measured in some of his testing, regardless of whether there was a head impact or not. When there is not a head impact, HIC indexes are minimal. But once a dummy's head strikes something in the vehicle, the HIC indicates a serious injury. There was a consensus that to reduce injury the excursion should be limited, or there should be padding of the object that will most likely be struck.

Non-securement Failure - Some of the researchers discussed the difficulty experienced in testing securements at the desired force levels, due to the failure of the wheelchair and the securement hardware (rather than the securement design).

Although the wheelchair proved to be stronger than had been originally believed, it still failed in some circumstances. For example, Caltrans originally planned to test securements at 30 mph, 10 g's. However, with the dummy restrained to the wheelchair during tests of wheelchair restraints which attached to the wheel rims, the wheels disintegrated at 26 mph. It was noted that wheels tend to be a weaker point of attachment than the frame, but securements which attach to the frame were not tested at 30 mph by Caltrans.

In addition to wheelchair failure, the securement hardware bought "off the shelf" failed in some of the testing. The researchers believed that these devices could have been constructed to be stronger or made of other material. To deal with this problem Caltrans constructed their own devices similar to those on the market, but built not to fail. Thus, they were able to test the design concept.

Another potential source of failure pointed out by some participants, and one that was not tested, is the lack of strong structural members in a vehicle to which a securement can be attached. Vans in particular have a weak construction and in some cases, according to one participant, an attachment could be pulled off the van by a person's hands.

<u>Passenger Restraint</u> - Existing wheelchair securement systems may or may not include a restraint for the passenger. Most passenger restraints are belts. The researchers pointed out that when the passenger is secured to the wheelchair it creates a whole new loading situation for the wheelchair and also for the securement system. It requires the securement system to handle the loads of both the passenger and the wheelchair. An example given by one participant was that with a power wheelchair weighing up to 110 pounds and a passenger that weighs about 150 pounds, the securement system would have to restrain 260 pounds of mass. Based on the test results, the researchers generally felt that few securements were designed to restrain the added load of a passenger during an impact.

In addition, participants generally recognized that it is common to secure the wheelchair and the passenger by the same belt, rather than having a separate passenger belt attached to the chair. However, a participant observed that upon impact, this results in excessively loading the passenger with the forces required to restrain the chair.

Participants discussed the great availability of information that has been developed for automotive vehicle securements which could be applied to the particular problem of transporting disabled passengers. However, it was acknowledged that the problem is more complex because of the physical differences of the disabled resulting from postural and strength problems. Yet, the test results have shown that the basic principles of passenger restraint design have not been applied to wheelchair securement systems, and in some cases have been violated. An example, given by a participant, of one of the basic principles in restraining a person, is that the forces must be applied to the skeletal regions of the body. If the forces are applied over the abdomen and other soft regions, there is a chance of causing internal injuries. Yet, according to that participant, some of the belts which are used for restraints are padded, but the placement of padded belts is usually on the abdomen. This results in the forces being on the abdomen rather than the pelvic region.

In the cases where a passenger always uses a belt to support himself/herself while in a wheelchair, it was suggested that a velcro type of fastener be used to lock the belt. Velcro was suggested because it gives in a serious impact which is important if the belt rests across the abdomen. An additional belt, resting on more appropriate regions of the body, should be used for vehicle travel and relied upon in an accident. Still, there are some difficult problems with providing properly fitted restraints for disabled individuals. It is not always the same as securing able-bodied individuals.

A representative from Caltrans said that Caltrans believes that in public transportation operations, the individual should be secured to the wheelchair before boarding the bus. Caltrans has done this very simply by attaching a belt to the chair. Although not recommended as a method for general use, they removed the nut on the axle and put a D ring there to attach the belt. Some participants noted that there may be some warranty implications in altering the chair. In any case, it was suggested that a simple piece of hardware could be developed to provide that same kind of securement and placed down near the axle of the frame, which is a very strong point on the chair. Thus, the belt would be permanently on the chair. The person would bring the belt up through the seat of the chair so that it would become a pelvic restraint. This would be superior to having the belt lie over the wheelchair armrests, which causes the belt to rest on the softer regions of the body. Restraints placed in this manner are commonly done with a belt that is applied in the vehicle, but the armrests are generally in the way of properly positoning the belt.

Wheelchair Orientation - Some of the researchers alerted the group to the fact that the dynamic testing simulating frontal impacts has shown that side-facing secured wheelchairs are very dangerous for the passenger. In an accident, a passenger has violent trunk rotations which the human torso cannot withstand. Some participants said that side-facing securements may be adequate if padded bulkheads or containment walls are placed alongside the wheelchair so that they limit the movement of the wheelchair and passenger.

The testing has also demonstrated that the safest wheelchair orientation during frontal impacts is rear facing, coupled with a padded head and back support directly behind the passenger. It was mentioned that aside from the fact that this arrangement requires a great deal of space and may not be easily removable, passengers generally prefer to travel facing forward so they can see where they are traveling.

d. Justification of Research

In terms of the low number of accidents and fatalities that have been reported, participants thought that it may be difficult to justify the expenditure of public funds for future research, despite the need for research to solve current problems with wheelchair securement. However, it was recognized that the Federal government directly procures securements through the Department of Transportation's grant programs, such as Sections 16(b)2, Section 3, and Section 5. The Department of Health and Human Services also supports the purchase of securements through its social serivce programs and rehabilitation programs. In additon, the Department of Education and the Veterans Administration support the purchase of securements through their programs. There has been a large investment in this equipment and there will continue to be. In most cases, 50 to 100 percent of the money used to purchase securements is public money.

Aside from this investment, the responsibility to improve the safety of securement systems must be viewed independently of the size of the statistical program reporting accidents.

II. WORKSHOP RECOMMENDATIONS

The following recommendations were generated by participants in their individual working group sessions and are presented here, for the most part, verbatim. All recommendations were presented to the full group for comment. Thus, although it is quite possible that not every participant may agree with each recommendation and some inconsistencies exist, these recommendations do represent a general consensus of the group at that time.

A. GENERAL

- The increasing number of persons confined to wheelchairs desiring to travel beyond the boundaries of their residence as a matter of choice, together with developing state and Federal requirements that persons in wheelchairs have access to public facilities, dictate that means be developed to promote the safe transportation of these persons in vehicles.

- The handicapped traveler should be afforded a level of personal safety equal to that enjoyed by able-bodied persons in all modes of transportation.

- As a general recommendation to all Federal, state, and local government agencies, as well as private industry organizations, the safety of all individuals in any mode of transit shall be equal. Secondly, we recommend that existing safety standards for all transportation modes shall not be impaired through implementation of Section 504 of the Rehabilitation Act of 1973.

- The public interest can best be served by requiring the use of wheelchair securement devices including passenger restraints by wheelchair persons traveling in public conveyances and by persons driving vehicles while seated in wheelchairs. Additionally, it is recommended that such devices be used by wheelchair passengers in private vehicles. The primary concern of securement should be the safety of the wheelchair passenger. The secondary concern should be prevention of movement of the wheelchair within the vehicle.

- To avoid the undesirable effects of individual jurisdictions adopting widely varying and potentially conflicting standards governing wheelchair securement, it is imperative that recommended guidelines and/or standards be established at the earliest instance. Since the problem is national in scope and bears directly on the health, safety, and welfare of a significant number of people, the participants at the National Workshop on Wheelchair Securement Systems in session on December 11, 1980, recommend that UMTA immediately undertake the preparation of the guidelines and/or standards with technical assistance from such other Federal agencies to be provided as UMTA may require.

