PAS 2012-1:2015

BSI Standards Publication

Specification for M1 vehicles for the carriage of one or more passengers seated in wheelchairs

Part 1: Manufacturing requirements

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Contents

Foreword *iii*
0 Introduction *1*
0.1 General *1*
0.2 Accessibility *1*
0.3 Wheelchair mass *2*
0.4 Forward and rearward-facing installations *2*
0.5 Assisted and unassisted entry WAVs *2*
0.6 Tie-downs *2*
1 Scope *3*
2 Normative references *4*
3 Terms, definitions and abbreviations *5*
3.1 Terms and definitions *5*
3.2 Abbreviations *7*
4 General provisions *7*
4.1 Structural integrity *7*
4.2 Wheel alignment *8*
4.3 Ground clearance *9*
4.4 Lowering suspension system *9*
4.5 Seats, fuel tanks, fittings and trim *9*
5 Wheelchair access and WAV dimensions *10*
5.1 Entrance *10*
5.2 Wheelchair space *10*
5.3 Ramps *11*
5.4 Lifts *17*
5.5 Ramp, lift and spare wheel mounting strength *18*
5.6 Winch *19*
6 Wheelchair tie-down and occupant-restraint systems and their anchorages *21*
6.1 WTORS *22*
6.2 Wheelchair occupant restraint effective anchorage locations *22*
6.3 Recommendations for four-point wheelchair tie-down anchorage locations *23*
6.4 Strength of WTORS anchorages *23*
6.5 Back and head support for WAVs for the carriage of rearward-facing wheelchairs *24*
7 User manual *25*
7.1 General *25*
7.2 Basic information *25*
7.3 WAV technical specification *25*
7.4 Operating and safety instructions *26*
8 Miscellaneous provisions *27*
8.1 Product information *27*
8.2 Repair services *27*
8.3 Re-call procedure *27*
8.4 Complaints procedure *27*
8.5 Replacement parts and service information provision *27*
8.6 Build records *27*
8.7 Provision of information to the WAV retailer *28*
9 Claims of conformance *28*

Annexes
Annex A (normative) Torsion test for a structurally modified WAV *29*
Annex B (normative) Method of measurement for WAV dimensions *33*
Annex C (normative) Dynamic strength test for ramp, lift and spare wheel mountings and WTORS anchorages for forward-facing wheelchairs ≤200 kg *48*
Annex D (normative) Static strength test for ramp, lift and spare wheel mountings *51*

Annex E (normative) Static strength test for WTORS anchorages for forward-facing wheelchairs ≤85 kg *53*
Annex F (normative) Static strength test for WTORS anchorages and back and head support for rearward-facing wheelchairs *56*
Annex G (normative) Surrogate wheelchair (SWC) *60*
Annex H (informative) Dimensional parameters of the back and head support *65*
Bibliography *68*

List of figures

Figure 1 – Maximum permitted obstructions in ramp surfaces *12*
Figure 2 – Example of a ramp side guard with height >25 mm – Permissible gaps and radii *14*
Figure A.1 – Initial measurement points across vehicle cross section closest to the area containing the main structural modifications *30*
Figure A.2 – Measurement points across vehicle cross section closest to the area containing the main structural modifications with deflection induced *31*
Figure B.1 – Accessibility gauge dimensions *34*
Figure B.2 – Accessibility gauge – Side board dimensions *35*
Figure B.3 – Accessibility gauge – General arrangement *36*
Figure C.1 – Acceleration/deceleration-time pulse *49*
Figure E.1 – Torso traction device *53*
Figure E.2 – Pelvic traction device *54*
Figure F.1 – Back and head support test equipment *57*
Figure G.1 – Side view of SWC *62*
Figure G.2 – Front view of SWC *63*
Figure G.3 – Plan view of SWC *64*
Figure G.4 – Scrap view of rear tie-down attachment point (Item 4, Figure G.1) *65*
Figure H.1 – Dimensional parameters (side view) *66*
Figure H.2 – Dimensional parameters (rear view) *67*

List of tables

Table 1 – WAV technical specification *(1 of 2)* *25*
Table B.1 – Accessibility gauge minimum and maximum measuring dimensions *33*
Table E.1 – Test loads applied to forward-facing WOTRS anchorages in the forward direction *55*
Table F.1 – Test loads applied to rearward-facing WOTRS anchorages in the rearward direction *59*
Table H.1 – Dimensional parameters of the back and head support *66*

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 70, an inside back cover and a back cover.

Foreword

Publishing information

This PAS was sponsored by the Wheelchair Accessible Vehicle Converters' Association (WAVCA)[1)] with support from the Motability Tenth Anniversary Trust. Its development was facilitated by BSI Standards Limited and it was published under licence from The British Standards Institution. It came into effect on 28 February 2015.

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- Vehicle Certification Agency – Department for Transport (VCA)
- Wheelchair Accessible Vehicle Converters' Association (WAVCA)

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The PAS process enables a specification to be rapidly developed in order to fulfil an immediate need in industry. A PAS may be considered for further development as a British Standard, or constitute part of the UK input into the development of a European or International Standard.

This PAS is not to be regarded as a British Standard. It will be withdrawn upon publication of its content in, or as, a British Standard.

Relationship with other publications

PAS 2012 is published in two parts, as follows:

- *Specification for M1 vehicles for the carriage of one or more passengers seated in wheelchairs – Part 1: Manufacturing requirements*
- *Specification for M1 vehicles for the carriage of one or more passengers seated in wheelchairs – Part 2: Retail requirements*

Supersession

This PAS supersedes PAS 2012-1:2012, which is withdrawn.

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1) www.wavca.co.uk

Use of this document

It has been assumed in the preparation of this PAS that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Product certification/inspection/testing. Users of this PAS are advised to consider the desirability of third-party certification/inspection/testing of product conformity with this PAS. Appropriate conformity attestation arrangements are described in BS EN ISO/IEC 17050. Users seeking assistance in identifying appropriate conformity assessment bodies or schemes may ask BSI to forward their enquiries to the relevant association.

Assessed capability. Users of this PAS are advised to consider the desirability of quality system assessment and registration against the appropriate standard in the BS EN ISO 9000 series by an accredited third-party certification body.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a PAS cannot confer immunity from legal obligations.

0 Introduction

0.1 General

The UK wheelchair accessible vehicle (WAV) industry started in the early 1960s to assist people with a mobility impairment to travel in their wheelchair in a motor vehicle.

In the beginning most conversions were rudimentary, addressing only access and basic securing of the wheelchair. Since then, the WAV industry has grown enormously and the range of WAVs offered has also grown in response to customer demand. With an ageing population, the number of wheelchair users who require access to transport in both wheelchair accessible taxis and personal private vehicles is set to rise higher in the future.

In recent years, as a result of campaigning by UK industry, the European Commission has included WAVs as a new category of "special purpose vehicle" within the amendments of Directive 2007/46/EC [1]. However, compliance with Directive 2007/46/EC is not mandatory for all WAVs produced in the UK, as there are alternative approval routes open to manufacturers. In addition, the requirements of the Directive are, in the main, limited to the securing of the wheelchair and occupant within the WAV. They do not address accessibility issues. Furthermore, the Directive specifies certain tests based on an assumed maximum wheelchair mass of 85 kg, whereas electric wheelchairs substantially in excess of this mass are already routinely being carried in WAVs. Although certain basic requirements for rearward-facing wheelchair installations (such as in many UK taxis) are now included in the Directive, there is still no requirement for a head and back support. This has therefore been included in this PAS.

0.2 Accessibility

Minimum generic accessibility dimensions for WAVs do not take account of the varying sizes of wheelchair users and their wheelchairs, resulting in some larger wheelchair users being denied the use of a WAV and some users of smaller wheelchairs having to use WAVs which are far larger than needed, with the associated increased cost and environmental impact of running a larger WAV. Each individual wheelchair user or each particular specifier of WAVs have their own particular requirements and capabilities, so a WAV suitable for one wheelchair user might not be suitable for another.

