

# American National Standard

*for Wheelchairs –*

**Volume 4:**

**Wheelchairs and Transportation**

**Section 19**

**Wheelchairs Used as Seats in Motor Vehicles**

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# RESNA

Rehabilitation Engineering and Assistive Technology Society of North America

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### **RESNA**

Executive Director: **Nell Bailey**

**1700 N. Moore Street, Suite 1540, Arlington VA 22209**

Tel **703/524-6686**

Fax **703/524-6630**

TTY **703/524-6639**

E-mail **publications@resna.org**

Web **www.resna.org**

**RESNA Assistive Technology Standards Board** (formerly Technical Standards Board)

E-mail **technicalstandards@resna.org**

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## **Section 19**

### **Wheelchairs Used as Seats in Motor Vehicles**

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## Section 19 Introduction

Providing safer transportation for occupants of motor vehicles is a systems problem in which the vehicle seat plays a key role. A vehicle seat must be effectively secured so that its mass does not add to crash-generated restraint forces on the occupant and so that seatbelts will effectively limit occupant movement within the vehicle. The seat must be designed so that it does not interfere with proper placement of belt restraints on the occupant and so that it does not cause failures of belt restraint components during dynamic loading. The seating system must support the occupant throughout the crash event so that properly positioned belt restraints remain on the bony regions of the body, and the seat should be designed so that it is not the source of occupant injuries.

For people with disabilities who are unable to transfer from their wheelchair when traveling in motor vehicles, the wheelchair must serve as the vehicle seating system and perform all the functions of a vehicle seat as described above. Additional equipment must also be installed to secure the wheelchair and provide effective occupant restraint. The design and performance of wheelchair tiedown and occupant restraint systems (WTORS) are addressed in RESNA WC-4:2012, Section 18: *Wheelchair Tiedown and Occupant Restraint Systems for Use in Motor Vehicles*.

The purpose of RESNA WC-4:2012, Section 19, hereafter referred to as “this section of RESNA WC-4” is to establish design and performance requirements, and associated test methods, for wheelchairs related to their use as seats in motor vehicles. This standard employs basic principles of occupant protection and accepted procedures for dynamic testing used in federal motor vehicle safety standards (FMVSS). In today's society where the number of people using wheelchairs is increasing, many wheelchair models will be used as seats in motor vehicles. Thus, wheelchair manufacturers are encouraged to acknowledge this use of wheelchairs and to proactively offer products that are compliant with this section of RESNA WC-4 whenever possible.

For purposes of this section of RESNA WC-4, a wheelchair is considered to be a personal mobility device comprised of a frame, a seat, wheels, and casters that provides seated support and mobility for persons with physical disabilities. The term “wheelchair” encompasses standard manual wheelchairs, stroller-type wheelchairs, power wheelchairs, powerbase wheelchairs, three- and four-wheeled scooters, wheelchairs with tilt seating systems, wheeled mobility devices with specialized seating systems, and wheelchairs consisting of a wheelchair-base frame, a seating-system frame, and a seating system.

This section of RESNA WC-4 applies to complete wheelchairs comprised of a wheeled frame and a seating system. While the majority of wheelchairs are marketed and purchased as complete systems, many wheelchairs are customized to meet the user's needs, and are comprised of a frame from one manufacturer and a seating system from a different manufacturer. For this reason, RESNA WC-4:2012, Section 20: *Wheelchair seating systems for use in motor vehicles*, has been developed to provide a means for evaluating the design and performance of wheelchair seating systems relative to their use as seats in motor vehicles independent of specific production wheelchair frames. A future section of RESNA WC-4 will provide a means to evaluate the crashworthiness performance of frames independent of production wheelchair seating systems.

This section of RESNA WC-4 requires that wheelchairs perform effectively in a moderate-to-severe frontal impact with a change in velocity (delta V) of 48 kph (30 mph) generated by a deceleration pulse with an average deceleration of 20 g. This is because people who are not able to transfer out of their wheelchair may travel in a wide variety of vehicles ranging from relatively small minivans to large city buses, and because frontal collisions account for more than half of all crash-related disabling and fatal injuries to motor vehicle occupants. This level of crash severity is similar to that used in Federal Motor Vehicle Safety Standard 213 (FMVSS 213) *Child Restraint Systems*, and is also specified for testing of WTORS in RESNA WC-4:2012, Section 18: *Wheelchair tiedown and occupant restraint systems for use in motor vehicles*.