- Interaction of users, industry, and government includes the political processes. We recommend identification of the constituent groups, and their activism in testimony, letters and petitions to legislative and regulatory bodies to increase the safety of wheelchair securement and restraints used in transportation. We note that there are some 400,000 users of wheelchairs in the United States, some 0.2 percent of the population, and some 10 percent of the population with significant handicap or infirmity in transportation. We recommend that these groups make their needs known.

- The final report of this conference shall allow comment by each individual participant to be recorded before any conference proceeding, report, recommendations, or final guidelines are published.

B. DESIGN

1. General

- Performance standards for wheelchair restraint devices and, when appropriate, passenger securement should be developed. Manufacturers appear to prefer performance-oriented standards to design-oriented standards. Performance standards promote the development of innovative concepts without unduly restricting the design.

- All design standards should be minimum requirements, and manufacturers should be encouraged to provide performance capabilities beyond the minimum requirements.

- Manufacturers should certify to the appropriate governmental agency that their securement device complies with the requirements.

2. Wheelchair Securements

- Wheelchair securement design should vary according to transportation mode, to properly consider the design parameters of each mode. Overdesign should be avoided.

  The impact pulse has been the subject of much discussion and controversy in the area of wheelchair securement performance. One of the significant achievements of this workshop has been the discussion of the appropriate test impact pulses and the subsequent general agreement reached by all involved groups. It is generally agreed that the severity of the impact test depends on the intended use of the device or system being tested. For example, a system which is to be used exclusively for heavy rail transit would require only low level deceleration and velocity levels in an impact test; on the other hand, a system for use by passengers or drivers of vans would require testing at much more severe levels. A system or device which does not have a specific end use, but which will be marketed for a range of transit modes, will also need to be tested for the worst case transportation mode of its intended or potential use. The recent bus crash test results by Minicars as well as other available crash test data for vans and automobiles provide a significant basis for determining the crash test pulses for the different transit modes.

- Rail Mode - Automatically controlled rail operations do not require securements other than wheelchair brakes and partitioning to limit sliding. Non-automatically controlled systems require that securement of the wheelchair be provided to restrain its mass and that of the occupant against longitudinal and lateral forces, perhaps securing the chair at an impact of 10 mph and 5 g's. The passenger should be secured to the wheelchair.

- Highway Modes - Securement design should be based on frontal impacts since they are the most frequent and most severe impacts.

  - Large bus transit - Securement design should restrain the wheelchair (and the passenger) against an impact of 20 mph, 10 g deceleration with a 100 millisecond duration.

  - Paratransit - Designs should consider velocities up to 30 mph, with a deceleration of 20 g, 100 millisecond duration.

  - Private vans - Designed protection should be similar to that of the automobile: 30 mph velocity, 30 g deceleration and 110 millisecond duration.

- Fatal or severe injury is usually the result of the passenger striking harsh objects within the vehicle. Therefore, provision of adequate excursion (movement) space free of objects, or limitation of such excursion should be of prime concern.

- Wheelchair restraints should fit a majority of wheelchairs without necessitating alteration of the wheelchairs.

- For those chairs which can not be accommodated, back-up restraints should be provided. They should be simple and retracting.

- Private vans should contain restraints customized for the specific wheelchair used by the driver. These securements should attach to the frame of the chair to provide maximum safety.

- The wheelchair restraint device must accommodate wheelchairs with footrests one inch from the ground plane.

3. Passenger Restraints

- Seat belts which are intended to secure the occupant of a wheelchair should be directed exclusively to that purpose, i.e., they should not perform the dual function of wheelchair restraint.

- The type of occupant or passenger restraint which is recommended depends to a great extent on the particular mode of transportation being considered. Minimally, the same level of protection which is provided to the non-disabled must be provided to the wheelchair user. Beyond this minimal requirement, however, the physical limitations of many of those confined to wheelchairs should be considered. In recognition of these considerations, the following recommendations are made regarding the installation of passenger restraint systems.

- For fixed-route buses and light and heavy rail transit vehicles, passenger restraint should not be provided unless subsequent scientific data indicates a need for such protection.

- In small buses and vans used for paratransit, a lap belt secured to the vehicular structure must be provided. A shoulder restraint should also be provided when the interior of the vehicle allows for proper anchorage.

- In privately owned vans, a shoulder and lap belt restraint system secured to the vehicular structure is required in at least one passenger location, and the driving position if the individual drives from his wheelchair.

- The design of restraints intended for use by individuals driving vans from wheelchairs should reflect the individual's specific physical capability to engage the system.

- The size of the passenger considered in designing a restraint should be respresentative of the transportation mode for which the restraint is intended, i.e., for a school service, consider a young child rather than an adult male.

- Each securement should be capable of securing a 95th percentile adult male under the worst conditions applicable to the specific transportation mode.

- As a long-term goal, the U.S. DOT, in conjunction with major wheelchair manufacturers, should initiate development of a wheelchair armrest which allows the proper positioning of a lap belt across the pelvic skeletal area.

4. Human Factors

In addition to the structural material and mechanical aspects of design, there are other human factors which should be considered in securement design including:

- Ergonomic requirements (operational handling) - Consideration for both hands-on and hands-off service should include handling of controls, forces, position and size of levers, identification of functions, etc. In addition, handicapped drivers and wheelchair occupants using public transportation must have wheelchair securement systems which secure without assistance from other persons.

- Psychological requirements - The development of systems should try to avoid a clinical technical appearance and emphasize more transportation environmental factors -- shape, color, touch, materials, surfaces, esthetics.

5. Wheelchair Orientation

- Previous and current research has shown that there are definite advantages to some seating positions over others. For example, the rear-facing position is definitely the preferred position for frontal accidents; however, a rear-facing position has obvious disadvantages for some applications such as the driver of a van. The forward-facing orientation is the next preferred position from a safety standpoint and is recommended over side-facing. The side-facing orientation, however, may be acceptable when accompanied by adequate and appropriate side support.

6. Maintainability

- All securement devices should be easily maintainable in order to insure vehicle availability.

7. Wheelchair Design

- Wheelchair manufacturers should recognize that their chairs are being used in transportation and consider modifications or adaptations to current and future designs to facilitate their securement and sustain user loadings caused in dynamic crashes, such as passenger belt attachment points, standardized clearance, removal of appurtenances which project from the wheelchair and obstruct or inhibit securement.

- All wheelchair manufacturers should be notified by the U.S. DOT as to the need for a common set of interface points on all wheelchairs.

8. Test Procedures

- It is clearly recognized that dynamic impact testing (rather than static) is required to obtain results which are indicative of real world conditions. This fact has been realized for some time with regard to performance testing of securement devices for general automotive applications, and it is especially important for wheelchair situations, where the couplings between the wheelchair and securement device and the passenger and wheelchair result in complex dynamic loading patterns which cannot be reasonably sinmulated or estimated with static tests. It is also recognized, however, that static testing can still play an important part in the research and evaluation process for determining component strengths, for example, but should not be relied upon for the final performance evaluation of a total system.

- With regard to instrumentation and data processing for dynamic tests, the procedures for FMVSS 208 for automotive restraint system testing should be adopted for wheelchair test situations as well. They involve the use of triaxial head and chest accelerometer packages for determining head injury criteria (HIC), and peak chest restraint acceleration over a specified time interval, as well as femur and seat belt load cells.

- Two other important considerations which must be included in any attempt to standardize test procedures are with regard to the use of a standard wheelchair model or models for testing, and the development of representative and standardized tests for simulating the impact environments of the various transit modes. These issues have not been seriously addressed at this workshop and need further discussion and consideration in the future.

