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BSI Standards Publication

Wheelchair containment and occupant retention systems for accessible transport vehicles designed for use by both sitting and standing passengers

Part 1: Systems for rearward-facing wheelchair-seated passengers

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National foreword

This British Standard is the UK implementation of ISO 10865-1:2012.

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A list of organizations represented on this committee can be obtained on request to its secretary.

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INTERNATIONAL STANDARD

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Wheelchair containment and occupant retention systems for accessible transport vehicles designed for use by both sitting and standing passengers —

Part 1: Systems for rearward-facing wheelchair-seated passengers

Produits d'assistance pour personnes en situation de handicap et systèmes d'immobilisation de fauteuil roulant, et de retenue des occupants pour les passagers assis sur les fauteuils roulants dos à la route —

Partie 1: Systèmes pour passagers en fauteuil roulant assis dos à la route

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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10865-1 was prepared by Technical Committee ISO/TC 173, *Assistive products for persons with disability*, Subcommittee SC 1, *Wheelchairs*.

ISO 10865 consists of the following parts, under the general title *Wheelchair containment and occupant retention systems for accessible transport vehicles designed for use by both sitting and standing passengers*:

— *Part 1: Systems for rearward-facing wheelchair-seated passengers*

The following parts are under preparation:

— *Part 2: Systems for forward-facing wheelchair-seated passengers*

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Introduction

Providing safe transportation for wheelchair-seated passengers in motor vehicles usually requires installation of aftermarket equipment to secure the wheelchair and provide passenger restraint during emergency vehicle manoeuvres and crash conditions that are appropriate to the size and travel conditions of the vehicle. ISO 10542-1[15] establishes design and performance requirements and associated test methods for wheelchair tiedown and occupant restraint systems (WTORS) intended for use by forward-facing wheelchair-seated passengers in all types of motor vehicles that have been modified for use by people seated in wheelchairs. The provisions of ISO 10542-1 were based on the belief that WTORS manufacturers are not able to control the types of vehicles and travel modes in which most of their products are installed and used. Therefore ISO 10542-1[15] requires frontal sled-impact testing of WTORS to nominal worst-case crash conditions of smaller vehicles, such as full-size vans and minivans, using a simulated crash acceleration/deceleration pulse that results in a change in sled speed (delta V) of 48 km/h.

While this one-size-fits-all approach to WTORS crashworthiness testing is appropriate for equipment intended for general use in all types of motor vehicles, it generally leads to products that are over designed for use in larger and heavier vehicles used primarily in low-speed intra-city transportation. This is particularly the case for larger accessible transit vehicles in which passengers are allowed to travel sitting as well as standing, hereafter referred to as accessible transit vehicles-sitting and standing, or ATV-SS.

Recognizing these different and significantly lower transportation safety requirements for ATV-SSs in a new standard can be expected to result in alternative solutions for safely transporting wheelchair-seated passengers in these vehicle environments. These solutions are more compatible with operational needs (e.g. fixed-route schedules) of these transportation services and offer wheelchair users a greater level of usability and independence than is achieved with WTORS designed to comply with 48 km/h crash conditions. More specifically, accident/injury data for ATV-SSs indicate that the frequencies of occupant fatalities and serious injuries per million passenger kilometres travelled are significantly lower than for smaller vehicles that travel at much higher speeds[1]. In fact, analysis of data from police reports of accidents involving fixed-route intra-city buses indicates that the likelihood of a collision event for these vehicles is sufficiently rare to justify basing performance requirements for safety equipment installed in these vehicles on accelerations and decelerations that occur during non-crash conditions, such as emergency vehicle manoeuvres, including sudden stopping, rapid acceleration, and turning corners at excessive speeds. Several studies have clearly demonstrated that ATV-SS accelerations that may result from such emergency manoeuvres are all below 1g[2][3].