A fundamental principle of this section of RESNA WC-4 is that effective wheelchair securement is essential to occupant safety and this requires compatibility of the wheelchair securement system available in public transportation vehicles, including paratransit vehicles, with the securement hardware provided on the wheelchair. Because the four-point, strap-type tiedown system is the most common and effective method for securing a wide range of wheelchair types and sizes in both public and private vehicles, this section of RESNA WC-4 requires that wheelchairs are designed and crash tested for securement by this method. However, wheelchairs may also be designed for securement in motor vehicles by other methods, such as docking-type devices, which are commonly used by wheelchair-seated drivers. It is therefore strongly recommended that the frontal-impact performance criteria and test methods of this standard are also used to evaluate wheelchair crashworthiness for these other securement modes that meet the requirements of RESNA WC-4:2012, Section 18.

While the four-point, strap-type tiedown system is currently the most universal and effective method for securing a wide range of wheelchairs in a wide range of vehicles, effective and proper use of this method of securement is limited by the significant time and effort required to secure and release different types of wheelchairs. Therefore, this section of WC-4 improves not only the strength of wheelchair securement points, but also the accessibility and ease of attaching end fittings of strap-type tiedown assemblies to these points.

In revising the initial version of this section of RESNA WC-4, which was originally published as Section 19 of WC-1, it was recognized that there is a considerable long-term benefit to extending the use of docking securement devices to public and para-transit vehicles where a wide range of occupied wheelchairs must be effectively secured in a single wheelchair station. Therefore, Annex F of this section of RESNA WC-4 provides specifications for a universal docking interface geometry (UDIG), which, if implemented into the securement components of wheelchairs, either by the wheelchair manufacturer or by add-on wheelchair securement adaptors, will provide the wheelchair user with increased independence and will reduce the time required for loading and unloading wheelchair passengers in public and school transportation.

In the previous version of this standard (Section 19 of ANSI/RESNA WC Volume1), the performance criteria for the 48 kph (30 mph) frontal-impact test did not allow for any "sign of failure" in primary load-carrying components of a wheelchair. However, it seemed unreasonable to fail a wheelchair because of a small sign of failure, such as a small hairline crack in a hardware component, when all other performance criteria are met. The failure-related criteria have therefore been changed to requiring that wheelchair components cannot "completely fail" upon completion of the 48 kph (30 mph) frontal-impact test. Nevertheless, all signs of wheelchair failures should be reported by the test lab and wheelchair manufacturers should consider all "signs of failure" when



interpreting the test results and should make modifications to the wheelchair to increase the design safety factor for those components and structures that show the potential for complete failure.

Another fundamental principle of this section of RESNA WC-4 is that proper use and placement of belt restraints (on the occupant) are essential to effective occupant safety and crash protection. Moreover, since publication of the initial version of Section 19 in ANSI/RESNA WC Volume 1, an increased awareness of the difficulty of achieving proper placement of belt restraints on many wheelchair-seated travelers has developed, and there is now clear evidence of the high risk of serious and fatal injuries to wheelchair occupants that results from the lack of proper seatbelt fit and use (Schneider et al., 2010). As a result, this section of RESNA WC-4 addresses the key deterrents to proper and effective belt-restraint use, including wheelchair interference with belt-restraint placement on the wheelchair occupant and intrusion into the personal space of the wheelchair user by drivers and caregivers. This is accomplished by: 1) requiring that wheelchairs provide the wheelchair user with the option of using a dynamically tested wheelchair-anchored pelvic belt to which a vehicle-anchored shoulder belt can be readily connected, and 2) requiring that wheelchairs achieve acceptable, good, or excellent ratings for both the ease of properly applying a vehicle-anchored belt restraint on the wheelchair occupant and the degree to which proper belt positioning is possible when the wheelchair is evaluated for its accommodation of vehicle-anchored belt restraints using the methods of Annex E.

