American National Standard

*for Wheelchairs –*

# Volume 4:
# Wheelchairs and Transportation

## Section 18
## Wheelchair tiedown and occupant restraint systems for use in motor vehicles

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# Section 18

# Wheelchair tiedown and occupant restraint systems for use in motor vehicles

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# Section 18 Introduction

For people with disabilities who are not able to safely transfer from their wheelchairs, including three- and four-wheeled scooters, when traveling in motor vehicles, the wheelchair must serve as the vehicle seat. This usually means that the belt-restraint system installed by the vehicle manufacturer (i.e., the OEM belt restraint) cannot be used to provide protection in a crash. In addition, the wheelchair must be effectively secured to the vehicle so that its mass does not add to restraint forces on its occupant and/or become a hazard to other vehicle occupants in a collision or sudden vehicle maneuver. Providing occupants seated in wheelchairs with adequate transportation safety and crash protection therefore requires the installation of equipment in vehicles to provide these travelers with the opportunity for effective wheelchair securement and occupant restraint during normal and emergency vehicle operation and crash situations.

The goal of RESNA WC-4:2012, Section 18, which is a revised and updated version of Society of Automotive Engineers (SAE) Recommended Practice J2249: *Wheelchair Tiedown and Occupant Restraint Systems for Use in Motor Vehicles*, hereafter referred to as “this section of RESNA WC-4,” is to encourage and promote the design, testing, installation, and use of wheelchair tiedown and occupant restraint systems (WTORS) that will provide effective frontal-crash protection for forward-facing occupants in wheelchairs comparable to that provided by OEM occupant-protection systems that must comply with federal motor vehicle safety standards (FMVSS). The primary purpose is to reduce the likelihood of serious and fatal injuries to occupants seated in wheelchairs who are involved in frontal vehicle crashes. However, use of equipment that complies with this section of RESNA WC-4 will also result in increased safety and security for occupants seated in wheelchairs during normal travel, emergency vehicle maneuvers, and other types of crashes, such as vehicle rollovers and side impacts.

The provisions of this section of RESNA WC-4 are based on the premise that WTORS manufacturers are generally not able to control the end use of their products and the vehicles in which they are installed. This section of RESNA WC-4 therefore requires crashworthiness evaluation of WTORS for general use in all types and sizes of motor vehicles by conducting a nominally worst-case 48 kph (30 mph) frontal sled-impact test using an 85 kg (185 lb) surrogate wheelchair and a midsize adult male anthropomorphic test device (ATD), or crash-test dummy, with a nominal mass of 78 kg (172 lb) to dynamically load the wheelchair tiedown and occupant restraint system, respectively. For vehicles with a gross vehicle weight (i.e., the fully loaded weight) greater than 5,000 kg (11,000 lb), it may be appropriate to qualify WTORS using a lower crash severity than is required by this standard because of the reduced likelihood of heavier vehicles being involved in severe impacts. Also, in large fixed-route transit vehicles in which passengers are allowed to stand during travel, the use of rearward-facing wheelchair passenger stations may be a reasonable solution to providing safe transportation for wheelchair users in a manner that is more acceptable to the operational needs of the transportation system. Requirements for WTORS intended for exclusive use in these larger low-*g* and ultra-low-*g* vehicles may be dealt with in a future section of RESNA WC-4.

In SAE J2249, 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 WTORS. However, it has seemed unreasonable to fail a WTORS because of a small sign of webbing failure, such as a small nick in

 

the edge of a seatbelt or tiedown strap, or 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 a WTORS component have “completely failed” upon completion of the 48 kph (30 mph) frontal impact test. Nevertheless, all signs of WTORS failures should be reported by the test lab and WTORS manufacturers should consider the “signs of failure” when interpreting the test results and should make appropriate modifications to the WTORS components.