In an attempt to address these issues, this PAS introduces a new gauge for measuring the accessibility of WAVs so that a set of key accessibility dimensions can be provided to the end user, enabling them to make an informed decision when selecting a WAV. Previous systems of providing measurements, based on simple linear dimensions taken with a tape measure, have not been able to take into account the space that might be required to manoeuvre a wheelchair from the WAV entrance to the travelling position. Potential purchasers of a WAV are usually aware of their principal dimensions when seated in their wheelchair and can compare these with a variety of potential WAVs prior to making a choice. Similarly, specifiers of WAVs for commercial duties (e.g. care homes or taxi licensing authorities) can select a particular set of minimum dimensions that satisfies their needs for any particular application.

The accessibility gauge used in this PAS was developed using data from the Department for Transport study, *A survey of occupied wheelchairs and scooters* (2006), conducted by CEDS. The survey took and catalogued various measurements of over 1 300 wheelchair users and their wheelchairs. The accessibility gauge used in this PAS is designed to be adjustable to represent the length, width and height

of all sizes of occupied wheelchair ranging from the 5th percentile child at the smallest end of the scale, to a size in excess of the 95th percentile adult at the largest. In this way, this PAS aims to encompass the vast majority of wheelchair users in the UK.

0.3 Wheelchair mass

This PAS specifies performance and test requirements for securing wheelchairs of an unoccupied mass of ≤200 kg.

Whilst no requirement contained in this PAS can be regarded as a substitute for any type approval requirement, it is recognized that in many cases, test work to satisfy the requirements of this PAS might be undertaken in parallel with test work undertaken as part of a type approval programme. It is therefore desirable to combine tests wherever possible. In some areas, this PAS specifies alternative test methods to demonstrate compliance with its requirements.

As an example, Annex C (a dynamic test) or Annex E (a static test), are both intended to determine the strength of wheelchair tie-down and occupant restraint anchorages for wheelchairs weighing ≤85 kg. Either method is acceptable as a means of satisfying the requirements of this PAS and WAV manufacturers may choose whichever test method provides the most convenient and cost-effective method of demonstrating compliance, when combined with their chosen type approval route.

However, none of the currently available type approval routes cater for wheelchairs weighing >85 kg, and when testing the strength of wheelchair tie-down and occupant restraint anchorages for such wheelchairs, the PAS specifies only a dynamic test method.

0.4 Forward and rearward-facing installations

Most privately-owned WAVs provide a forward-facing designated travelling position. However, some WAVs, such as accessible UK taxis, might have a rearward-facing designated travelling position. This PAS differentiates between the testing requirements for forward and rearward testing by providing separate test methods for each case. The strength requirements for the back and head support for a rearward-facing wheelchair occupant closely mirror those currently applicable to accessible buses, and are primarily intended to provide comfort and stability for a rearward-facing wheelchair occupant rather than crash protection.

0.5 Assisted and unassisted entry WAVs

This PAS is not applicable to completed drive-from-wheelchair WAVs, because such WAVs are always bespoke, taking into account an individual's ability to access the WAV and drive it. Wheelchair tie-down arrangements and driving controls for these WAVs would be difficult to standardize, however, some of the requirements of this PAS can be usefully applied to drive-from-wheelchair WAVs insofar as their basic level of accessibility is concerned. Two definitions are used in this PAS – "AWAV" (assisted entry wheelchair accessible vehicle), (see **3.1.3**) and "UWAV" (unassisted entry wheelchair accessible vehicle) (see **3.1.21**) to cover the two basic types of WAV. In some parts of the PAS, separate requirements apply to each.

0.6 Tie-downs

This PAS is limited to WAVs in which the wheelchair is restrained using four-point strap-type tie-downs due to the lack of technical data to support the drafting of requirements for other types of wheelchair tie-down equipment. In particular, when securing the wheelchair with a docking station, there are difficulties in

standardizing the attachment method of the docking station interface pin to the surrogate wheelchair (SWC), especially when ballasted to masses well in excess of 85 kg. Also, the bespoke nature of installations involving docking stations makes each WAV fitted with a docking station different, and therefore impractical to test destructively. However, the general principles of the test methods in this PAS may also be applied to other types of WTORS and WTORS anchorages, subject to it being possible to make suitable modifications to the SWC used for testing.

1 Scope

This part of PAS 2012 specifies design and manufacturing requirements for a wheelchair accessible vehicle (WAV) of EC Category M1, in which one or more passengers travel, each seated in a wheelchair that is secured in the WAV using four-point strap-type tie-downs.

NOTE 1 Some four-point strap-type tie-downs are wheelchair-specific, and are designed to be used with only one particular model of wheelchair. Care should be taken when selecting appropriate tie-downs, as not all four-point strap-type tie-downs might be suitable for test in accordance with the requirements of this PAS. For example, it might not be possible to attach some wheelchair-specific tie-downs to a SWC and some wheelchair-specific WTORSs include wheelchair occupant restraint anchorages that attach to the wheelchair itself rather than the WAV structure.

It specifies:

a) a gauge-based method for measuring the key accessibility dimensions of WAVs capable of transporting occupied wheelchairs ranging from 775 mm to 1 350 mm long, 500 mm to 830 mm wide and 975 mm to 1 550 mm high;

b) a separate method for measuring the key accessibility dimensions of WAVs capable of transporting occupied wheelchairs in excess of 1 350 mm long, 830 mm wide or 1 550 mm high;

c) requirements for wheelchair access devices (where fitted), including:

   1) ramps;

   2) lifts;

   3) winches;

d) requirements for wheelchair tie-down and occupant restraint system (WTORS) anchorages for securing wheelchairs ≤200 kg in mass, and wheelchair users, within the WAV, including:

   1) static and dynamic test methods, (either of which can be used), for determining the strength of WTORS anchorages for forward-facing wheelchairs ≤85 kg;

   2) a dynamic test method for determining the strength of WTORS anchorages for forward-facing wheelchairs >85 kg to ≤200 kg;

e) requirements for rearward-facing wheelchair installations including:

   1) static test method for WTORS anchorages;

   2) static test method for wheelchair occupant head and back support;

f) structural integrity; and

g) requirements for service elements, for example, a user manual (including WAV technical specification to facilitate direct comparisons between WAVs) and re-call procedures.

It does not specify requirements for securing an occupied wheelchair in the driving position of a WAV.

NOTE 2 The securing of an occupied wheelchair in the driving position of a WAV tends to be a bespoke solution for which appropriate design and test requirements have not yet been fully developed.

It does not specify requirements for securing the wheelchair other than with four-point strap-type tie-downs.

NOTE 3 PAS 2012-1 is limited to four-point strap-type tie-downs due to the lack of technical data to support the drafting of requirements for other, more bespoke types of wheelchair tie-down equipment. However, the general principles of the test annexes may be applied to other types of wheelchair tie-down equipment, subject to it being possible to make appropriate modifications to the SWC.

This part of PAS 2012 does not specify requirements for the retail of WAVs.

NOTE 4 PAS 2012-2 specifies requirements for the retail of WAVs conforming to PAS 2012-1.

NOTE 5 In cases where items or features fitted to a WAV are optional, the requirements applicable to them only apply where fitted.

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.

Standards publications

BS 6109-2:1989, *Tail lifts, mobile lifts and ramps associated with vehicles – Part 2: Code of practice for passenger lifts and ramps*

BS EN 1756-2:2004+A1:2009, *Tail lifts – Platform lifts for mounting on wheeled vehicles – Safety requirements – Part 2: Tail lifts for passengers*

BS ISO 6487, *Road vehicles – Measurement techniques in impact tests – Instrumentation*

BS ISO 10542-1:2001, *Technical systems and aids for disabled or handicapped persons – Wheelchair tie-down and occupant-restraint systems – Part 1: Requirements and test methods for all systems* [2)]

BS ISO 10542-2:2001, *Technical systems and aids for disabled or handicapped persons – Wheelchair tie-down and occupant-restraint systems – Part 2: Four-point strap-type tie-down systems* [3)]

BS ISO 10542-1:2012, *Technical systems and aids for disabled or handicapped persons – Wheelchair tie-down and occupant-restraint systems – Part 1: Requirements and test methods for all systems*

Other publications

[NR1] DRIVER & VEHICLE STANDARDS AGENCY. *Code of Practice on Vehicle Safety Defects and Recalls.* Bristol. DVSA, 2014. (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/302292/code-of-practice-vehicle-safety-defects-and-recalls.pdf)

2) Withdrawn

3) Withdrawn

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3 Terms, definitions and abbreviations

For the purposes of this PAS, the following terms, definitions and abbreviations apply.