- Another important realization which has become apparent from the discussions of this workshop and which relates to the procedures for evaluating a securement system, is that even for public transit situations where the primary purpose of a securement is to secure only the wheelchair without concern for passenger restraint, the performance test must consider the worst case situation where the wheelchair user is lap belted to his/her chair. Thus, all tests should include the use of an anthropomorphic test dummy lap belted to the wheelchair -- whether or not the intended application of the wheelchair securement device involves a transportation mode where passenger restraint is considered important.

In order to best evaluate a product, test procedures should meet the following requirements:

- Test procedures should be defined such that the final results will not only provide a success/failure boundary but also will provide some quantitative grading for the systems that succeed. The success/failure boundary can be the minimum requirement and the quantitative grading of success can be disseminated to the manufacturers and the consumers to promote fair and healthy competition.

- Test procedures should be general enough to be able to accommodate the system concept/design variation. Yet they should meet the basic needs of repeatability.

- Test procedures should specify operational requirements, such as ease of ingress/egress and ease of deployment, as well as accident crash protection requirements.

9. Advanced Research

- We recommend that government and industry support advanced research in wheelchair securement design, to provide increased safety and ease of use and/or decreased weight and cost. We consider the cost of improved wheelchair securements and designs to be potentially within the range of the costs of present devices. Increased safety or ease of use is not necessarily more expensive. We recommend cooperative research and development among universities, industry, and government, with involvement, at least in the final stages of development, of those with production capability. Research is recommended on universal and automatic securements for any wheelchair size and design, on head and distributed load, on the potential for side support of wheelchairs with improved stall barriers and padding, and on the special tolerance limitations of the handicapped and infirm, notably bone strength limitations when restrained by narrow belts.

- To the extent practicable, all modes of public transportation should have universal wheelchair securement devices within each mode. This necessarily requires standardized fittings at prescribed points on the wheelchair to permit effective coupling to the securement device. Research in this area should be undertaken and take into account the following considerations: strength of the wheelchair; alternative attachment positions relative to the chair or passenger's center of gravity; maintenance of the chair's dimensions; possible added weight to the chair; and cost.

- One area which certainly needs additional work is accident data collection, analysis, and assimilation to quantify the level of protection that can be cost beneficial. Such work can be undertaken in conjunction with other potential problem areas to pool the sources of funds. One such example is to apply the accident data which defines the requirements of normal bus seats to wheelchair securement systems.

C. LIABILITY

- Liability is an issue for manufacturers, retrofitters, and providers which should be a motivating factor in the development of standards. To the extent practicable, the standards should reflect the parameters within which liability exists.

- The use of standardized testing through independent research and testing facilities will give the manufacturer of wheelchair securement systems the only legal basis of defense in the case of a law suit. The manufacturer and installer will remain liable for installing the systems properly and making sure that the proper securement system is installed in the right type of vehicle. Training in proper installation of the system is considered mandatory for the manufacturer. periodic and documented quality control must be maintained by the manufacturer.

- Operator and users must be physically trained in the proper operation of the systems by the manufacturer/vendor and eductated to the consequences of improper engagement. Written material concerning proper operation must also be supplied, and in the case whereby the user must independently operate the system written and illustrated instructions should be posted in clear view.

D. COORDINATION

- At times we get the feeling that different administrations, agencies of DOT, try to have their own selected limited responsibilities. For example, UMTA claims that safety regulations are NHTSA's responsibility. It should be recognized that the wheelchair issue must be treated at the system level where wheelchair designs, securement systems and passenger protection are addressed in a coordinated fashion.

- We recommend the designation of a lead Federal agency to address wheelchair restraint needs for all transportation modes. Such an agency should be responsible for assisting transit agencies, users, and manufacturers in addressing all aspects of wheelchair and passenger restraints (i.e., safety, operation, maintenance, cost, design).

- As soon as it is practical, a set of interim performance standards should be developed based upon the recommendations of the National Workshop on Wheelchair Securement Systems. Appropriate local, state, and Federal agencies should be involved in development of these standards. Additionally, a national advisory group representing handicapped consumers, transportation providers, product manufacturers, technical personnel, and others should be involved in this issue on an ongoing bases.

- A number of groups are involved in securement research, development, and testing without being fully aware of the total activity in the field. In view of the benefits of a coordinated, unduplicated, and planned effort, it is recommended that an appropriate body be designated to act as a coordinator and to investigate a means of developing a coordinated development effort. As part of this coordination effort, more workshops, seminars, and conferences should be arranged.

- One important benefit of a coordinated and centrally supported research effort would be the standardization of, or at least agreement on, a set of test procedures for developing and evaluating wheelchair securement systems. This is necessary if the results from different investigators and test facilities are to be meaningful and comparable. This workshop has been a significant step in moving toward this goal.

E. FUNDING

- It is recognized that coordinated funding disbursement is required to utilize the available funding support in the most cost-effective fashion. We recommend continued, better coordinated funding of this problem.

- One way of identifying the need for additional work will be to ascertain and assess the work already completed at different places and then identify the data gaps or data duplication. By following such a procedure, unnecessary duplication of work will be minimized and every dollar spent will be effectively utilized.

- Each of the recommended activities is going to require some level of funding from some source. The exact source and amount need to be identified through a single coordinated program. Possible sources of obtaining such funds can be: Federal agencies; state agencies; local agencies; interest groups; charitable organizations, such as the Easter Seal Society; and industry itself.

- Wheelchair securement system devices are relatively low cost, low volume items and this limits the manufacturers' ability to test their products. There is a need to test currently available devices and proposed designs to assure a minimum level of effectiveness. To meet this need a separately funded system should be established to test devices submitted by manufacturers. Submitted devices would be screened by an independent committee, and a fee would be charged to assure that the test facility was not abused. All devices would be subjected to standardized tests and all results would be made public as soon as testing was completed. Care must be made to assure equal access to all manufacturers, as well as the autonomy of the test facility staff.

F. COMMUNICATION

- UMTA should establish an appropriate communications network for dissemination of information relating to all areas of wheelchair securement. The information to be assembled and distributed by UMTA should include:

  a. Summary of the state of the art
  b. Plans for filling knowledge gaps through further study
  c. Dissemination of information on new developments to persons concerned
  d. Product information, including warranty and liability
  e. Product capital and maintenance costs
  f. Product servicing requirements; advantages, disadvantages
  g. Product adaptability to interface with other products
  h. Special training required to operate securements, if any.

- The last three days of discussion have shown that there are a number of different terms we have been using to describe the same things, e.g., wheelchair tie-downs, securement systems, wheelchair restraints. At least in the record of this workshop, we should use the same term consistently and provide a brief glossary of terms that have been used.

- Our key concern is that the different groups interested in wheelchair securement systems be aware of one another and the different resources available. We believe that the clearinghouse entitled Elderly and Handicapped Transit Technology Transfer Program, at the Transportation Systems Center, would be an excellent means of achieving this end. Prompt and full disclosure of the results of testing and research are of particular importance.

- Whatever the structure of the system, it will only be effective if all of us accept the responsibility to both contribute and seek out information. Investigators must publish their results quickly, in a form that would be useful to other interested parties; in addition, manufacturers and others who want the information should recognize the need to seek out that information.

- This conference has served well to initiate this kind of communication and we believe that it would be worthwhile to maintain the momentum we have achieved.

APPENDIX A

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LIST OF PARTICIPANTS

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APPENDIX B

MANUFACTURERS OF WHEELCHAIR SECUREMENT SYSTEMS*

This information has been taken from the draft compendium of systems and equipment used internationally in the transportation of the mobility disadvantaged, prepared by Transport Canada's Research and Development Centre.