Recognizing the different safety needs of ATV-SS passenger environments in the early 1990s, many European countries[4][5][6], as well as Canada and Australia[7], began implementing rearward-facing wheelchair passenger stations (RF-WPS) for use by wheelchair-seated passengers travelling in these vehicles. In practice, the RF-WPS concept has been well received by both wheelchair users and transit providers because of increased passenger independence, significantly reduced driver involvement and reductions in schedule delays[7][8]. However, from an injury-risk perspective, the concept is not ideal in several important ways. For example, some wheelchairs do not have brakes or may have defective brakes, allowing the wheelchair to have excessive movement. Also, some aisle-side barriers do not work effectively with some types of wheelchairs, such as scooters, and allow tipping or swerving of wheelchairs into the centre aisle during vehicle turning. Attempts to resolve these deficiencies by some transporters have resulted in the addition of various types of auxiliary wheelchair securement straps that require driver intervention[7][9]. This nullifies a main advantage of the RF-WPS-independent vehicle access by the wheelchair user. Furthermore, many countries have no national standards for the design, testing and installation of a RF-WPS, therefore misapplication of the rearward-facing concept may readily occur in practice.

The purpose of this part of ISO 10865 is to establish minimum design and performance requirements for RF-WPS and to establish test methods for the performance requirements. This will provide wheelchair-seated passengers using RF-WPS with a reasonable level of transportation safety while maintaining a high level of usability and independence during travel in ATV-SS.

A fundamental principle behind the concept of an RF-WPS in ATV-SS is that correctly designed passive containment (which does not require the physical attachment of securement devices by the wheelchair user or vehicle operator) of an occupied wheelchair during normal travel and emergency vehicle manoeuvres is sufficient to provide a reasonable level of transportation safety to wheelchair-seated passengers. This level of safety is comparable to that provided to other vehicle occupants, including standing passengers, who hold

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onto stanchions and straps to resist movement during vehicle accelerations and decelerations. In this regard, a primary feature of RF-WPS required by this part of ISO 10865 is a forward excursion barrier (FEB) against which the wheelchair passenger backs their wheelchair upon entering the RF-WPS. The primary function of the FEB is to prevent forward movement of the wheelchair during vehicle decelerations of normal or emergency braking. However, if the wheelchair backrest and the back of the head of the wheelchair user are in close proximity to the FEB, this structure may also limit forward movement of the wheelchair passenger beyond that provided by the wheelchair backrest during emergency braking, or even in the rare event of a frontal collision. With regard to the latter, while the primary performance requirements for wheelchair containment set forth in Annex B are for non-collision vehicle accelerations and decelerations of less than 1g, Annex C specifies strength testing of the FEB structure based on 3g wheelchair-plus-occupant loading.

Lateral displacement, rotation or tipping of occupied wheelchairs in an RF-WPS are typically limited in one direction by the vehicle sidewall. Lateral displacement, rotation or tipping of the wheelchair into the centre aisle are typically limited by a physical barrier, such as a vertical stanchion or horizontal padded arm or bar, referred to as a lateral excursion barrier, or LEB. However, in an effort to avoid being unnecessarily design restrictive, this part of ISO 10865 does not require or specify any particular structure to limit displacement, rotation or tipping of the wheelchair toward the vehicle aisle. Rather, this part of ISO 10865 establishes performance requirements and associated test methods to assess whether the features of the RF-WPS sufficiently limit lateral wheelchair movement and tipping in this direction.

Wheelchair movement toward the rear of the vehicle is limited in the passive mode by requiring minimum friction properties for the vehicle floor within the RF-WPS that generate friction forces on the tyres of wheels that have been locked by applying the wheelchair brakes or by the drive train of powered wheelchairs for which the power has been turned off during travel. Active resistance to rearward wheelchair movement may also be provided by implementing vehicle-anchored occupant retention and/or wheelchair containment devices, such as a pivoting padded bar, and/or by the wheelchair user grabbing a handhold within the RF-WPS that complies with geometry and location specifications of this part of ISO 10865. Use of a handhold and/or an active occupant retention device will also help limit rearward movement of the wheelchair passenger relative to the wheelchair seat during vehicle accelerations. If a specific RF-WPS design requires active application of an occupant retention and/or wheelchair containment device to pass the rearward wheelchair containment test of Annex B, it is important that a warning to use this device be clearly displayed in the RF-WPS.

