INTERNATIONAL STANDARD

ISO 7176-19

Second edition
2008-07-15

AMENDMENT 1
2015-11-15

Wheelchairs —

Part 19: Wheeled mobility devices for use as seats in motor vehicles

AMENDMENT 1: Annex G

Fauteuils roulants —

Partie 19: Dispositifs de mobilité montés sur roues et destinés à être utilisés comme sièges dans des véhicules à moteur

AMENDEMENT 1: Annexe G

Reference number
ISO 7176-19:2008/Amd.1:2015(E)

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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Amendment 1 to ISO 7176-19:2008 was prepared by ISO TC 173, *Assistive products for persons with disability*, Subcommittee SC 1, *Wheelchairs*.

Wheelchairs —

Part 19:
Wheeled mobility devices for use as seats in motor vehicles

AMENDMENT 1: Annex G

Page vi, Introduction

Add the following paragraphs to the end of the 4th paragraph, just before the last sentence.

Recent research has shown that some commercial wheelchairs offer significantly less protection in rear-impact than conventional motor vehicle seats. Manufacturers who wish to test wheelchairs to determine their performance in rear-impact conditions should use the test methods and performance measures in Annex G.

Page 9, 4.2.3

Add the following sentences to the last paragraph of 4.2.

Annex G provides additional design guidelines for wheelchair back and head supports for equipment that is also intended to serve as back and head restraints that provide occupant protection in a vehicle rear-impact crash event. These design guidelines are based on strategies used in designing conventional vehicle seats with the goal of reducing the risk of serious and fatal injuries to forward facing occupant seated in wheelchairs during rear-end impacts. In cases where these are incompatible with the person's medical/therapeutic needs, accommodation of the person's emergent healthcare needs should be given precedence.

Page 13, 5.4

Add new Note following 5.4.

NOTE The impact response of wheelchairs and particularly the performance of wheelchair back supports and head supports/restraints in moderate-level rear impacts can be determined using the test methods and performance measures set forth in Annex G

Annex G
(informative)

Wheelchair design, performance, and labelling recommendations for improved protection of occupants seated facing forward in wheelchairs during rear impacts

G.1 General

When people who remain seated in forward-facing wheelchairs riding in or driving motor vehicles are involved in rear-impact collisions, the wheelchair back support is the primary occupant restraint. As with vehicle seatbacks, wheelchair back supports must limit rearward movement of the occupant's torso relative to the vehicle interior to prevent occupant ejection from the wheelchair and/or the vehicle that will significantly increase the risk of serious injury due to contact with vehicle components, other occupants, or objects outside the vehicle.

At the current time, the only test of wheelchair back supports is rebound loading of the anthropomorphic test device (ATD), or crash-test dummy in the frontal impact test of Annex A. Wheelchair back supports are not tested to the same static and dynamic load levels used in performance testing of vehicles seatbacks in FMVSS 207, ECE R17, and other motor-vehicle safety standards, such as the rear-impact fuel-tank integrity test of FMVSS 301. Additionally, rear-impact sled tests of wheelchairs, including wheelchairs that comply with the performance criteria of ISO 7176-19:2008, 5.2, have shown that wheelchair back supports often do not provide effective occupant restraint in moderate-to-severe rear impacts, and may fail catastrophically in these tests.

Vehicle rear-head restraints are attached to, or integrated into, the vehicle seatback and are designed to limit the rearward movement of an occupant's head relative to the torso, and thus limit rearward rotation of the neck (i.e. neck extension) during rear impacts. When properly designed and positioned relative to the occupants head during normal vehicle travel, head restraints can further reduce the risk of serious head and neck injuries in rear-impact crashes. While all wheelchairs have back supports, some wheelchairs are also equipped with rear head supports that were designed to keep the head and neck upright during normal operation of the wheelchair, but were not designed to provide effective rear head restraint in rear-impact crashes. It is, however, possible to design wheelchair head supports, whether part of the original wheelchair equipment or added to the wheelchair as aftermarket components, so that they can serve a dual role of offering head support during normal wheelchair use and effective head restraint in vehicle rear impacts.

This Annex sets forth design guidelines, a rear-impact test method and associated performance criteria, and manufacturer product labelling and literature recommendations for wheelchair manufacturers who wish to design their products with back supports and head supports that will provide effective restraint for the torso and head of their occupants when seated in wheelchairs while facing forward in motor vehicle during rear-impact collisions. Wheelchairs that comply with these guidelines and performance rear-impact performance criteria will reduce the risk of serious head, neck, and torso injuries during rear-end crashes.