While the primary goal of this section of RESNA WC-4 is to reduce the risk of injury to wheelchair-seated occupants in vehicle crash events, and particularly in frontal impacts, it is recognized that many wheelchair-seated travelers are injured because of adverse events that occur in non-crash situations, such as wheelchairs tipping over during vehicle turns and occupants coming out of wheelchairs during sudden vehicle stops. Wheelchairs that meet the requirements of this standard will also reduce the risk of serious injury in non-crash situations by making it easier to properly secure a wheelchair using all four tiedown straps and by facilitating the proper use of belt-restraint systems that will keep the occupant in their wheelchair during low-g non-crash vehicle accelerations and decelerations.

This section of RESNA WC-4 also addresses wheelchair performance in motor vehicles related to issues of vehicle usability and rider comfort. For example, the size and turning radius of a wheelchair may affect the ease with which the wheelchair-seated occupant can enter and exit a motor vehicle, and maneuver inside the vehicle into a forward-facing position at a designated wheelchair passenger station. This section of RESNA WC-4 therefore requires that information on wheelchair size and turning radius be provided in the wheelchair manufacturer's presale literature. Also, the lateral stability of a wheelchair can affect the comfort and sense of security experienced by the wheelchair user during normal travel. This section of RESNA WC-4 therefore requires measurement and rating of sideways movement of the wheelchair at seat-height level during a 45° lateral tilt test of the occupied wheelchair secured by a surrogate four-point, strap-type tiedown, and disclosure of poor, acceptable, or good ratings in presale literature.

Finally, this section of RESNA WC-4 should be implemented in the context of the full spectrum of daily activities of wheelchair users and the range of industry standards to which all wheelchairs should comply. Wheelchairs must first serve as effective mobility devices and must comply with the applicable requirements of RESNA WC-1:2009 and RESNA WC-2:2009. Although this section of RESNA WC-4 introduces additional and unique requirements for wheelchairs that will provide increased levels of occupant security and safety while riding in motor vehicles, the use of

wheelchairs as seats in motor vehicles is only one of many functions related to activities of daily living for which wheelchairs must effectively perform. Therefore, **failure of an individual's wheelchair to comply with the provisions of this section of RESNA WC-4 should not, and cannot, under federal law, be used to limit access to, and availability of, motor vehicle transportation to wheelchair users.**

## Section 19: Wheelchairs Used As Seats in Motor Vehicles

### 1 Scope

This section of RESNA WC-4 specifies design requirements, performance requirements, associated test methods, and product labeling and literature requirements for complete wheelchairs that are designed for use by single occupants as forward-facing seats in motor vehicles. The provisions of this section of RESNA WC-4 apply to wheelchairs that may be used for seating in a wide range of transportation modes and vehicle types, including intra-city transit buses, paratransit vehicles, school buses, over-the-road coaches, and personally licensed vehicles. The requirements of this section of RESNA WC-4 apply to a wide range of wheelchair types, including manual wheelchairs, power wheelchairs, powerbase wheelchairs, stroller-type wheelchairs, and three- and four-wheeled scooters. They also apply to wheelchairs with tilt or back-recline seating systems, specialized mobile seating bases with fixed or removable seating systems, and to wheelchairs consisting of a wheelchair-base frame, a seating-system frame, and a seating system. The section applies to wheelchairs that are designed for children with a body mass of 12 kg (26 lb, approximately 3 years old) or more, as well as to wheelchairs designed for use by adults.

The requirements of this section of RESNA WC-4 are specific to wheelchairs occupied by passengers of motor vehicles when their wheelchairs are secured facing forward by four-point, strap-type tiedown systems. However, the performance requirements, and particularly the frontal-impact crashworthiness requirements, are also applicable to occupied forward-facing wheelchairs secured by other methods, including docking-type securement commonly used by wheelchair-seated drivers.

### 2 Normative references

The following documents contain provisions, which, through reference in the text, constitute provisions of this section of RESNA WC-4. For dated references, subsequent amendments and revisions of these publications do not apply. However, parties to agreements based on this section of RESNA WC-4 are encouraged to investigate the possible application of the most recent editions of the normative documents listed below. For undated references, the latest edition of the normative document referred to applies. The Bibliography provides source information for these documents.

Federal Motor Vehicle Safety Standard 201 (FMVSS 201) 49 CFR part 571.201 Occupant protection in interior impacts

Federal Motor Vehicle Safety Standard 209 (FMVSS 209) 49 CFR Part 571.209 Seat belt assemblies

Federal Motor Vehicle Safety Standard 210 (FMVSS 210) 49 CFR Part 571.210 Seat belt assembly anchorages