3.1 Terms and definitions

3.1.1 approval route
regime under which the WAV was approved for use on a public road

NOTE 1 Such routes may include schemes such as EC Whole Vehicle Type Approval, EC Small Series Type Approval, National Small Series Type Approval, EC Whole Vehicle Type Approval as a Special Purpose Vehicle and Individual Vehicle Approval.

NOTE 2 In some cases, such as highly bespoke conversions to suit a particular user's needs, a WAV might not have been approved in its completed state, but converted "post-registration". Similarly, a WAV that has been approved prior to registration might also have been subsequently subjected to further modifications.

3.1.2 assistant
person who assists a wheelchair user to board and alight the vehicle and aid the correct use of WTORS

NOTE The assistant is usually the driver.

3.1.3 assisted entry wheelchair accessible vehicle (AWAV)
WAV designed such that an assistant is required to aid the boarding and alighting of a wheelchair user

3.1.4 base vehicle
vehicle used as the foundation for a WAV conversion

3.1.5 conversion warranty
warranty provided by the WAV manufacturer on those parts of a WAV that are not covered by the base vehicle warranty

NOTE A WAV converted from a base vehicle (as distinct from a WAV built in a single stage) is typically covered by two warranties. Those parts and systems on the WAV that relate to the base vehicle (e.g. transmission, brakes, steering) are covered by the base vehicle manufacturer's warranty, and those that are peculiar to the converted WAV are covered by the conversion warranty.

3.1.6 designated travelling position
position of the occupied wheelchair in the WAV whilst travelling

NOTE For measuring and testing purposes, to achieve the designated travelling position, point P on the accessibility gauge or SWC is aligned with point W as nominated by the WAV manufacturer.

3.1.7 forward-facing
orientation of the occupied wheelchair within the WAV facing towards the front of the WAV such that the longitudinal centre line of the wheelchair or seat is at an angle of 3° or less to the longitudinal centre line of the WAV

3.1.8 four-point strap-type tie-down
wheelchair tie-down system that uses four or more strap assemblies to secure the wheelchair in the vehicle, attaching to four separate securement points on the wheelchair

[BS ISO 10542-1:2012, **3.17**, modified]

3.1.9 kerb weight
weight of the WAV with no occupants and a full supply of fuel in its tank, an adequate supply of other liquids incidental to its propulsion and no load other than the loose tools and equipment with which it is normally equipped

3.1.10 lift
device or system with a platform that can be raised or lowered to provide access for occupied wheelchairs between the floor of a passenger compartment and the ground or kerb

[Directive 2001/85/EC [2], modified]

3.1.11 line pull
mass, in kg, that a winch is able to lift vertically through a height of not less than 0.5 m

3.1.12 lowering suspension system
system which lowers and lifts totally or partially the body of a vehicle relative to the normal running position

[Directive 2001/85/EC [2], modified]

3.1.13 M1
vehicles designed and constructed for the carriage of passengers and comprising no more than eight seats in addition to the driver's seat

[Directive 2007/46/EC [1]]

3.1.14 mass in running order
mass of an unladen vehicle, carrying all liquids needed for operation, tools, spare wheel, if fitted, a mass of 75 kg in the driving seat and its fuel tank filled to at least 90% of rated capacity

[Directive 2007/46/EC [1], modified]

3.1.15 maximum access dimensions
maximum length, width and height of the accessibility gauge that can be manoeuvred from the ground, into each designated travelling position, and back

3.1.16 point P
reference point on the accessibility gauge or SWC, taken to represent the wheelchair user's hip when seated in their wheelchair

3.1.17 point W
location of point P relative to a WAV datum when the accessibility gauge or SWC is in its designated travelling position

3.1.18 ramp
series of one or more movable elements used to form an inclined track for wheelchairs to enter the vehicle from the ground

3.1.19 rearward-facing
orientation of the occupied wheelchair within the WAV, facing towards the rear of the WAV such that the longitudinal centre line of the wheelchair or seat is at an angle of 10° or less to the longitudinal centre line of the WAV

3.1.20 tie-down
device or system designed to secure a wheelchair in place in a WAV

3.1.21 unassisted entry wheelchair accessible vehicle (UWAV)
WAV designed such that an assistant is not required to aid the boarding and alighting of a wheelchair user

3.1.22 WAV manufacturer
person or company that manufactures a WAV through the conversion of a base vehicle or through building in a single stage

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3.1.23 wheelchair
device to provide wheeled mobility with a seating support system for a person with impaired mobility

[BS ISO 7176-26:2007, **4.1.1**]

3.1.24 wheelchair accessible vehicle (WAV)
vehicle designed to transport one or more passengers seated in their wheelchair

3.1.25 wheelchair occupant restraint
system or device intended to restrain a wheelchair occupant within their wheelchair during an abrupt vehicle movement or an impact, in order to prevent ejection from the wheelchair, and to prevent or minimize contact with the vehicle interior components and other passengers

3.1.26 wheelchair occupant restraint effective anchorage
point used to determine the angle or position of each part of the wheelchair occupant restraint belt in relation to the wheelchair occupant, and taken as the centre of the webbing strap as it passes over the last hard surface of the anchorage that alters its lie, prior to reaching the wheelchair occupant

3.1.27 wheelchair tie-down and occupant-restraint system (WTORS) anchorage
part of the WAV to which a wheelchair occupant restraint and/or tie-down can be secured

3.1.28 wheelchair tie-down effective anchorage
point used to determine the angle or position of each part of a strap-type wheelchair tie-down in relation to the wheelchair, and taken as the centre of the webbing strap as it passes over the last hard surface of the anchorage that alters its lie, prior to reaching the wheelchair

3.2 Abbreviations

ATD	anthropomorphic test device
AWAV	assisted entry wheelchair accessible vehicle
GVW	gross vehicle weight
PTV	pendulum test value
SWC	surrogate wheelchair
SWL	safe working load
UWAV	unassisted entry wheelchair accessible vehicle
VIN	vehicle identification number
WAV	wheelchair accessible vehicle
WTORS	wheelchair tie-down and occupant-restraint system

4 General provisions

4.1 Structural integrity

4.1.1 General

Where the construction of a WAV involves modification to the structure of a base vehicle in the floor, roof, door or tailgate aperture area, the torsional stiffness of the WAV shall be tested in accordance with Annex A.

When tested in accordance with Annex A, the deflection of the completed WAV shall be between 0.5 times and 1.5 times the deflection of the base vehicle.

4.1.2 Structural modifications

NOTE 1 Where a base vehicle structure has been modified, consideration should be given to the design, validation and execution of the modifications, with regard to the demands likely to be placed on the completed WAV structure in use. There are no type approval requirements relating to the durability of the completed WAV, and consideration should be given to the effects of fatigue loadings on the structure and the effects of corrosion – particularly in areas where the corrosion protection of the base vehicle has been breached during the conversion. This can be especially important where galvanically dissimilar metals are placed in electrical contact with one another. Accelerated life cycle tests (such as salt spray and pavé track work) might be useful in validating the design of the WAV structure. In all cases where a structural modification is made, a suitable quality inspection procedure of the completed joints should be implemented.