The severity of the rear-impact test in this Annex has been selected to be representative of the impact severity used to test vehicle seatbacks in the FMVSS 301 fuel-tank integrity test, and has been shown to also represent a moderate-to-severe real-world impact (about 80th percentile) based on analysis of representative crash-investigation databases, such as the National Automotive Sampling System (NASS) established and maintained by the National Highway Traffic Safety Administration (NHTSA).

G.2 Design recommendations for back supports and head support/restraints

G.2.1 Principle

A head restraint is a device intended to limit the rearward displacement of an occupant's head during crash events, and when properly designed and positioned, a head restraint can reduce the incidence of head and neck injuries in rear-impact crashes. Many wheelchairs are equipped with back supports or head supports that were not designed to provide crash protection and whose effect on injury outcomes is unknown. In some cases, head supports and head restraints are added to a wheelchair as aftermarket items and these would need to be tested per the dynamic test protocols in Annex A and Annex G with

a commercial wheelchair to ensure that the attachment hardware is sufficient for the transportation environment. This subclause provides specifications for head supports that can function as head restraints and are consistent with the goal of reducing injury.

G.2.2 General specifications

All wheelchair posterior back and head supports that are also intended to also perform as back and head restraints should

a) have head supports/restraints that are attached to the back support and not detach from the wheelchair when tested to the dynamic test requirements of Annex A or Annex G,

b) have head supports/restraints that are recommended for use with a back support for the wheelchair occupant with sufficient height so that the top of the back support is at or above the height of the centre of rotation of the shoulder joint for the ATD selected for testing in G.3.2,

c) provide a padded head support/restraint contact surface that has energy absorbing properties that meet FMVSS 201 and/or ECE Reg 17,

d) provide a padded head support/restraint surface of width ≥ 170 mm,

e) allow the head support/restraint to adjust so that the top-edge height equal to that of the most rearward point on the head of the ATD selected for testing in sections G.3.2, and

f) be able to adjust and fix the fore/aft position of the head support/restraint so that the smallest gap between the horizontal distance of front surface is no further than 55 mm from the most rearward point on the ATD's head when the ATD is set up for testing in accordance with G.3.2

NOTE The 170 mm minimum width of the head support/restraint and the 55 mm backset are drawn from the requirements for automotive head restraints.

G.3 Rear-impact test

To simulate a typical moderate-to-severe rear-impact event to an occupied wheelchair, the wheelchair is placed on the test platform of an impact sled facing rearward to the direction of sled acceleration and/or deceleration. The wheelchair is loaded with an appropriate-size ATD and is secured by a four-point, strap-type tiedown system, and the ATD is restrained by a three-point vehicle or wheelchair-anchored belt restraint. The sled is subjected to an acceleration/deceleration-time pulse that falls within a specified corridor to achieve the required horizontal change in velocity, or delta V. Observations and measurements are made during and after the test to determine if the wheelchair was effectively secured throughout the test, and if the back support and head support/restraint provided effective restraint for the ATD during rear-impact loading."

G.3.1 Test sample

An unused, complete production or prototype wheelchair should be used for each test.

NOTE 1 The wheelchair may include a head support/restraint or an aftermarket head support/restraint may be added to the wheelchair.

NOTE 2 Wheelchairs that have back supports and head supports/restraints that meet the design guidelines of G.2.2 are more likely to meet the performance criteria of this rear-impact test.

G.3.2 Test equipment

G.3.2.1 Impact simulator and surrogate tiedown/restraint equipment

An impact simulator should be used that includes

a) an impact sled equipped with a flat, horizontal, structurally rigid platform on which the wheelchair can be placed and to which anchorages of a WTORS with a four-point, strap-type tiedown and three-point lap/shoulder belt restraint can be fastened,

b) a rigid structure for attaching the upper shoulder-belt anchorage with adjustability in anchor-point location to achieve the desired shoulder-belt angles specified in Annex A,

c) a means to accelerate and/or decelerate the impact sled such that the processed acceleration and/or deceleration-time pulse falls within the shaded area of Figure G.1 and to achieve a change in sled velocity of 25 km/h to 0,2 km/h,

d) a surrogate four-point strap-type tiedown and complete upper and lower belt restraint system, as defined in this International Standard that conforms to ISO 10542-1, and

e) a Hybrid III ATD selected from Table G.1 based on wheelchair manufacturer's recommended occupant mass capacity.