*Not all entries have been verified for accuracy by the manufactuers.

W H E E L C H A I R   S E C U R E M E N T   S Y S T E M S

MANUFACTURER	TYPE	POINT OF ATTACHMENT TO ... VEHICLE: FLOOR	VEHICLE: WALL	WHEELCHAIR WHEEL: RIM	WHEELCHAIR WHEEL: TIRE	WHEELCHAIR FRAME: FORWARD POST	FRAME: FOOTREST	FRAME: CASTER ARCH	FRAME: BOTTOM RAIL	FRAME: CROSS BRACE	FRAME: BACK POST	REMARKS
1. ABC ENTERPRISES	(i) Rim Pin	X	X	X								Manual
	(ii) T-Bar	X							X			
	(iii) Channel & Strap		X	X								
2. AEROQUIP CORPORATION	(i) 3 Point Belt	X				X				X		Manual
	(ii) 4 Point Belt	X				X					X	
	(iii) "One-Buckle"	X				X					X	
3. AMERICAN SEATING CO.	Wheel Lock			X								Semi-Automatic. Lock is on the bottom of a two-person flip transit seat. Passenger belt available.
4. AMF	2 Stabilizing Bars with 3 Belts	X				X					X	Manual
5. ATLANTIC RESEARCH CORP.	(i) Automatic Rim Clamp	X		X								(i) Wheelchair Driver
	(ii) Wall Rim Pin	X		X								(ii) Manual
6. BRAUN CORPORATION	(i) Over-the-Center	X						X				All systems manual, for wheelchair passengers, except (ii) for wheelchair driver.
	(ii) Electric Tie Down	X				X						
	(iii) Cam Lock	X					X					
	(iv) Belt & Track	X				X					X	
	(v) Wall Rim Pin	X		X								

W H E E L C H A I R   S E C U R E M E N T   S Y S T E M S

PAGE 2

MANUFACTURER	TYPE	VEHICLE: FLOOR	VEHICLE: WALL	WHEELCHAIR WHEEL: RIM	WHEELCHAIR WHEEL: TIRE	WHEELCHAIR FRAME: FORWARD POST	WHEELCHAIR FRAME: FOOTREST	WHEELCHAIR FRAME: CASTER ARCH	WHEELCHAIR FRAME: BOTTOM RAIL	WHEELCHAIR FRAME: CROSS BRACE	WHEELCHAIR FRAME: BACK POST	REMARKS
7. COACH & CAR EQUIPMENT	Rim Pin			X								Semi-Automatic. Lock is on the bottom of a two-person flip transit seat.
8. COLLINS INDUSTRIES INC.	Wall Rim Pin	X		X								Manual, Semi-Automatic and Automatic Models.
9. CREATIVE CONTROLS INC.	Powered Framelock	X										Attached to adaptive hardware mounted on wheelchair. Primarily wheelchair driver application
10. CROW RIVER INDUSTRIES INC.	(i) 3 Point Belt	X						X		X		
	(ii) 4 Point Belt	X				X					X	
11. DRIVE-MASTER Corp.	(i) Wall Rim Pin	X		X								(i) & (ii) Manual
	(ii) Cross Brace to Floor	X								X		
	(iii) Automatic Driver Lock	X				X						(iii) Wheelchair Driver Application
12. DYNAMIC MOBILITY	(i) Driver Securement	X										(i) Automatic. Attaches to reinforcing hardware mounted on chair.
	(ii) Over-Center Load Binder	X				X						
13. ELECTRO VAN LIFT INC.	Lock Down	X				X						Automatic
14. GRESHAM DRIVING AIDS	(i) Rod & Hook Assembly	X										(i) Manual various points of attachment
	(ii) Electric Tie Down	X			X							(ii) Wheelchair Driver
	(iii) T-Bar	X							X			(iii) Manual

WHEELCHAIR SECUREMENT SYSTEMS

MANUFACTURER	TYPE	POINT OF ATTACHMENT TO ... VEHICLE: FLOOR	VEHICLE: WALL	WHEELCHAIR WHEEL: RIM	WHEELCHAIR WHEEL: TIRE	WHEELCHAIR FRAME: FORWARD POST	FOOTREST	CASTER ARCH	BOTTOM RAIL	CROSS BRACE	BACK POST	REMARKS
14. HANDICAPS INC.	Wheelwell and Belt Combination	X										Wheels rest in wheelwell. Belt attached to floor wraps over armrests.
15. HANDI-RAMP INC.	(i) User & Chair Belt	X or	X			X						Manual
	(ii) Rim Pin	X or	X	X								
16. MOBILITY DYNAMICS INC.	T-Bar	X							X			
17. CHAS. OLSEN & SONS	Manual Framelock	X or	X			X						Floor track installation requires panel assemblies. User/attendant operated.
18. PARA INDUSTRIES (1978) LTD.	(i) T-Bar	X							X			
	(ii) Electric Tie Down	X										(ii) Cross bar welded between bottom rails of wheelchair.
19. R. J. MOBILITY SYSTEMS	Adjustable Anchor Rod	X								X		Manual
20. ROOTES MAIDSTONE LTD.	Stemlock Clamp	X							X			Manual
21. SASKATCHEWAN COUNCIL FOR CRIPPLED CHILDREN & ADULTS	Hook and Cable	X								X		In conjunction with wheelchair-ambulatory flip seat.

W H E E L C H A I R   S E C U R E M E N T   S Y S T E M S

MANUFACTURER	TYPE	FLOOR (VEHICLE)	WALL (VEHICLE)	RIM (WHEELCHAIR – WHEEL)	TIRE (WHEELCHAIR – WHEEL)	FORWARD POST (WHEELCHAIR – FRAME)	FOOTREST (WHEELCHAIR – FRAME)	CASTER ARCH (WHEELCHAIR – FRAME)	BOTTOM RAIL (WHEELCHAIR – FRAME)	CROSS BRACE (WHEELCHAIR – FRAME)	BACK POST (WHEELCHAIR – FRAME)	REMARKS
22. FRED SCOTT & SONS	Translock (T-Bar)	X							X			User Belt Provided
23. SKILLCRAFT INDUSTRIES INC.	T-Bar	X							X			
24. TARGET INDUSTRIES INC.	Speedylock											
25. TRANSPORTATION DEVELOPMENT CENTRE	(i) Securement Arm	X &	X		X							Lap Belt Provided (i) Train application
	(ii) Securement Arm	X &	X		X							(ii) Multi-Modal Application
	Multi-Modal Securement Arm											Lap + Torso Belt Provided
26. TRANSI-LIFT EQUIPMENT	Automatic Rim Clamp		X	X								User Operated
27. C. N. UNWIN LTD.	Stemlock Clamp	X							X			Manual

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Electro Van Lift, Inc.
140 Concord Street
St. Paul, MN 55107
(612) 298-0721

Gresham Driving Aids
P.O. Box 405
30800 Wixom Road
Wixom, MI 48096
(313) 624-1533

Handicaps, Inc.
4335 South Santa Fe Drive
Denver, CO 80110
(303) 781-2062

Handi-Ramp
1414 Armour Blvd.
Mundelin, IL 60060
(312) 566-5861

Medicab, Inc.
68 Runyon Ave.
Yonker, NY 10710
(212) 798-5380

Midwest Handicap Equipment Co.
510 North 5th Street
St. Charles, MO 63301
(314) 724-0400