NOTE 2 Where welding operations are carried out, particularly to structural areas of the WAV and to suspension components and their attachment brackets, consideration should be given to the selection of materials and welding consumables, so as to maximize compatibility with the parent metal on the base vehicle. Consideration should also be given to the metallurgical compatibility and gauges of the materials being joined. BS EN ISO 3834, combined with the product specification, gives guidance on selection of appropriate levels of weld quality for each weld. Those welds requiring welder certification can then be identified and consideration should be given to ensuring that appropriately coded welders are available to carry out these welding operations. Commonly used standards for approval testing of coded welders include BS 4872-1, BS 4872-2, BS EN ISO 9606-1 and BS EN ISO 9606-2, depending on the material(s) being welded and the welding processes being used.

NOTE 3 Mechanical fastening techniques commonly used in WAVs include screwing, bolting and riveting (including clinched threaded fasteners). Consideration should be given to the specification of all fasteners with regard to loading, corrosion resistance (including galvanic compatibility of the materials to be joined), and the environment in which the fasteners might be expected to operate. In the case of threaded fasteners, appropriate selection of tightening torques and the correct specification of anti-vibration locking features and mating fasteners should be considered. Fasteners subject to replacement or inspection at specified intervals in service should be listed in the user manual, along with the specified replacement interval and tightening torque. Where automated or semi-automated assembly techniques are used (e.g. rivets or other types of clinched fastener), consideration should be given to the correct selection of the consumables, as well as the maintenance and regular inspection of the tools used, to ensure the correct grip range is maintained.

NOTE 4 Adhesives are increasingly being used in the conversion of base vehicles to WAVs, often in conjunction with mechanical fasteners. Consideration should be given to the specification of any structural adhesives used in the WAV, and their compatibility with the material(s) to be joined. The design of any joints should be considered with regard to the properties of the particular adhesive being used. Appropriate protection from heat sources and complimentary traditional joining techniques for joints subject to tensile or peeling loads should be considered. Consideration should also be given to the application of the adhesives, and, in particular, the cleaning and surface preparation of the substrates and the control of temperature and humidity during the curing process.

4.2 Wheel alignment

Where wheel alignment could be affected by the conversion process, the WAV manufacturer shall have a system in place for checking and, if necessary, re-adjusting the wheel alignment.

NOTE Such modifications may include, but are not limited to: modification of a suspension linkage or attachment point, modifications to the base vehicle structure within 500 mm of a suspension attachment point or the alteration of spring rates or base vehicle ride height.

4.3 Ground clearance

When measured in accordance with Annex B (see **B.3.14**), the minimum ground clearance shall be 120 mm.

4.4 Lowering suspension system

4.4.1 A failure of the lowering suspension system shall not leave the WAV immobilized.

NOTE It is acceptable for the WAV's speed to be considerably reduced by a failure of the lowering system, provided that it can be moved to a place of safety under its own power.

4.4.2 At least one set of controls for the operation of the lowering suspension system shall:

a) for an AWAV, be located at the entrance used for wheelchair access;

b) for a UWAV, be operable remotely from outside the UWAV.

4.4.3 The design of the lowering suspension system shall be such that either:

a) the system automatically raises itself to normal running position if the WAV is moved under its own power before the speed reaches 10 km/h; or

b) an audible and/or visual warning device alerts the driver if the handbrake is released whilst the lowering suspension system is in its lowered state.

4.4.4 The WAV shall incorporate one or more features intended to prevent the lowering suspension system from being activated when the WAV is being driven.

NOTE Examples of such features may include, but are not limited to, interlocks preventing the lowering suspension from being activated under the following conditions:

a) the parking brake being released;

b) all doors (including the tailgate) being closed;

c) the road wheels turning;

d) the driver's seat occupied.

4.4.5 A lowering suspension system relying on compressed air in order to function shall be equipped with a means of either preventing the formation of condensation or automatically draining condensation.

4.5 Seats, fuel tanks, fittings and trim

NOTE All conversions should be carried out with due regard to the function of the finished WAV. Fittings and trim used in the section of the WAV in which the wheelchair occupant travels should be of the same or similar quality to those used throughout the rest of the base vehicle. Upholstery and floor coverings should match, as closely as possible, those in the parts of the WAV in which other passengers travel.

4.5.1 For every seating position in the WAV, including any wheelchair space(s), a minimum of a three-point occupant restraint shall be provided.

4.5.2 Where any new seat belt anchorage is provided, or modifications to the base vehicle or seat structure are carried out within 300 mm of any existing seat belt anchorage, the seat belt anchorages of the affected seating position(s) shall conform to the strength, positional and testing requirements for three-point belt anchorages fitted to vehicles of category M1, set out in either UN/ECE Regulation 14.05, 14.06 or 14.07 [3], Sections 5, 6 and 7 or Directive 76/115/EC [4] (as amended).

NOTE 1 UN/ECE Regulation 14 [3] and Directive 76/115/EC [4] are considered equivalent and interchangeable. Depending on the approval route used by the WAV manufacturer, they are not always mandatory. In order for a WAV to conform to this PAS, this requirement is always applicable regardless of the approval route.

NOTE 2 EC Regulation 661/2009 (the "General Safety Regulation") [5] repeals Directive 76/115/EC [4] and all its amending directives. However, some levels of approval in the UK still accept compliance with the Directive. For this reason, references to the Directive have not been removed in this review.

4.5.3 Where base vehicle seating positions or their anchorages are modified and those seats were originally equipped with one or more ISOFIX child seat anchorages, the ISOFIX anchorages on the modified seat shall either:

a) conform to the requirements of either UN/ECE Regulation 14.06 [3] or any subsequent amendment UN/ECE Regulation 14, Sections 5, 6 and 7; or

b) any label or other marking denoting their presence on the seat be removed or defaced and a note fixed in the base vehicle handbook amending any pages relating to the ISOFIX fittings.

4.5.4 Where one or more seats within the WAV need to be tilted or folded to allow a wheelchair user to be carried, a means of preventing the seats from falling back down shall be provided.

NOTE Such means may include a mechanical lock, prop or strap to secure the seat in its tilted or folded position.

4.5.5 Where an existing fuel tank for liquid fuel or its filler neck and associated pipework is modified, or an alternative tank is fitted, the fuel tank, the filler neck and associated pipework used shall conform to either the requirements of UN/ECE Regulation 34.02 [6], Part I, or EC Directive 70/221 (as amended) [7], Annex I, Sections 5 and 6.

NOTE 1 UN/ECE Regulation 34 [6] and Directive 70/221/EC [7] are considered equivalent and interchangeable. Depending on the approval route used by the WAV manufacturer, they are not always mandatory. In order for a WAV to conform to this PAS, this requirement is always applicable regardless of the approval route.

NOTE 2 EC Regulation 661/2009 (the "General Safety Regulation") [5] repeals Directive 70/221/EC [7] and all its amending directives. However, some levels of approval in the UK still accept compliance with the Directive. For this reason, references to the Directive have not been removed in the revision of this PAS.

NOTE 3 Attention is drawn to Regulation 39 of the UK Road Vehicles (Construction and Use) Regulations 1986 [8] containing legal requirements for fuel tanks made from a plastic material.

5 Wheelchair access and WAV dimensions

5.1 Entrance

5.1.1 At least two entrances on the WAV shall provide access to the wheelchair space.

5.1.2 At least one entrance, the wheelchair access entrance, shall allow access and egress for an occupied wheelchair of the dimensions determined in **B.3.15**.

5.2 Wheelchair space

5.2.1 The maximum length, width and height of an occupied wheelchair that can be accommodated in each designated travelling position shall be determined in accordance with Annex B.

5.2.2 The maximum dimensions of the wheelchair access entrance shall be determined in accordance with Annex B.

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5.2.3 The maximum access dimensions (as defined in **3.1.14**) shall be determined in accordance with Annex B.

5.2.4 The slope of the wheelchair in each designated travelling position shall be determined in accordance with Annex B.

5.2.5 The seated eye height of each designated travelling position shall be determined in accordance with Annex B.

NOTE The floor in the wheelchair area should be slip resistant. Materials that are likely to achieve slip resistance include coatings with granular aggregate. As there is considerable variation in the materials that may be used to form the floors of WAV wheelchair areas, it is impossible to specify a level of slip resistance that will guarantee stability in all cases. However, a "dry grip value" (or "PTV") of 36 or more, when measured in accordance with the test method specified in BS 7976-2:2002+A1:2013 (or a similar standard relating to a specific flooring material), on all floors inclined at >5° to the horizontal, is likely to prove adequate in most cases.