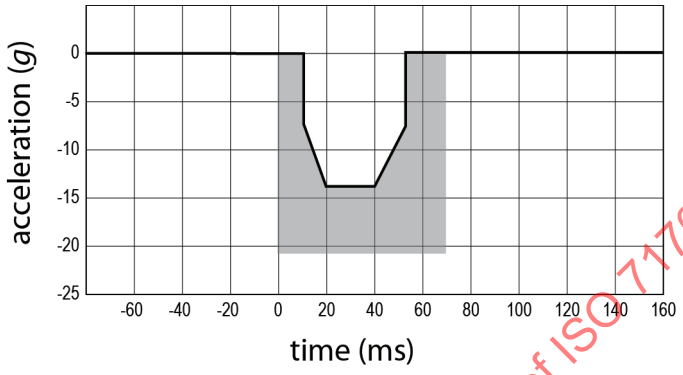

Figure G.1 — 25 km/h acceleration corridor for rear impact test

Table G.1 — Available ATD for wheelchair rear-impact testing

Occupant mass range kg (lb)	ATD size	Approximate mass of ATD kg (lb)
>18 to 27 (>40–60)	6 year-old child	23,4 (52)
>27 to 43 (>60–95)	10 year-old child	35,2 (78)
>43 to 57 (>95–125)	Small adult female	49,0 (108)
>57 to 75 (>125–165)	Small adult female weighted to 59 kg	59,0 (130)
52 to 95 (>165–300)	Midsize adult male	77,1 (170)
95 to 125 (>300)	Large adult male	101,2 (223)
NOTE The ATD mass may be increased by attaching weighted material, such as lead, to the exterior of the ATD.		

G.3.2.2 Test instrumentation and data collection

A means should be provided to

a) measure the ATD and wheelchair horizontal excursions specified in G.3.5.1 with a precision and accuracy of ±5 mm,

NOTE A side-view high-speed camera or video system with a frame rate of 500 frames per second is required.

b) measure the horizontal acceleration and/or deceleration of the impact sled in the direction of travel, at a sampling rate in accordance with ISO 6487, and with a precision of +0.5 *g*,

c) measure the horizontal velocity change (delta-V) of the impact sled during the impact with a precision of +0,5 km/h, and

d) filter transducer signals using a low-pass filter in accordance with ISO 6487, including:

1) pre-filtering of all transducer signals to Channel Class 1000 (−4 dB at 1650 Hz) prior to digitizing at 10,000 Hz, and

2) filtering of the digitized accelerometer and load-cell signals to Channel Class 60 (−4 dB at 100 Hz).

G.3.3 Test preparation and procedure

G.3.3.1 Perform the following prior to initiating the test.

a) Adjust the ATD to achieve a static resistance of 1 *g* at each joint indicated by just noticeable movement from the weight of the distal body segment as specified by the ATD manufacturer.

b) Place snug-fitting cotton clothing on the pelvis, thighs, and torso of the ATD.

c) Prepare the wheelchair for use in a motor vehicle as specified by the manufacturer's user instructions.

NOTE If a range is specified for any adjustments then the midpoint of the range should be used, when possible.

d) Equip the wheelchair with any required add-on components as specified by the manufacturer.

e) If a pelvic belt intended for use as an occupant restraint is provided as a component of the wheelchair, attach it to the wheelchair according to the manufacturer's instructions.

f) If the wheelchair is equipped with non-impact worthy batteries they should be replaced by the nearest equivalent gel, sealed or a surrogate battery. Supplemental weights, if used, must provide equivalent mass distribution to the original batteries.

g) Inflate any pneumatic tyres to the pressure recommended by the wheelchair manufacturer.

h) Turn the wheelchair power off, if applicable.

G.3.3.2 Install the wheelchair tiedown anchorages on the sled platform in accordance with the WTORS instructions as found in Annex E and the tiedown spacing and installation procedures of ISO 10542-1, Annex A.

G.3.3.3 Position the wheelchair on the sled in the orientation appropriate for representing vehicle accelerations during rear impact event and with the wheelchair reference plane parallel to the direction of sled travel ±3°.

G.3.3.4 Secure the wheelchair with the surrogate wheelchair tiedown according to the instructions in Annex E. Follow the tiedown spacing and installation procedures in of ISO 10542-1.

G.3.3.5 If applicable, apply wheelchair brakes.

G.3.3.6 If applicable, adjust the seat, back support, and head support/restraint per the instructions in A.4.5 and also adjust the rear head support/restraint so that its centre is vertically aligned with the most prominent point on the back of the ATD's head and so that the gap between head and head restraint is minimized.

G.3.3.7 Position the ATD in the wheelchair as described in A.4.6.

G.3.3.8 If the wheelchair is provided with postural belts, install and fasten the belts on the ATD as recommended by the manufacturer.

G.3.3.9 If the wheelchair is provided with a pelvic belt intended to provide protection in a crash, fasten the belt on the ATD as recommended by the manufacturer and then complete the three-point occupant restraint with a vehicle-mounted shoulder belt. If the wheelchair does not provide a wheelchair-anchored pelvic belt, then apply the vehicle-anchored three-point belt restraint of the surrogate WTORS to the ATD.