Mobility Dynamics
21029 Itasca Avenue
Chatsworth, CA 91311
(213) 998-1026

Charles Olson and Sons
677 Transfer Road
St. Paul, MN 55114
(612) 641-3900

Para Industries
74 Jamie Street
Nepean, Ontario K2E 6T6
Canada
(613) 226-5506

R. J. Mobility Systems
715 South 5th Avenue
Maywood, IL 60153
(312) 344-2705

Rootes Maidstone Ltd.
Mill Street
Maidstone, Kent
England
Maidstone 53333

Saskatchewan Council for
Crippled Children and Adults
1410 Kilburn Avenue
Saskatoon, Saskatchewan S7M 0J8
Canada
(306) 653-1694

Fred Scott and Sons
1444 Rand Road
Des Plaines, IL 60016
(312) 297-1603

Skillcraft Industries
1270 Ogden Road
Venice, FL 33595
(813) 488-1501

Target Industries
55 Newbury Road
Warehouse Point, CT 06088
(203) 627-9329

Transport Development Centre
1000 Sherbrooke Street West
Montreal, Quebec H3A 2R3
Canada
(514) 283-4072

Transi-Lift Equipment, Inc.
4826 11 Street, N.E.
Calgary, Alberta T2E 2W7
Canada
(403) 276-7818

C. N. Unwin Limited
Adam's Peak Works
Lufton
Yeovil, Somerset BA22 857
England

APPENDIX C

GLOSSARY

ACCELERATION

Rate of change of velocity or the change in velocity per unit of time. The magnitude of acceleration is indicated in terms of g's and sometimes can be used interchangeably with deceleration; acceleration is the increase in velocity and deceleration is the decrease in velocity.

ACCELERATION AMPLIFICATION FACTORS

Due to a complex interaction between the mass segments of a body, if a vehicle impacts at a specific g level, parts of the body may experience higher g levels.

ACCESSIBILITY

Designates a transportation facility or service which does not have barriers which prevent its use by all travellers.

ANTHROPOMORPHIC TEST DUMMY

A dummy with body components resembling those of a human with respect to size, shape, mass, and kinematics.

BACK-UP SECUREMENT

A device or devices used to prevent continued movement of the dummy and chair in the event the securement system being tested fails upon sled impact. The device is usually a belt(s) or rope. A back-up securement can also refer to a device, often a belt, which can be used in the event the regular securement in a vehicle does not accommodate a specific wheelchair.

BELT

A securement system consisting of webbing.

FOUR POINT BELT SYSTEM

A securement system consisting of belts which attach to the wheelchair or vehicle at four different locations.

BELT AND TRACK

A securement system consisting of belts and a track. The track is attached to the vehicle wall or floor, and has holes or slits into which the belts can be hooked.

BODY ON CHASSIS

A vehicle which has a body added to a light truck chassis, similar to school bus construction.

BUS, MINIBUS

A minibus is any one of a number of different vehicles which are all smaller than a standard transit bus, and usually have the engine in the front of the vehicle.

BUS, SMALL TRANSIT

A 25- to 35-foot integrally constructed bus, similar in construction to a standard transit bus.

BUS, STANDARD TRANSIT (Also LARGE TRANSIT)

A 40-foot bus commonly used in fixed-route services. The engine is in the rear of the bus.

CAM LOCK

A friction type of lock which revolves eccentrically on a shaft.

CHAIR

Wheelchair.

CHANNEL AND STRAP

A securement device which utilizes straps, or belts, and a device (channel) which guides the movement of the straps at a particular point.

CHEST SEVERITY INDEX (CSI)

Method of measurement used to approximate the severity of a crash as it relates to the chest.

CONTAINMENT

Limitation placed on the movement of a wheelchair and passenger inside the vehicle.

CRASH TEST PULSE

The deceleration, velocity, and time duration of an impact event.

CRASHWORTHINESS

A measurement of the ability to resist the effects of a collision.

DECOUPLING EFFECT

Implies that because a wheelchair and passenger are not rigid with the dynamic test sled, due to the looseness between the wheelchair securement system and the wheelchair and passenger, they will experience different g's from the test sled during an impact.

D RING

A retaining ring made in the shape of the letter "D".

DESIGN GUIDELINES (Or STANDARDS)

Guidelines which recommend specific construction, materials, etc., in the production of an item.

DUMMY

(See ANTHROPOMORPHIC TEST DUMMY).

DYNAMIC LOADING

Rapid, as opposed to slow (static), loading.

DYNAMIC TESTING

A test which creates dynamic forces by accelerating or decelerating an object.

ELDERLY AND HANDICAPPED TRANSIT TECHNOLOGY TRANSFER PROGRAM

A cooperative program of the Urban Mass Transportation Administration, Office of Socio-Economic and Special Projects, and the Transportation Systems Center, Office of Technology Sharing. The program will develop and operate a central clearinghouse of information on research results and operating experience relating to elderly and handicapped people's local options in public transportation.

ERGONOMICS

The aspect of technology concerned with the application of biological and engineering data to problems relating to humans and machines.

EXCURSION

The distance traveled by the wheelchair or anthropomorphic dummy, from an initial position, relative to the test sled.

FHWA

Federal Highway Administration, an agency of the U.S. Department of Transportation.

FIXED-ROUTE SERVICE

A regularly scheduled service operating over a set route.

FMVSS

Federal Motor Vehicle Safety Standards

- No. 207 - Seating Systems
- No. 208 - Occupant Crash Protection
- No. 209 - Seat Belt Assemblies
- No. 210 - Seat Belt Assembly Anchorages
- No. 222 - School Bus Passenger Seating and Crash Protection

FRAME ANCHOR

A method of securement which attaches the frame of the wheelchair to the vehicle. Securements which use this method consist of belts, chains, clamps, or T-bars.

FRAMELOCK

(See FRAME ANCHOR)

g

A unit of acceleration exerted by gravity on an object. The force, F, resulting from an acceleration of n g's on an object's mass of M is equal to n times M, F=n x M.

HANDS-OFF SYSTEM

A securement system which can be operated (attached or released) by the wheelchair passenger without assistance.

HANDS-ON SYSTEM

A securement system which requires the vehicle driver or an attendant to assist the passenger in operating the system.

HARDWARE

The individual parts that make up a securement system.

HEAD INJURY CRITERIA (HIC)

Method of measurement used to approximate the severity of a crash involving the head.

HSRI

Highway Safety Research Institute, of the University of Michigan.

IMPACT PULSE

(See CRASH TEST PULSE)

IMPACT TEST

(See DYNAMIC TESTING)

JACKKNIFE

A motion resulting from an impact in which the dummy bends forward around the securement belt; its arms and legs are outstretched forward and together, so that the dummy's body is bent at the waist area and is approximately horizontal with the floor.

LOAD CELLS

A transducer device which measures force in terms of an electrical signal.

LOADED CHAIR

A wheelchair with a person secured to the wheelchair.

MODE (TRANSIT MODE)

A particular form of travel, i.e., rail, bus, walking, etc.

NHTSA

National Highway Traffic Safety Administration, a department of the U.S. Department of Transportation.

PANIC STOP

An emergency stop required to avoid an accident. Typical deceleration rates would range from 0.3 g to 0.5 g.

PARATRANSIT

Flexible transportation services operated publically or privately. Typically small-scale operations using low capacity vehicles.

PASSENGER RESTRAINT

A device, or combination of devices, which secures a wheelchair passenger within a vehicle against forces occurring from the front, back, or sides of the vehicle. One component of a total wheelchair securement system.

PEAK CHEST RESTRAINT ACCELERATION

Peak force of a restraint device measured at the chest location during changes in motion.

50TH PERCENTILE MALE DUMMY

A dummy which represents the median in the male population with regard to height and weight (i.e., a male weighing 160 pounds.)

95TH PERCENTILE MALE DUMMY

A dummy which has measurements of height and weight which are greater than 95 percent of the male population.