5.2.6 For a UWAV, any door through which the wheelchair user can enter the WAV shall be operable with remote controls, from both inside and outside the UWAV.

5.2.7 The use of any one set of controls shall inhibit all other controls, such that only the control being used can operate the door or any powered part of the access equipment.

5.3 Ramps

5.3.1 Surface

NOTE 1 The ramp surface should be slip resistant. The slip resistance needed depends on the ramp angle in use and on whether the ramp could become wet. Materials that are likely to achieve slip resistance include coatings with granular aggregate. As there is considerable variation in the materials that may be used to form the surfaces of ramps, it is impossible to specify a level of slip resistance that will guarantee stability in all cases. However, a "wet grip value" (or "PTV") of 36 or more, when measured in accordance with the test method specified in BS 7976-2:2002+A1:2013 (or a similar standard relating to a specific flooring material), is likely to prove adequate in most cases.

NOTE 2 Attention is drawn to the UK Road Vehicle Lighting Regulations 1989 [9] which require certain rear lights to be visible when all doors, tailgates, and for a WAV, ramps or lifts, are open or deployed.

5.3.1.1 When the ramp is deployed, it shall provide a continuous surface with no gaps, holes or recesses within the working surface capable of allowing the complete insertion of a spherical probe greater than 15 mm in diameter.

5.3.1.2 Where a ramp is composed of more than one separate part, and those parts are not permanently attached to each other:

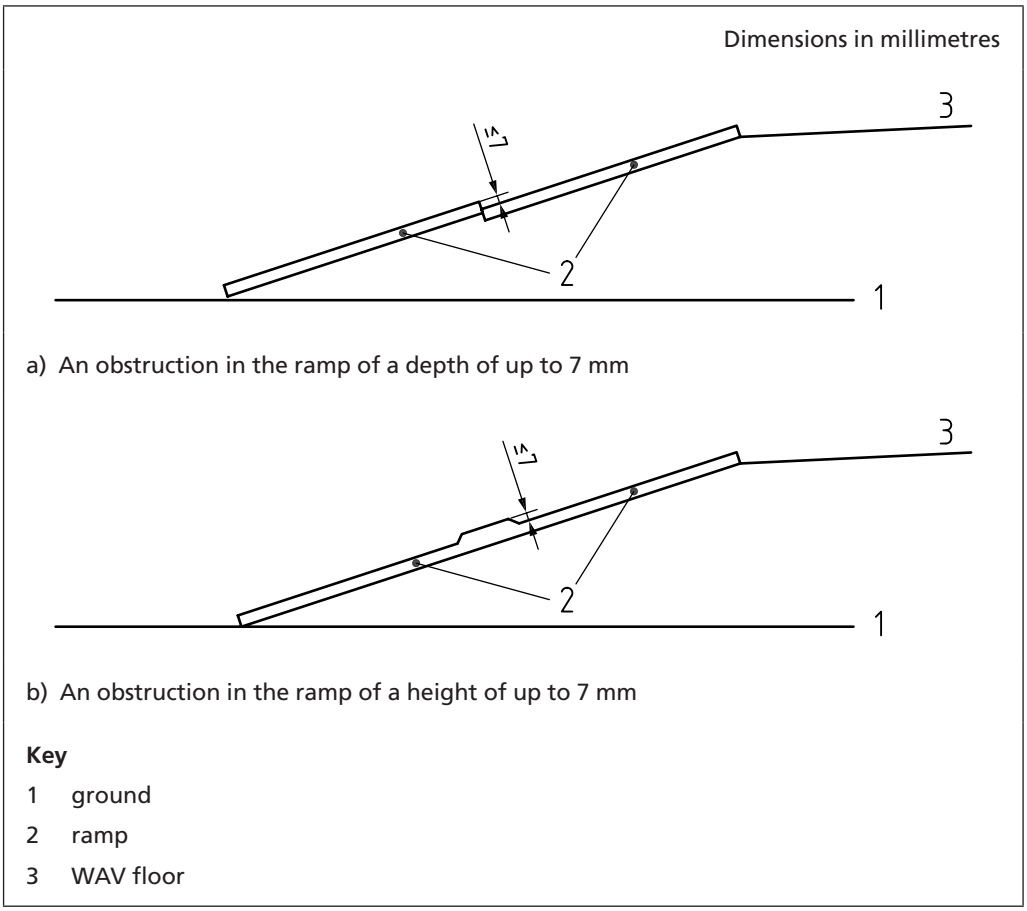
a) all mating parts shall be positively located together when deployed; and

b) the part closest to the wheelchair access door shall display the following text so as to be visible when the ramp is deployed: "WARNING Ramp extension piece may be required to provide satisfactory gradient".

5.3.1.3 The ramp surface shall contain no obstructions greater than 7 mm in height or depth, except at the point where the ramp meets the surface on to which it is deployed and where it meets the WAV floor. The extent of any obstruction shall be measured perpendicular to the ramp surface in accordance with Figure 1.

5.3.1.4 Any gap between the ramp and the WAV floor shall not be capable of allowing the complete insertion of a spherical probe greater than 15 mm in diameter.

Figure 1 **Maximum permitted obstructions in ramp surfaces**



5.3.2 Side guards

NOTE Side guards on ramps are also known as upstands.

5.3.2.1 When deployed, the ramp shall be provided with side guards along either side of its surface.

NOTE Side guards are necessary to reduce the risk of the wheelchair falling off the side of the platform. Side guards may be an integral part of the ramp structure or a part of the surrounding WAV bodywork or a combination of the two. For example, the WAV rear bumper in the area towards the top of the ramp could be used as a side guard.

5.3.2.2 Side guards shall, when deployed:

a) lie within 50 mm of the edge of the ramp surface, measured in the plane of the ramp surface;

b) extend from the point where the ramp crosses the door aperture, to within at least 100 mm of the edge of the ramp in contact with the ground;

c) be ≥25 mm high, measured perpendicular to the ramp surface;

NOTE Whilst the minimum side guard height specified in this PAS is 25 mm to align with existing standards, a minimum height of 40 mm is recommended. Some wheelchairs, particularly those with large diameter wheels or powered wheelchairs suitable for outdoor use, are capable of overcoming a 25 mm side guard. For the more powerful outdoor wheelchairs, even a side guard 100 mm high might not guarantee that the wheelchair remains on the ramp. At the same time, tall side guards increase the trip hazard for the assistant, encroach into the

wheelchair space on many WAV designs when the ramp is stowed, and increase the risk of "railroading" (where the side guard becomes trapped between the wheel and the manual propelling rings on some designs of manual wheelchair).

d) contain no gaps in the side guards, or between the upper end of the side guard and the door aperture, that exceed 25 mm in length at any point to a height of 25 mm above the ramp surface, measured perpendicular to the ramp surface;

NOTE 1 Figure 2 shows an example of a ramp with gap ("G") in the side guard.

NOTE 2 The intention behind the requirement is to reduce the possibility of one or more wheelchair wheels dropping over the edge of the ramp either on the way in or out of the WAV. For this reason, it is necessary to ensure that any gaps in the side guards (or between the side guards and the bodywork at the point the wheelchair enters the vehicle interior), are kept below 25 mm – at least up to the minimum required height of the side guard (which is 25 mm). As there is no requirement for a side guard higher than 25 mm, it follows that gaps longer than 25 mm are acceptable above this height.