As indicated above, this part of ISO 10865 assumes that retention of the occupant in their wheelchair, which is important to minimize the risk of serious injuries, even in low-g non-crash events, depends largely on retention features provided by, and on, the wheelchair. The wheelchair backrest will generally provide sufficient retention during vehicle braking but, as previously noted, the FEB can further reduce forward occupant movement in the vehicle when the back and head of the wheelchair passenger are in close proximity to the FEB. Retention of the wheelchair passenger during lateral accelerations caused by vehicle turning is generally provided by wheelchair armrests and lateral torso postural supports that are customized components of the wheelchair seat, but may be augmented by LEBs. The use of wheelchair-mounted postural belts are important for passive occupant retention during vehicle accelerations and this practice is therefore encouraged by requirements for user warnings displayed in the RF-WPS. In addition, as noted above, this part of ISO 10865 allows RF-WPS to provide active vehicle-anchored passenger retention and wheelchair containment devices that can be easily implemented by the wheelchair user or driver, and it specifies design and location requirements for handholds that can be used by capable wheelchair-seated passengers to augment containment of the wheelchair and enhance retention and stability of the wheelchair passenger. In addition, a vehicle-mounted lap belt or some other retention device is required in order to prevent an otherwise unrestrained occupant from falling out of their wheelchair during unexpected vehicle manoeuvres.

Informative design guidelines are provided in Annex E to aid manufacturers in designing RF-WPS that conform with the requirements of this part of ISO 15608. An RF-WPS may also be equipped with WTORS for use by forward-facing wheelchair users, but requirements and specifications for these systems are not within the scope of this part of ISO 10865.

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Wheelchair containment and occupant retention systems for accessible transport vehicles designed for use by both sitting and standing passengers —

Part 1: Systems for rearward-facing wheelchair-seated passengers

1 Scope

This part of ISO 10865 is applicable to wheelchair passenger spaces (RF-WPSs) intended for use by rearward-facing wheelchair-seated occupants, with a body mass greater than 22 kg, when travelling in accessible transport vehicles. It is applicable to systems for use in vehicles used mainly on fixed route services when operated under normal and emergency driving conditions, where passengers are allowed to travel both sitting and standing. It assumes that the maximum acceleration imparted to the vehicle in any direction during emergency driving manoeuvres will not exceed 1g.

This part of ISO 10865 specifies design and performance requirements and associated test methods, requirements for manufacturer instructions and warnings to installers and users as well as requirements for product labelling and disclosure of test information.

The primary purpose of this part of ISO 10865 is to limit those movements of a rearward-facing wheelchair, including scooters with three or more wheels, that can result in hazardous contact with the vehicle interior or injury to other passengers.

The provisions of this part of ISO 10865 apply primarily to a complete RF-WPS, but subsets of the provisions can be applied to components and subassemblies sold separately, as appropriate to the specific functions of the components and/or subassemblies they are intended to replace.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3795, *Road vehicles, and tractors and machinery for agriculture and forestry — Determination of burning behaviour of interior materials*

ISO 7176-11, *Wheelchairs — Part 11: Test dummies*

ISO 7176-13, *Wheelchairs — Part 13: Determination of coefficient of friction of test surfaces*

ISO 7176-26, *Wheelchairs — Part 26: Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7176-26 and the following apply.

3.1
ambulatory passengers
passengers who do not require the use of a wheelchair

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3.2
forward excursion barrier
FEB
padded structure designed to limit forward movement relative to the vehicle of a rearward-facing wheelchair and its occupant

3.3
gross vehicle weight rating
GVWR
maximum total weight, as determined by the vehicle manufacturer, at which the vehicle can be safely and reliably operated for its intended purpose

3.4
handhold
grab bar
handrail
any device on board a transport vehicle that is designed to allow passengers to use their hand grip to manoeuvre through the vehicle or provide passengers with a more stable ride while on board the vehicle

3.5
accessible transport vehicle for sitting and standing passengers
ATV-SS
a motor vehicle, designed and manufactured to provide transport service for primarily seated and standing passengers, with provision for the needs of persons with physical disabilities

3.6
lateral excursion barrier
LEB
structure or device to the right and/or left of the occupied wheelchair, designed to prevent the wheelchair from tipping, rotating or sliding into the centre aisle or vehicle wall during transport

NOTE The LEB can be padded to reduce or cushion the impact of any accidental contact.