This section of RESNA WC-4 requires that every WTORS include a belt-type occupant-restraint system with both a pelvic belt and one or more shoulder belts since the evidence is clear that the combination of upper- and lower-torso belt restraints is the most effective method of reducing injuries and fatalities in a wide range of crash conditions, including frontal crashes, vehicle rollovers, and a large percentage of side impacts. In addition, belt restraints can be easily implemented in most forward-facing seating positions of passenger vehicles. However, this section of RESNA WC-4 allows for, and applies to, WTORS that use different approaches to wheelchair tiedown, including four-point, strap-type tiedowns, and docking securement devices.

Although the Scope of SAE J2249 allowed for WTORS manufacturers to certify separate components and subassemblies of WTORS as being in compliance with applicable requirements of the Recommended Practice, this section of RESNA WC-4 does not include this provision. Rather, WTORS that include components and subassemblies designed for use with portions of vehicle-manufacturer restraint systems (i.e., buckle receptacles and associated anchorage components) must be tested and evaluated as part of a complete WTORS using that portion of the particular OEM belt restraint system for which the components and/or subassemblies have been designed. Also, components and subassemblies of WTORS that are sold as replacement components and subassemblies of WTORS currently in use must have been tested as part of the complete WTORS for which the components and/or subassemblies are intended.

At the time this section of RESNA WC-4 was developed, the four-point, strap-type tiedown was considered to be the only commercially available method for securing a wide range of wheelchairs in vehicles used for public and school transportation. However, wheelchairs can also be secured in motor vehicles using docking securement devices, whereby the wheelchair is locked in a forward-facing position when the wheelchair is moved into the designated wheelchair station. Currently, use of docking-type securement systems is most common in private vehicles where only one individual and wheelchair must be accommodated because it is usually necessary to modify the specific wheelchair model (SWM) by installing a docking securement adaptor to the wheelchair frame to provide for engagement with a specific wheelchair securement device installed in the vehicle.

In view of the time and effort by drivers and caregivers required to properly secure wheelchairs using a four-point, strap-type tiedown system and the potential for interfering with the personal space of the wheelchair occupant during the tiedown process, there is considerable benefit to expanding the use of docking securement devices to public and paratransit (i..e., door-to-door service) vehicles. Therefore, Annex G of this section of RESNA WC-4 provides specifications for a universal-docking-interface geometry (UDIG) that can be implemented into design of the wheelchair base frame by wheelchair manufacturers, or that can be added to the wheelchair base frame by wheelchair securement adaptors designed with securement structures that comply with the UDIG. In either case, the implementation of securement structures with UDIG on wheelchairs and UDIG-compatible docking securement devices in public and paratransit vehicles will allow wheelchair

users increased independence and reduce the time required for loading and unloading passengers seated in wheelchairs.

In developing RESNA WC-4, the importance of the vehicle seat to providing effective occupant protection in frontal crashes was also recognized. Therefore, RESNA WC-4:2012, Section 19: *Wheelchairs Used as Seats in Motor Vehicles* establishes the design and performance requirements for complete wheelchairs with regard to their use as seats in motor vehicles. In addition, RESNA WC-4:2012, Section 20: *Wheelchair Seating Systems for Use in Motor Vehicles* establishes design and performance requirements for wheelchair seating systems and, in particular, provides a test method and associated performance criteria for evaluating the frontal-impact performance of wheelchair seating systems independent of frames of models by installing the seating system on a surrogate wheelchair frame (SWCF).

Since publication of the initial version of RESNA WC-1, Section 19, evidence has become available of a high risk of serious and fatal injuries to occupants seated in wheelchairs that result from the lack of proper seatbelt use (Schneider et. al. 2010). Much of this is due to the difficulty of achieving proper placement of vehicle-anchored belt restraints on wheelchair-seated travelers due to interference by wheelchair components. As a result, RESNA WC-4:2012, Section 19 addresses the key deterrents to proper and effective belt-restraint use in two ways: a) by requiring that wheelchairs provide for the use of a dynamically tested and crashworthy wheelchair-anchored pelvic belt to which a vehicle-anchored shoulder belt can be connected to a pin-bushing anchorage located near the occupant's hip to comprise a three-point belt restraint, and b) by requiring that wheelchairs achieve at least "acceptable" ratings for: 1) the ease of properly positioning a belt restraint on wheelchair occupants, and 2) the degree to which proper belt positioning can be achieved.