NOTE 3 The term "door aperture" refers to the aperture left by the door when the door is open, usually defined by the door seal round the perimeter of the aperture or, in the absence of a door seal, the plane occupied by the ramp when in the stowed position.

e) have an edge radius of ≥0.5 mm on all edges contactable with a sphere of diameter (100 ± 5) mm;

f) where the thickness of the side guard t < 20 mm, have corner radii R ≥ 5 mm;

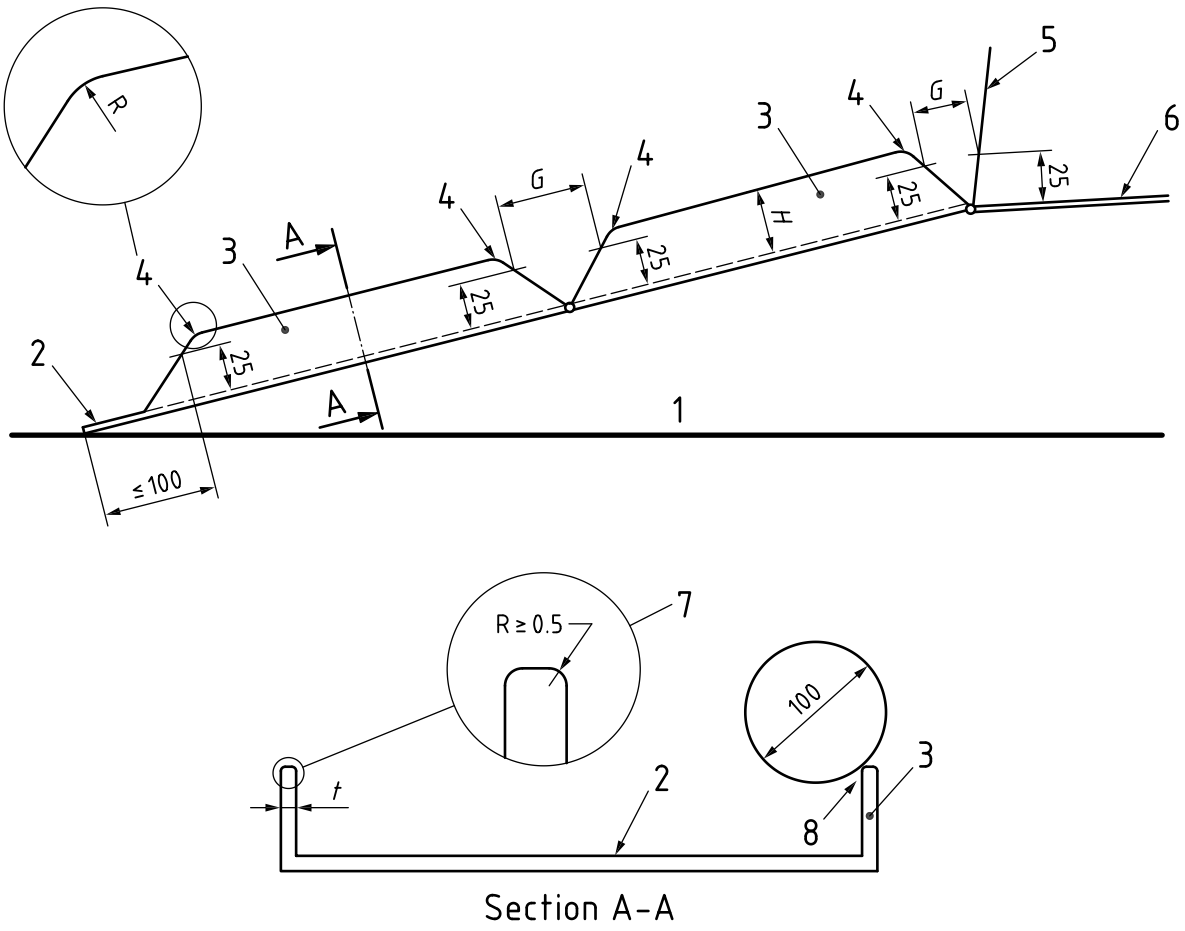
NOTE Figure 2 shows a side view and sectional view of a typical WAV ramp.

g) where the thickness of the side guard t ≥ 20 mm, have corner radii R ≥ 0.5 mm.

NOTE Figure 2 shows a side view and sectional view of a typical WAV ramp.

Figure 2 **Example of a ramp side guard with height >25 mm – Permissible gaps and radii**

Dimensions in millimetres



Key

1	ground	7	edge radius, *R*, of ≥0.5 mm
2	ramp working surface	8	upstand edge contactable with 100 mm sphere
3	side guard	*H*	side guard height of >25 mm
4	corner radius, *R*	*G*	gap in the side guard of ≤25 mm
5	door aperture	*t*	side guard thickness
6	WAV floor		

5.3.3 Stability

5.3.3.1 Any special instructions for ramp use or limitations when deployed under particular conditions shall be provided in the WAV user manual.

NOTE All ramps should be able to accommodate a variety of ground and kerb surface conditions. In particular, consideration should be given to all reasonably foreseeable conditions of WAV use (e.g. accessing the WAV on slopes or uneven, unstable, wet or slippery surfaces).

5.3.3.2 For an AWAV, the ramp, when deployed, shall be positively located at the point of its attachment to the WAV.

NOTE When the ramp is deployed, the edge of the ramp attached to the WAV should be located in such a way as to minimize the risk of it becoming dislodged during boarding or alighting of the wheelchair user.

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5.3.3.3 For a UWAV, the ramp shall be permanently attached to the WAV at the point of entry for the wheelchair.

5.3.3.4 It shall be possible to lock any additional ramp supports (e.g. a prop under the central hinge of a folding ramp) in position when the ramp is deployed. The locking mechanism shall prevent movement of the ramp support whilst the ramp is deployed and:

a) in the case of an AWAV, operate either automatically or manually; or

b) in the case of a UWAV, operate automatically.

5.3.4 Dimensions

5.3.4.1 The width of a ramp measured between the side guards at any point along its length shall be ≥500 mm. The width shall be determined in accordance with Annex B (**B.3.9**).

5.3.4.2 For a rear-entry WAV, the ramp projection from the WAV, when deployed, shall be ≤2.1m, when determined in accordance with **B.3.13**.

5.3.4.3 For a side-entry WAV, ramp projection, when deployed, shall be ≤1.5 m, when determined in accordance with **B.3.13**.

NOTE The widest part of the WAV when the ramp is deployed might be the edge of the open wheelchair access door or a door mirror.

5.3.5 Safe working load (SWL)

5.3.5.1 For an AWAV designed for a wheelchair mass of ≤150 kg, the ramp SWL shall be ≥300 kg.

NOTE In order to carry a wheelchair of ≤150 kg, plus an occupant of nominal mass 75 kg and an assistant of nominal mass 75 kg, the ramp needs to be capable of carrying a load of ≥300 kg.

5.3.5.2 For an AWAV designed for a wheelchair weighing >150 kg, the ramp SWL shall be at least equivalent to the maximum mass of the wheelchair that can be carried plus 150 kg.

5.3.5.3 For a UWAV, the ramp SWL shall be at least equivalent to the maximum combined mass of the wheelchair and occupant for which the UWAV has been designed.

5.3.5.4 The ramp SWL shall be tested in accordance with BS 6109-2:1989, **A.3**.

5.3.5.5 The ramp SWL in kg shall be marked on all ramps in characters ≥15 mm in height.

5.3.6 Angle

NOTE 1 If a lowering suspension system is fitted, it may be in the lowered position when measuring the ramp angle.

NOTE 2 It is possible that some combinations of wheelchair and occupant might become unstable on slopes exceeding a certain angle. This varies with factors such as the design of wheelchair, the weight and size of the occupant, and any additional equipment or luggage being carried on the wheelchair. Depending on these factors and the position of the attachment point of any winch line to the wheelchair, it might become possible for the wheelchair and its occupant to tip backwards if the wheelchair is released by the assistant. Given the current designs of both wheelchairs and base vehicles, it is not possible to produce AWAVs with ramps of a sufficiently shallow angle to guarantee stability for all wheelchair and occupant combinations. The presence of an assistant at all times when the wheelchair user is boarding or alighting and the provision of adequate warnings and guidance by both wheelchair manufacturers and WAV manufacturers should therefore be regarded as current best practice.