PERFORMANCE STANDARD

A standard which specifies a minimum level at which a device should perform regardless of its design.

PULSE

(See CRASH TEST PULSE)

RATCHET BUCKLE

A buckle which provides a means of tightening a belt or strap mechanically.

RESTRAINT ARM

A passenger restraint which is generally an arm which lies perpendicular to a wheelchair passenger's body at chest level. It is often attached to the wall and swings out to secure the passenger.

RESTRAINT SYSTEM

(See WHEELCHAIR SECUREMENT SYSTEM)

RIM CLAMP

(See WHEEL ANCHOR)

RIM PIN

(See WHEEL ANCHOR)

SECONDARY IMPACT

A second collision that occurs after an initial collision, such as a vehicle's striking one object with a glancing blow (initial impact) and continuing on to strike another object.

SECTION 13(c)

A section of the Urban Mass Transportation Act of 1964, as amended, which protects collective bargaining rights and assures that wages and working conditions will not be adversely affected by Federally funded programs.

SECTION 16(b)(2)

A section of the Urban Mass Transportation Act of 1964, as amended, which provides money to each state by formula to help private nonprofit organizations provide for the special transportation needs of elderly and handicapped persons that are not currently being met.

SECTION 18

A section of the Urban Mass Transportation Act of 1964, as amended, which provides money to states by formula to assist local public agencies, non-profit organizations, and operators of public transportation services in the provision of services in rural and small urban areas. Provides 80 percent of the capital costs and 50 percent of the operating cost deficits of these projects.

SECTION 504

A section of Title V, Rehabilitation Act of 1973, which states that handicapped people cannot be discriminated against under any program or activity receiving Federal financial assistance solely by reason of their disability.

SECTOR

Used in this report to refer to areas of activity relating to wheelchair securement, such as research, evaluation and testing, product development, and utilization.

SECUREMENT SYSTEM

(See WHEELCHAIR SECUREMENT SYSTEM)

SLED

The moving platform used in a dynamic test.

STATIC TESTING

A test which applies a specified force (a weighted load) to a stationary object in order to evaluate the resulting movement and/or deformation of the object.

T-BAR

A wheelchair restraint which is a horizontal bar placed between the wheels of the wheelchair. Each end of the bar grabs onto the lower wheelchair frame, and a vertical rod or screw in the center of the bar attaches the bar to the floor.

TETHER

Attachments to the anthropomorphic dummy or the wheelchair to prevent excessive differential movement between either of these objects and the sled during the acceleration phase of a test. They become inactive either before or upon sled impact.

TIE-DOWN

A wheelchair restraint.

TRIAXIAL CHEST ACCELERATION

An acceleration experienced by the chest from any three directions.

TRIAXIAL HEAD ACCELERATION

An acceleration experienced by the head from any three directions.

UMTA

Urban Mass Transportation Administration, an agency of the U.S. Department of Transportation.

UNIVERSAL SECUREMENT

A securement system that accommodates all wheelchairs and passengers.

VELCRO

Self-adhering fasteners which have a surface of little hooks or projections and fine loops.

WHEEL ANCHOR

A method of wheelchair restraint which anchors the rim of a wheelchair's wheel(s) to the wall or floor of the vehicle. The restraint device is usually a clamp, or a rod or pin, placed between U-shaped brackets.

WHEELCHAIR ORIENTATION

The direction a wheelchair and passenger face with respect to the direction of travel of the vehicle or test sled.

WHEELCHAIR RESTRAINT

A device, or combination of devices, which secures the wheelchair within the vehicle against forces occurring from the front, back, or sides of the vehicle.

WHEELCHAIR SECUREMENT SYSTEM

Device, or combination of devices, including any installed on the wheelchair, which acts to fasten the wheelchair to the vehicle and the passenger to either the wheelchair or the vehicle in order to secure the wheelchair and passenger within the vehicle against forces occurring from the front, back, or sides of the vehicle.

APPENDIX D

STANDARD FOR WHEELCHAIR SECUREMENT DEVICES

STATE OF MINNESOTA

OFFICE OF THE CHIEF
MINNESOTA STATE PATROL
107 TRANSPORTATION BUILDING
(612) 296-3080

STATE OF MINNESOTA
DEPARTMENT OF PUBLIC SAFETY
SAINT PAUL 55155

TO : Providers of Wheelchair Transportation Service — DATE: October 26, 1979

FROM : Colonel D. Roger Ledding
Chief

SUBJECT: Wheelchair Securement Devices

Effective November 5, 1979, it will be unlawful to transport a person in a wheelchair by motor vehicle unless the wheelchair is secured to the vehicle and the occupant of the wheelchair is restrained by at least one strap or belt encircling the person and the backrest of the wheelchair. The restraining strap or belt cannot be the same device which is used to secure the wheelchair.

The law applies ".....to any person, firm, partnership, corporation, service club, public or private agency, city, town or county...." transporting by motor vehicle "...any sick, injured, invalid, incapacitated or handicapped individual while occupying a wheelchair, which transportation is offered or provided by any operator to the public or to its employees or in connection with any other service offered by the operator including schooling or nursing home, convalescent or child care services." The law does not apply, at this time, to any school bus which is subject to regular school bus inspection.

The following is a copy of the law and a copy of the rules adopted by the Commissioner of Public Safety pursuant to Minnesota Statute 299A.18. Violation of the law or a rule is a misdemeanor punishable by a fine of up to $500 and/or 90 days in jail.

In general, the use of "approved" wheelchair securement devices is required. The approval process requires an application be completed and submitted to the Commissioner of Public Safety and that the adequacy of the wheelchair securement device be demonstrated by actual testing of the securement device installed in a motor vehicle and using a "loaded" wheelchair. The approval process will normally be handled by the manufacturer of the securement device or his agent.

Independent of the approval process, each wheelchair securement device installed in a vehicle must be "inspected" following installation and annually thereafter. The inspections will be conducted by the State Patrol. Upon successfully passing the inspection, an inspection certificate will be affixed to the lower left corner of the vehicle windshield.

Since it will take a few months to approve wheelchair securement devices and develop a stock of them in Minnesota and since providers of this specialized transportation service cannot be expected to switch over to "approved" securement devices on short notice, Rule 11MCAR1.0196 will permit the continued use of presently installed securement devices through December 31, 1980, if the device is in good operating condition and it prevents the occupied wheelchair from moving about in the vehicle. However, any securement device installed after December 31, 1979, must be of an approved type and after December 31, 1980, each wheelchair securement device installed in any vehicle must be of an approved type.

The law also requires the use of an occupant restraint to hold the person in the wheelchair. The occupant restraint cannot be the same device which secures the wheelchair. Until an "approved" securement device is installed in a vehicle, a suitable belt or strap can be used to encircle the occupant and the backrest of the wheelchair.

When an approved wheelchair securement device is installed, an approved occupant restraint must be simultaneously installed. Seat belt systems meeting Federal Motor Vehicle Safety Standard requirements are deemed to be approved when installed in accordance with Federal Motor Vehicle Safety Standard requirements. In effect, the rule requires a lap belt and shoulder belt arrangement (Type 2) or a lap belt (Type 1) and the use of a length of seat belt material to encircle the chest of the occupant and the backrest of the wheelchair. Universal seat belt assemblies are available through auto parts dealers and installation instructions accompany each set.