G.3.3.10 Apply contrast markers at

a) the lateral aspect of the ATD's shoulder,

b) Point P of the wheelchair (see Figure 2), or a point on the side of the back support of a wheelchair that is as close to the wheelchair point P as possible,

c) points corresponding to rigid structural parts of both sides of the top and the bottom of the back support to provide for measuring back-support angle during and after the test,

d) two points on the lateral surface of the ATD head, one at the head centre of gravity and one approximately 50 mm directly above the centre of gravity, and

e) on the side of the head support/restraint.

G.3.3.11 Ensure that there is sufficient clear space around the wheelchair so that nothing will interfere with movements of the ATD and wheelchair during the test.

G.3.3.12 Measure and record the locations of all WTORS anchor points relative to the wheelchair rear axle.

G.3.3.13 Measure and record the projected angles of tiedown straps and restraint belts relative to the horizontal longitudinal axis of the sled platform.

G.3.3.14 Measure and record the horizontal and vertical distance between the top front edge of the back support relative to the centers of the tops of the ATD's shoulders.

G.3.3.15 Measure the vertical distances from the centre of the front surface of the rear head support to the ATD's head centre of gravity and the top-front edge of the back support.

G. 3.3.16 Measure the smallest distance between the back of the ATD's head and the front surface of the head support/restraint.

G.3.3.17 Measure the back support angle.

G.3.3.18 Measure the right and left H-point height of the ATD.

G.3.3.19 Conduct the impact test by activating she sequence of events to record data and initiate the impact acceleration/deceleration of the impact sled

G.3.4 Test and post test measurements and calculations

G.3.4.1 Examine the wheelchair and ATD to determine and/or measure:

a) whether the ATD remained in the wheelchair,

b) whether the wheelchair remained on the test platform,

c) whether any securement points on the wheelchair showed signs of failure,

d) whether any load-bearing parts of the wheelchair became separated, deformed, or fractured,

e) whether rigid wheelchair components greater than 100 g became detached,

f) the average of the angles, relative to the vertical, of the left and right structural members of the back support, and

g) the final distance between the centre of the head support/restraint and the top edge of the back support.

G.3.4.2 Determine peak excursions X_{wc} and X_{headR} as defined in G.3.5.2, to a precision and accuracy of ±5 mm.

G.3.4.3 Determine the change in head-to-torso angle between the pre-impact posture and peak head-to-back rotation to a precision and accuracy of ±0,5° through analysis of the high-speed digital video and/or analysis of transducer information.

G.3.4.4 Determine peak dynamic back support angle to a precision and accuracy of ±0,5° by averaging the maximum angles observed on the left and right sides through analysis of the high speed digital video.

G.3.4.5 Use an inclinometer to estimate the maximum projected angle, relative to the vertical, of the ATD's torso in the post-test orientation, when viewed from all directions.

G.3.4.6 Release the occupant restraint and remove the ATD, while noting any wheelchair deformation that interferes with removal of the ATD from the wheelchair.

G.3.4.7 Release the wheelchair from the tiedown hooks/straps and document any conditions that prevent manual removal of the tiedowns from the wheelchair securement points.

G.3.4.8 Measure and record the final location of adjustable wheelchair and seating components from their pre-test locations.

G.3.4.9 Measure the right and left H-point height of the ATD.

G.3.5 Performance requirements

When the wheelchair is tested in accordance with G.3.1 to G.3.4 the following criteria should be met.

G.3.5.1 During the test

a) The horizontal excursions of the ATD and the wheelchair with respect to the impact sled should not exceed the limits in Table G.2.

b) The change in head-to-torso angle of the ATD should not exceed 30°.

NOTE 1 Torso angle can be more easily measured with the addition of a rigid target bracket bolted between the torso and neck of the ATD or with the addition of appropriate transducers in the ATD head and chest.

c) The post-test back support recline angle must increase during the test by at least 10 º to the vertical.

d) The peak dynamic back support angle of the wheelchair should not exceed 65° to the vertical.

NOTE 2 Back support angle is the angle relative to vertical of the surface supporting the ATD torso. Automotive research has shown that deflections exceeding 65 degrees are associated with an increased threat of ejection.

Table G.2 — Horizontal excursion limits (mm)

Dimensions in millimetres

		excursion limit (mm) for each ATD size			
Measure	Excursion variable	six-year-old	10-year-old	small female	mid-size /large male
Wheelchair Point P	X_{wc}	150	175	200	200
ATD rear of head	X_{headR}	350	400	400	450

where

X_{wc} is the horizontal distance relative to the sled platform between the contrast target placed at or near point P on the wheelchair at time t_o, to the Point P target at the time of peak rearward wheelchair excursion;