*NOTE 3 Although there is a requirement (see **5.3.6.2**) to fit a winch, or other assistive device, to an AWAV whose ramp angle >13°, winches may be fitted to AWAVs whose ramp angle ≤13° and to UWAVs. However, the maximum ramp angle for a UWAV is not permitted to be >11° even if a winch is fitted (see **5.3.6.4**).*

5.3.6.1 The ramp angle of the WAV shall be determined according to **B.3.11**.

5.3.6.2 For a ramp fitted to an AWAV and used without any other assistive device for aiding access (e.g. a winch), the angle that it makes with the horizontal, shall be ≤13° when measured:

a) for a rear-entry AWAV, with the ramp deployed on to level ground; and

b) for a side-entry AWAV, with the ramp deployed on to a horizontal surface 125 mm above the ground on which the WAV rests.

NOTE 1 The 125 mm represents the height of a typical pavement.

NOTE 2 The maximum ramp angle is not specified for an AWAV fitted with an additional device for aiding access (e.g. a winch) that might be attached to the wheelchair in such a way so as to:

a) reduce the level of effort required from the assistant to load the occupied wheelchair; and

b) ensure that the wheelchair is prevented from rolling back down the ramp if released by the assistant.

5.3.6.3 For a side-entry AWAV, a second measurement of the ramp angle shall be taken with the ramp deployed on to the ground on which the WAV rests.

5.3.6.4 For a ramp fitted to a UWAV, the angle that it makes with the horizontal shall be a maximum of 11° when the ramp is deployed on to the ground.

5.3.6.5 For a side-entry WAV, with a ramp intended to be deployed on to a pavement, the following text shall be reproduced on the ramp so as to be visible when the ramp is deployed: "WARNING Ramp intended for use onto pavements".

5.3.7 Powered ramp

5.3.7.1 Any ramp fitted to a UWAV, shall be powered.

NOTE An AWAV may be fitted with a powered ramp.

5.3.7.2 The powered ramp controls shall be marked as such and shall be located at the point of entry served by the ramp.

5.3.7.3 For a UWAV, the powered ramp controls shall be remotely operable.

NOTE 1 This is to ensure that the wheelchair user can operate the powered ramp whilst seated in their wheelchair, i.e. without having to stand up.

NOTE 2 For a UWAV, it should be possible for the wheelchair user to operate the power ramp controls whilst seated in the wheelchair, from both inside and outside the UWAV. Whilst it is impossible to prescribe precise requirements to enable unassisted use of a ramp to a UWAV in all cases, consideration should be given to the siting of the remote control unit, provision for its stowage when not in use, the length of the connecting lead, or, if a cordless remote control is used, the ease of replacement of batteries and provision for backup in the event of failure. Consideration should also be given to the provision of a master switch to avoid inadvertent use, and an indicator to denote that the powered ramp is operational.

5.3.7.4 A powered ramp shall not be capable of operation when the WAV is in motion.

NOTE An interlock requiring the handbrake to be engaged is sufficient to satisfy this requirement.

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5.3.7.5 Powered ramps shall be capable of manual operation.

NOTE Powered ramps need to be capable of manual operation so that in the event of power failure the wheelchair user can alight the WAV whilst remaining seated in their wheelchair.

5.3.7.6 A WAV fitted with a powered ramp shall also be fitted with a means of providing the wheelchair user with information on the position of the ramp.

NOTE 1 Such means may include audible tones to signal complete deployment, a mirror or CCTV camera and display screen positioned so as to provide a wheelchair user facing away from the ramp with information as to whether the ramp is fully deployed, partially deployed or stowed.

NOTE 2 Attention is drawn to the UK Supply of Machinery (Safety) Regulations 2008 [10].These regulations require compliance with the EC Machinery Directive (2006/42/EC) (as amended) [11]. Powered ramps generally fall within the scope of these regulations and the EC Machinery Directive (2006/42/EC).

5.4 Lifts

NOTE 1 BS 6109-2 gives details of design and safety recommendations, operating procedures, installation and inspection recommendations for lifts for assisting entry or exit of passengers with or without wheelchairs into and out of WAVs through a height of ≤1.7 m.

NOTE 2 BS EN 1756-2 provides information on the design, fitting and operation of tail lifts for WAVs.

NOTE 3 Lifts should be able to accommodate a variety of ground surface conditions. In particular, consideration should be given to all reasonably foreseeable conditions of WAV use (e.g. accessing the WAV on slopes or uneven surfaces).

5.4.1 Lift platform dimensions

The maximum dimensions of an occupied wheelchair that can be loaded using the lift shall be determined in accordance with Annex B (**B.3.12**).

5.4.2 Edges

NOTE Any edges of the lift that, when the lift is deployed, are contactable by a sphere of 100 ± 5 mm diameter, should have an edge radius of ≥0.5 mm and a corner radius of ≥5 mm.

5.4.3 Side guards

5.4.3.1 When deployed, the lift platform shall have side guards extending along the full length of either side of its surface.

5.4.3.2 The side guards shall be ≥25 mm high perpendicular to the lift platform surface.

5.4.4 Guards

5.4.4.1 A guard, ≥70 mm high when deployed, shall be fitted to the end of the lift platform furthest from the WAV.

NOTE Large powered wheelchairs suitable for outdoor use could be capable of overcoming a 70 mm high guard. On WAVs intended to transport such wheelchairs, the guard height of 100 mm is preferred. Consideration should also be given to the strength of the guard for such applications.

5.4.4.2 The guard shall operate automatically as the lift platform leaves the ground. Full deployment of the guard shall be achieved before the closest distance between any moving part of the platform and the ground reaches 50 mm.

5.4.5 SWL

5.4.5.1 For an AWAV designed for a wheelchair mass of ≤150 kg, the lift SWL shall be ≥225 kg.

NOTE In order to carry a wheelchair of ≤150 kg, plus an occupant of nominal mass 75 kg, the lift needs to be capable of carrying a load of ≥225 kg.

5.4.5.2 For an AWAV designed for a wheelchair weighing >150 kg, the lift SWL shall be at least equivalent to the maximum mass of the wheelchair that can be carried plus 75 kg.

5.4.5.3 For a UWAV, the lift SWL shall be at least equivalent to the maximum mass of the wheelchair and occupant for which the UWAV has been designed.

5.4.5.4 The lift SWL shall be tested in accordance with BS EN 1756-2:2004+A1:2009, Annex F.

5.4.5.5 The lift SWL in kg shall be marked on all lifts in characters ≥15 mm in height.

5.4.6 Lift controls

5.4.6.1 The lift controls shall be marked as such and shall be located at the point of entry served by the lift.

NOTE For a UWAV, it should be possible for the wheelchair user to operate the lift controls whilst seated in the wheelchair, from both inside and outside the UWAV. Whilst it is impossible to prescribe precise requirements to enable unassisted use of a lift fitted to a UWAV in all cases, consideration should be given to the siting of the remote control unit, provision for its stowage when not in use, the length of the connecting lead, or, if a cordless remote control is used, the ease of replacement of batteries and provision for backup in the event of failure. Consideration should also be given to the provision of a master switch to avoid inadvertent use, and an indicator to denote that the lift is operational.

5.4.6.2 A lift shall not be capable of operation when the WAV is in motion.

NOTE An interlock requiring the handbrake to be engaged is sufficient to satisfy this requirement.

5.4.6.3 Powered lifts shall be capable of manual operation.

NOTE This is to enable an occupied wheelchair to alight from the WAV in the event of power failure.

5.5 Ramp, lift and spare wheel mounting strength

NOTE It is recognized that in many cases, test work to satisfy the requirements of this PAS might be undertaken in parallel with test work undertaken as part of a type approval programme. It is therefore desirable to combine tests wherever possible. In various places, this PAS offers more than one testing method that can be used to demonstrate compliance with its requirements. For testing the strength of a ramp, lift and spare wheel mounting, either Annex C (a dynamic test) or Annex D (a static test) is acceptable as a means of satisfying the requirements of this PAS. In carrying out combined tests, however, careful consideration should be given to the possibility of the behaviour of one test item (e.g. a ramp) affecting the outcome of the test on other items within the WAV (e.g. a WTORS test).