Members of the State Patrol will be in a position to inspect wheelchair securement devices shortly after November 1, 1979. We urge you to telephone the nearest State Patrol District Office at an early opportunity after that date to arrange for inspection. The telephone numbers are: Rochester -(507) 285-7407, Mankato - (507) 389-1171, Marshall -(507) 537-6277, East Metro -(612) 482-5905, West Metro -(612) 482-5902, St. Cloud -(612) 255-4224, Duluth- (218) 723-4888, Brainerd -(218) 828-2400, Detroit Lakes -(218) 847-5633, Eveleth -(218) 741-5575, Thief River Falls -(218) 681-3741.

Feel free to telephone the State Patrol at (612) 296-8052 if you have any questions.

Sincerely,

Colonel D. Roger Ledding
Chief
Minnesota State Patrol

DRL: RGL: bal

Adopted Rules
Effective November 5, 1979

Department of Public Safety
Safety Administration Division

Chapter 21: Standard for Wheelchair Securement Devices
11 MCAR 1.0188 Purpose, authority and scope.

A. Purpose. The purpose of these rules is to establish minimum standards for approval of wheelchair securement devices in vehicles and approval of seat belt assemblies and anchorages used to protect persons in wheelchairs while transported in vehicles.

B. Authority. These rules are promulgated pursuant to the authority granted by Laws of 1978, Chapter 752.

C. Scope.

1. These rules apply to the transportation by motor vehicle of any sick, injured, incapacitated or handicapped person while occupying a wheelchair, which transportation is offered or provided by an operator to the public or to its employees or in connection with any other service offered by the operator including schooling or nursing homes, convalescent or child care services.

2. These rules do not apply to any school bus subject to regular school bus inspection pursuant to Minn. Stat. 169.451 nor do they apply to incidental transportation of an occupied wheelchair under circumstances other than as provided in Paragraph (1) above.

11 MCAR 1.0189 Definitions.

For the purpose of these rules, the following terms shall have the meanings ascribed to them:

A. Anchorage. The provision for transferring wheelchair securement loads to the vehicle structure.

B. Commissioner. The Commissioner of Public Safety or his duly authorized agent.

C. Interior Paneling. Material used to finish the interior of a vehicle, not including the floor.

D. Occupant Restraint. A seat belt assembly and/or upper torso restraint intended to hold the occupant of a wheelchair in a generally seated position during transportation by motor vehicle.

E. Wheelchair. A chair mounted on wheels to facilitate the mobility of a sick, injured, invalid or handicapped person in a generally seated position. The term includes a device generally recognized as a wheelchair even though equipped with reclining backrest or special apparatus.

The term does not include any device not equipped with wheels, nor does it include an ambulance stretcher or cot whether equipped with wheels or not.

F. Operator. Any person, firm, partnership, corporation, service club, public or private agency, city, town or county.

G. Wheelchair Securement Device or Securement Device. An apparatus installed in a motor vehicle for the purpose of securing an occupied wheelchair into a location in the vehicle.

11 MCAR 1.0190 Wheelchair Securement.

A. An occupied wheelchair transported in a vehicle shall be secured with a securement device of sufficient strength to prevent forward, backward, lateral or vertical movement of the wheelchair when the device is engaged and the vehicle is in motion, accelerating or braking.

B. Each wheelchair securement device shall attach to the frame of the wheelchair without damaging the frame. "Damage" includes effects harmful to the strength, integrity or serviceableness of the wheelchair, but does not include minor dents, scratches or other cosmetic blemishes not materially affecting serviceableness.

C. A wheelchair securement device shall not be attached to a wheel of a wheelchair.

11 MCAR 1.0191 Minimum Standards.

Each wheelchair securement device shall:

A. Attach to the wheelchair frame on at least three (3) points. The three (3) points of contact shall be spaced to provide effective securement. Alternatively, a securement device meeting all other requirements of these rules may attach to two widely spaced points on the wheelchair frame if the wheel tires or the wheelchair frame abuts an unyielding surface in a manner which meets the approval requirements of 11 MCAR 1.0192.

B. Consist of at least two (2) webbing - type belts described in clause (1) or at least two (2) all-metal devices described in clause (2) or one or more of each such device.

1. Webbing-type devices shall be assemblies that meet or exceed Type 2 pelvic restraint seat belt requirements as specified in Section S4.2 (2) (b) of Federal Motor Vehicle Safety Standard No. 209, 49 Code of Federal Regulations, Part 571.209 (1977 edition) or be certified by the manufacturer that such device meets or exceeds assembly strength of 5,000 pounds in loop fashion or 2,500 pounds on each anchorage leg.

    a. Certification may be the specification listed in catalogs or publications by the manufacturer.

    b. All new construction of such securement devices and repairs to webbing shall conform with standards established by the manufacturer of the webbing.

2. All metal securement devices shall be of a design and construction which provides wheelchair securement strength at least equal to the strength of a webbing-type device comprised of three separate attachments and anchorages.

C. Be free of sharp edges, corners and jagged projections to minimize injury to persons in the event of unintentional contact.

D. Be capable of retraction, and be readily removable or otherwise suitably storable when not in use.

E. Be anchored to the vehicle at not less than two separate points with bolts, nuts and lock washers or self-locking nuts.

1. Bolts used shall be not less than 3/8 inch in diameter and of National Fine Thread S.A.E. grade 5 designation or equivalent.

2. Where anchorage bolts do not pierce the vehicle frame, subframe, bodypost or equivalent metal structure, a metal reinforcement plate or washer not less than 1/16 inches thick by 2 1/2 inches in diameter is required.

3. In no event shall interior paneling constitute anchorage for a point of securement.

4. A metal track, rail or similar device permitting attachment of the securement device at optional points thereon may be used to anchor the securement device, provided:

a. The track, rail or other device is secured to the vehicle in compliance with anchorage requirements of this rule.

b. The attachment of the securement device to the anchor point is by means of a positive attachment metal fitting.

F. The method or device which provides attachment of the securement device to the wheelchair frame and the method or device locking the securement device in the load-holding mode shall each be of a strength and design which will assure performance of their intended function until the securement device is intentionally released.

G. Buckles, anchorage fittings and other components essential to the functioning of the securement device shall be integrated into the securement device in accordance with recognized practices and in a manner which preserves the overall strength of the securement device.

11 MCAR 1.0192 Approval procedure.

A. Application for approval of a wheelchair securement device shall be made to the Commissioner and shall be accompanied by the manufacturer's actual or proposed written installation instructions and photographs or drawings clearly depicting the construction of the device and its physical characteristics, including all mounting hardware.

B. The applicant shall furnish a vehicle with the securement device installed therein and demonstrate the device by attaching it to a wheelchair furnished by the applicant. The Commissioner may load the wheelchair to 140 pounds and require the vehicle be accelerated, driven around corners and subjected to hard braking at speeds of thirty miles per hour or less. Movement of the wheelchair more than (1) inch in any direction, including vertically, during such test shall be grounds for refusal of approval. Measurement of movement shall be at the points where wheelchair wheels contact the floor. Damage to the wheelchair or any other property during such test shall be the responsibility of the applicant.

C. Upon determing that the securement device meets the requirements of these rules, the Commissioner shall issue a certificate of approval authorizing use of the device.

D. The Commissioner may revoke any approval granted hereunder upon a showing that the securement device does not meet a requirement of these rules.

E. Each wheelchair securement device shall be permanently labeled with the name, initials or trademark of the manufacturer and the model designation of the device. The label shall be readily visible and legible from the outside of the device when it is properly mounted to the vehicle and in use.

11 MCAR 1.0193 Occupant Restraint.

A. Each vehicle equipped with a wheelchair securement device shall be equipped with a Type 2 seat belt assembly with a detachable upper torso portion at each wheelchair position in the vehicle or, in the alternative, shall be equipped with a Type 1 pelvic restraint assembly and a length of Type 1 or Type 2 seat belt webbing, with buckle, adequate to encircle the chest of the wheelchair occupant and the backrest of the wheelchair.