To address the expectation that an increasing number of occupants seated in wheelchairs that comply with RESNA WC-4:2012, Section 19 will be using a wheelchair-anchored pelvic-belt restraint, it is important for wheelchair tiedown/securement systems to be able to withstand the additional occupant restraint loads that will result from this belt-restraint condition. For this reason, this section of RESNA WC-4 requires that, beginning three-years from the date of publication, two frontal impact tests must be conducted for WTORS that provide a complete three-point belt restraint with a vehicle-anchored pelvic-belt restraint and that are intended for general use. The first test evaluates the complete WTORS with the vehicle-anchored belt restraints and is effective upon publication of this section of RESNA WC-4. The requirement to conduct a second test becomes effective three-years after the publication of RESNA WC-4:2012 and evaluates the dynamic strength of the tiedown/securement system when occupant-restraint loads are transferred though a wheelchair-anchored pelvic belt to the wheelchair and the tiedown/securement system.

The purpose of RESNA WC-4 is to promote and encourage the use of equipment that improves motor-vehicle transportation safety, usability, and independence for people who remain seated in their wheelchairs during travel, and to thereby reduce the risks of serious and fatal injuries to occupants seated in a wheelchair in the event of a collision or other moving-vehicle incident. However, **failure of equipment to comply with the provisions of RESNA WC-4 should not, and cannot, under federal law, be used to limit access to, and availability of, motor vehicle transportation to provide and enhance mobility for people who use wheelchairs**.

# Section 18:
# Wheelchair tiedown and occupant restraint systems for use in motor vehicles

## 1 Scope

This section of RESNA WC-4 applies to wheelchair tiedown and occupant restraint systems, or WTORS, comprised of a system or device for securing or tying down wheelchairs, including three- and four-wheeled scooter wheelchairs, and a system of belts for restraining occupants seated in wheelchairs. It applies to complete WTORS in which all components are provided by the WTORS manufacturer, but it also applies to WTORS that are completed by using portions of belt-restraint systems provided by the vehicle manufacturer (i.e., OEM belt restraints), particularly for people who drive while seated in their wheelchair.

This section of RESNA WC-4 applies to WTORS designed for use with a wide range of wheelchairs and their occupants, as well as to WTORS designed for limited use with a specific wheelchair model and/or occupant size range. It applies only to WTORS intended for use with forward-facing wheelchair-seated children and adults with a body mass of 12 kg (26.5 lb) or more who are traveling as passengers or drivers in private, paratransit, public, and school vehicles. It applies to WTORS that use all types of wheelchair tiedown and securement methods, but it only applies to WTORS that include both upper- and lower-torso belt-type occupant restraints.

This section of RESNA WC-4 specifies design requirements and performance requirements and associated test methods for WTORS, as well as requirements for product labeling and manufacturer literature, including presale literature, instructions to installers and wheelchair users, and placards for installation in vehicles at wheelchair stations. The key design and performance requirements apply to all types of WTORS but some requirements are specific to WTORS that use a particular type of wheelchair tiedown/securement system, such as the four-point, strap-type tiedown or a docking securement device.

This section of RESNA WC-4 places particular emphasis on the dynamic strength of WTORS in a 48 kph (30 mph) frontal-impact sled test, but it also includes requirements and test methods for achieving proper and effective use of WTORS on different size occupants in different types of wheelchairs, for ensuring effective engagement of WTORS components, and for webbing slippage at adjustment mechanisms of strap-type tiedown assemblies. It also establishes specifications for universal docking interface geometry (UDIG) for wheelchairs and wheelchair securement adaptors with the ultimate goal of providing for docking-type wheelchair securement in public and paratransit vehicles that must accommodate a wide range of wheelchairs.

## 2 Normative references

The following documents contain provisions, which, through reference in this text, constitute provisions of this section of RESNA WC-4. For dated references, subsequent amendments to, or revisions of any of these publications do not apply. However, parties to agreements based on this

 