3.7
occupant retention device
system or device used to retain the occupant of the wheelchair in a low-g environment

3.8
passive securement system
method of preventing undesirable wheelchair movement (containment) that does not require the physical attachment of securement devices by the wheelchair user or vehicle operator

3.9
rearward-facing wheelchair passenger space
RF-WPS
location in a large transport vehicle that limits movement of an occupied rearward-facing wheelchair through the use of structures and devices that do not require the physical attachment of wheelchair securement devices by the wheelchair user or vehicle operator

3.10
rearward excursion barrier
REB
structure or device designed to limit rearward movement, relative to the vehicle, of a rearward-facing wheelchair

3.11
seat bight height
vertical distance from the floor to the intersection of the seat and back planes of a wheelchair

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3.12
surrogate wheelchair
SWC
reusable device, which conforms to Annex D, that is used to simulate a production wheelchair for the purpose of Annex B containment testing

3.13
wheelchair reference plane
vertical plane in the longitudinal centre line of the wheelchair

4 Design requirements

4.1 A rearward-facing wheelchair passenger space (RF-WPS) shall:

a) comply with the dimensional and clear space requirements specified in Annex A;

b) be fitted with

1) a FEB that limits the wheelchair's movement toward the front of the vehicle,

2) a handrail or handhold to facilitate wheelchair occupant stability during transport,

3) a means to limit lateral tipping, sliding and rotational movement of the wheelchair,

NOTE The vehicle wall can be the means to limit movement in one direction.

4) an occupant retention device for optional use by the wheelchair occupant,

5) a means to limit rearward motion, relative to the vehicle, sliding or tipping of the wheelchair, and

NOTE The occupant retention device or an auxiliary securement strap may be such a means.

6) a device affixed within the wheelchair passenger space, located as specified in Annex A, that allows the wheelchair passenger to request a normal stop to egress from the vehicle;

c) be ready for use (access for a wheelchair is unobstructed and any flip-down seats are in the up position) when entered by a wheelchair user;

d) be usable by other passengers (sitting or standing) when no wheelchair user is present;

e) have components or structures that may contact the wheelchair occupant or other passengers during emergency driving manoeuvres covered by energy absorbing materials that conform to the performance specifications of FMVSS 201 or ECE R 21;

f) have components that are smoothly finished without sharp (radius <2 mm) edges, burrs or irregularities.

5 Performance requirements

5.1 Static strength of wheelchair passenger space components

5.1.1 Forward excursion barrier

When tested in accordance with C.5.1, the FEB shall:

a) not fracture or expose sharp structures with a radius of <2 mm;

b) not permanently deform by >15 mm from the pre-test configuration;

c) not have adjustable components that will move by >15 mm from their original position.

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5.1.2 Lateral excursion barrier(s)

If provided, the LEB shall be tested in accordance with C.5.2 and shall:

a) not fracture or expose sharp structures with a radius of <2 mm;

b) not permanently deform by >15 mm from the pre-test configuration;

c) not have adjustable components that will move by >15 mm from their original position.

5.1.3 Rearward excursion barrier(s)

If provided, the REB shall be tested in accordance with C.5.3 and shall:

a) not fracture or expose sharp structures with a radius of <2 mm;

b) not permanently deform by >15 mm from the pre-test configuration;

c) not have adjustable components that will move by >15 mm from their original position.

5.2 Wheelchair movement

When tested in accordance with Annex B, the wheelchair passenger space shall prevent:

a) lateral tipping of the wheelchair to an angle of >10°;

b) rearward tipping of the wheelchair (i.e. forward tipping relative to vehicle) to an angle of >10°;

c) translation of the wheelchair in any direction by >50 mm;

d) lateral rotation (about a vertical axis) of the wheelchair reference plane by >15° in either direction from the longitudinal reference axis of the RF-WPS.

5.3 Coefficient of friction of floor material

When tested in accordance with ISO 7176-13, the RF-WPS floor surface material shall have a coefficient of friction in the range of 0,65 to 0,8.

6 Information, identification and instruction requirements

6.1 Identification and labelling of RF-WPS components and subassemblies

6.1.1 Permanent labelling of components

Permanently installed and replacement parts shall be permanently and legibly marked with:

a) the manufacturer's name or trademark;

b) the month and year of manufacture, and any other identification necessary to clearly identify an assembly or subassembly in the event of a product recall;

c) a mark showing that the device conforms to this part of ISO 10865.

6.1.2 Identification

Primary components and subassemblies shall be accompanied by information that includes:

a) the manufacturer's model and part number or an equivalent identification code;

b) the name and intended use of each component.

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