B. Type 1 and Type 2 seat belt assemblies shall meet the requirements of Sections S 1 through S 4.4 of Federal Motor Vehicle Safety Standard No. 209, 49 Code of Federal Regulations, Part 571.209 (1977 edition).

C. Type 1 and Type 2 seat belt assemblies and the detachable upper torso restraint, if a detachable upper torso restraint is installed in lieu of using a length of seat belt webbing to encircle the chest of the occupant and the backrest of the wheelchair, shall be installed and anchored in accordance with Sections S 1 through S 4.3.2 of Federal Motor Vehicle Safety Standard No. 210, 49 Code of Federal Regulations, Part 571.210 (1977 edition).

11 MCAR 1.0194 Securement.

It shall be the responsibility of the driver of any vehicle equipped with a wheelchair securement device to:

A. Properly secure an occupied wheelchair prior to moving the vehicle unless the wheelchair occupant is capable of securing the device and does so.

B. Fasten the seat belt assembly, and upper torso restraint if so equipped, around the occupant of the wheelchair unless the occupant is capable of fastening same and does so. The driver shall not fasten the seat belt assembly or the upper torso restraint if the occupant or other responsible person advises the driver that to do so would aggravate a physical condition of the occupant. In the event the physical condition would be aggravated by the use of but one of the devices, the device which would have no effect on the physical condition shall be fastened in the required manner.

C. Retract, remove or otherwise store securement devices and seat belt assemblies when not in use to prevent tripping of persons and damage to devices.

11 MCAR 1.0195 Inspection.

The Commissioner may order the removal or correction of any securement device upon determining that the device, without regard to date of installation:

A. Is not capable of sustaining loads imposed thereon in restraining an occupied wheelchair, or

B. The securement device permits excessive movement of an occupied wheelchair.

11 MCAR 1.0196 Effective dates.

A. Wheelchair securement devices and occupant restraint systems installed in vehicles after December 31, 1979 must be of a type approved in accordance with these rules. After December 31, 1980, every vehicle included within the scope of these rules must be equipped with an approved wheelchair securement device and occupant restraint system at each wheelchair position.

B. From the effective date of these rules and until an approved wheelchair securement device is installed in a vehicle, no person shall transport an occupied wheelchair in a vehicle unless the wheelchair is secured to prevent forward, backward, lateral or vertical movement when the vehicle is in motion, accelerating or braking, and the occupant is restrained by at least one belt or strap.

299A.11 VEHICLES TRANSPORTING WHEELCHAIR USERS; DEFINITIONS. The following terms have the definitions given them for the purposes of Sections 299A.11 to 299A.18:

(a) "Wheelchair securement device" or "securement device" means an apparatus installed in a motor vehicle for the purpose of securing an occupied wheelchair into a location in the vehicle and preventing movement of that wheelchair while the vehicle is in motion.

(b) "Operator" means any person, firm, partnership, corporation, service club, public or private agency, city, town or county. The provisions of Laws 1978, Chapter 752, shall not apply to any school bus as defined in Section 169.01, subdivision 6, which is subject to regular school bus inspections pursuant to section 169.451.

(c) "Transportation service" means the transportation by motor vehicle of any sick, injured, invalid, incapacitated, or handicapped individual while occupying a wheelchair, which transportation is offered or provided by an operator to the public or to its employees or in connection with any other service offered by the operator including schooling or nursing home, convalescent or child care services.

299A.12 WHEELCHAIR SECUREMENT DEVICES. Subdivision 1. Any vehicle used by an operator to provide transportation service shall be equipped with wheelchair securement devices which are approved by the commissioner of public safety as meeting the specifications of this subdivision. A wheelchair securement device shall prevent any forward, backward or lateral movement of an occupied wheelchair when the device is engaged and the vehicle is in motion, accelerating or braking, and shall attach to the frame of the wheelchair without damaging it. Wheelchair securement devices installed in any vehicle shall be maintained in working order.

Subdivision 2. A vehicle used to provide transportation service shall carry only as many persons seated in wheelchairs as the number of securement devices approved by the commissioner of public safety as meeting the specifications of subdivision 1 with which the vehicle is equipped, and each occupied wheelchair shall be secured by such a securement device before the vehicle is set in motion.

299A.13 ADDITIONAL SAFETY REQUIREMENTS. Subdivision 1. Any vehicle used to provide transportation service shall be equipped with seat belts which are approved by the commissioner of public safety. The seat belts required by this subdivision shall be adequate to secure the occupant of a wheelchair who is being transported by the vehicle. These seat belts shall be used only to secure the person and shall not be used to secure the wheelchair. The seat belts shall meet all other applicable state and federal requirements for safety.

Subdivision 2. When transportation service is provided to an individual in an electrically powered wheelchair, the main power switch of the wheelchair shall be placed in the "off" position at all times while the vehicle is in motion.

299A.14 INSPECTION. Subdivision 1. No person shall drive and no operator shall knowingly permit or cause a vehicle to be used for transportation service unless there is displayed thereon a certificate issued upon inspection by the commissioner of public safety as provided in this section.

Subdivision 2. Inspection shall be made by personnel in the department of public safety assigned to the highway patrol. An operator of transportation services shall submit a vehicle for inspection after the installation of a wheelchair securement device in the vehicle and before using the vehicle for transportation service, but not later than one month after the date of installation. Evidence of the date of installation shall be provided by the operator at the inspection.

Subdivision 3. The inspection shall be made to determine that the vehicle complies with the provisions of sections 299A.12, subdivision 1 and 299A.13, subdivision1; that the securement device is in working order; and that the securement device is not in need of obvious repair. The inspection may include testing the use of a securement device while the vehicle is in motion.

Subdivision 4. A certificate furnished by the commissioner shall be issued upon completion of inspection if the vehicle complies with the requirements set forth in subdivision3. The certificate shall be affixed to the lower left corner of the windshield. It shall note compliance with this section, record the number of wheelchairs which may be simultaneously carried in the vehicle, and note the month and year in which the next inspection is required.

Subdivision 5. Subsequent inspections shall be made annually. If additional securement devices are installed in a vehicle already equipped with a securement device, inspection is required as specified in subdivision 2.

299A.15 AID AND LICENSES WITHHELD. No agency of the state, political subdivision or other public agency shall grant or approve any financial assistance to any operator for the purchase or operation of any vehicle used for transportation service or grant any permit or license otherwise required by law for operation of that service unless the operator of the transportation service complies with the provisions of sections 299A.11 to 299A.14.

299A.16 EVIDENCE. Proof of the installation or failure to install wheelchair securement devices, or proof of faulty installation of wheelchair securement devices, or proof of the maintenance or failure to properly maintain wheelchair securement devices, or proof of the use or failure to use wheelchair securement devices is admissible in evidence in any litigation involving personal injuries or property damage arising out of the use or operation of a vehicle providing transportation service. For the purposes of this section "wheelchair securement device" means such a device approved by the commissioner of public safety.

299A.17 PENALTY. For each failure to comply with any requirement of sections 299A.12, 299A.13 or 299A.14 an operator is guilty of a misdemeanor.

299A.18 RULES; APPROVAL OF DEVICES. The commissioner of public safety shall, no later than July 1, 1979, adopt rules containing standards for wheelchair securement devices that meet the requirements of sections 299A.12, subdivision 1, and 299A.13, subdivision 1, and shall approve or disapprove of securement devices that meet those standards.

APPENDIX E

WHEELCHAIR SECUREMENT REFERENCES

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