5.5.1 Any ramp or lift stowed within the WAV passenger compartment shall be tested in accordance with either Annex C or Annex D.

5.5.2 The mountings for any spare wheel stowed within the WAV passenger compartment, shall be tested in accordance with either Annex C or Annex D.

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5.5.3 When tested in accordance with either Annex C or Annex D, the following requirements shall be met.

a) The ramp or lift shall not become detached.

b) The spare wheel shall not become detached.

c) Mechanisms to release the ramp or lift shall be capable of release after completion of the test.

NOTE 1 Deformation, partial rupture or breakage of any mounting and the surrounding area need not constitute failure.

NOTE 2 The test is to ensure that any ramp, lift or spare wheel located within the passenger compartment remains attached to its mountings in the event of a forward crash. The requirement for the release mechanisms on ramps and lifts to be operable is in order to allow the ramp or lift to either be deployed or moved aside to allow access to the wheelchair user. It is accepted, however, that the ramp or lift might not be in a fully functional condition after the test.

5.6 Winch

*NOTE 1 Winches are assistive devices that might be used in combination with a ramp to aid in accessing a WAV. For an AWAV ramp making an angle with the horizontal >13°, a winch is required (as specified in **5.3.6.2**).*

NOTE 2 Attention is drawn to the UK Supply of Machinery (Safety) Regulations 2008 [10]. These regulations require compliance with the EC Machinery Directive (2006/42/EC) (as amended) [11]. Winches generally fall within the scope of these regulations, and the Directive. The following requirements are in addition to the legal requirements of the regulations. Attention is also drawn to BS EN 14492-1 relating to power driven winches and hoists. Although winches for the lifting of persons are specifically excluded from its scope, it contains useful general guidance.

5.6.1 General

5.6.1.1 A winch shall be provided in an AWAV whose ramp angle exceeds 13° (see **5.3.6**).

NOTE A winch may be fitted to an AWAV whose ramp angle does not exceed 13° or a UWAV whose ramp angle does not exceed 11°.

5.6.1.2 With the WAV engine switched off, and not less than half of the total length of the winch line (disregarding any attachment device to attach the winch line to the wheelchair) wound on to the winch drum, the winch shall be capable of exerting a line pull, *P*, of at least:

$$P = (M_{max} + 75) \times \text{Sin } R \quad (1)$$

where:

M_{max} is the heaviest wheelchair the WAV is designed to carry (in kg)

R is the ramp angle (in degrees)

5.6.2 SWL

5.6.2.1 The winch SWL shall be marked on the WAV in kg.

NOTE The marking should be applied in a conspicuous location on or near the winch control.

5.6.2.2 The SWL shall not be greater than the line pull, P, obtained in **5.6.1.2.**

*NOTE The WAV manufacturer may declare a SWL of less than the line pull, P, obtained in **5.6.1.2**. The line pull, P, represents the theoretical pull that the winch needs to exert, in order to be capable of pulling the maximum mass of wheelchair that the WAV is*

designed to carry, plus a 75 kg wheelchair user, up the ramp without assistance. It should be noted that in use, a degree of assistance might be required, due to factors such as the wheelchair tyre inflation, any slope on which the WAV is parked, the state of charge of the WAV's battery, and various other factors.

5.6.3 Safety features

5.6.3.1 All winches shall incorporate at least one feature intended to prevent any part of the wheelchair or its occupant being trapped by the winch or its attachment device to the wheelchair. Operation of such features shall not prevent further movement of the winch in the opposite direction.

NOTE Such features may include electrical limit switches that cut the power to the winch before any danger of entrapment is likely, or physical stops capable of preventing the winch line from being wound on to the drum beyond a particular point.

5.6.3.2 It shall not be possible to operate the winch whilst the AWAV is in motion.

NOTE An interlock requiring the handbrake to be engaged or an inhibitor switch acting when the ramp is stowed are sufficient to satisfy this requirement.

5.6.4 Winch line and attachment device

NOTE Any attachment device between the winch line and the wheelchair should not come in contact with the wheelchair occupant's body during use.

5.6.4.1 For a winch with a single line, the exit point of the winch line from the winch shall lie within 100 mm of a vertical plane passing through the longitudinal centre line of the ramp surface.

5.6.4.2 For a winch with multiple winch lines, the winch lines shall be disposed symmetrically about any vertical longitudinal plane passing within 100 mm of the longitudinal centre line of the ramp surface.

5.6.4.3 The winch line and any attachment device shall have a combined length that clears the end of the deployed ramp, allowing it to be connected to the wheelchair on level ground outside the AWAV.

5.6.5 Direction of winch line movement

5.6.5.1 The winch line shall be capable of operating in either direction. The controls shall operate in such a way that releasing any switch or button stops the winch automatically with no roll back.

NOTE 1 The winch line should operate in a controlled manner and in the event of releasing any switch or button, the winch should stop as quickly as possible.

NOTE 2 A "soft start" system can be incorporated to reduce the initial acceleration (and therefore "snatch") on the wheelchair user.

5.6.5.2 At any point between fully deployed and fully retracted, it shall be possible to stop and reverse the direction of movement of the winch line.

5.6.6 Controls

Pendant or remote controls shall be sited so as to enable the assistant to operate them both inside and outside the AWAV whilst attending the wheelchair.

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6 Wheelchair tie-down and occupant-restraint systems and their anchorages

NOTE 1 Wheelchair tie-down and occupant restraint anchorages are already subject to certain strength and positional requirements depending on the type approval route chosen by the WAV manufacturer. However, not all WAVs are produced under an approval scheme (e.g. some are converted after registration) and are therefore not subject to any approval requirements.

The requirements set out in this Clause of the PAS are not intended to replace any of those approval requirements, but to provide supplementary requirements in areas not covered by existing type approval requirements (e.g. for wheelchairs weighing >85 kg, or rearward-facing wheelchair installations) and to provide an alternative for WAVs converted after registration.

In those areas where there is overlap with existing type approval requirements, the PAS provides two alternative methods for testing strength of WTORS anchorages, so as to minimize the burden of compliance on WAV manufacturers seeking to comply with both the type approval and PAS requirements.

Manufacturers following an EC Whole Vehicle Type Approval programme may consider using either Annex C or Annex E to demonstrate PAS compliance, whilst those pursuing national approval schemes (or post-registration conversions) may consider using Annex E. It is not necessary to use both. However, as none of the current approval routes contain requirements for the strength of wheelchair tie-down anchorages for wheelchairs weighing >85 kg, there are no appropriate static test protocols in existence for heavier wheelchairs, so static testing for these anchorages is not permitted, and only Annex C may be used to demonstrate compliance.

The following Annexes set out requirements for wheelchair tie-downs and occupant restraints and their anchorages.

a) Annex C sets out a dynamic test method for WTORS anchorages for forward-facing wheelchairs weighing ≤200 kg in WAVs large enough to accommodate the SWC in Annex G, and ATD used in the test method.

b) Annex E sets out a static test method for WTORS anchorages for forward-facing wheelchairs ≤85 kg. For WAV manufacturers pursuing a type approval route that calls for static testing, or producing WAVs too small to accommodate the SWC and ATD, this could be the most appropriate route to achieving PAS compliance in respect of WTORS anchorages, but may only be used for WAVs designed to transport wheelchairs ≤85 kg in weight.

c) Annex F sets out a static test method for WTORS anchorages for rearward-facing wheelchairs of any weight. The strength requirements for the back and head support for a rearward-facing wheelchair occupant closely mirror those currently applicable to accessible buses, and are primarily intended to provide comfort and stability for a rearward-facing wheelchair occupant rather than crash protection.

NOTE 2 This PAS is limited to four-point strap-type tie-downs due to the lack of technical data to support the drafting of requirements for other types of more bespoke wheelchair tie-down equipment. However, the general principles of the test annexes may be applied to other types of wheelchair tie-down equipment, subject to it being possible to make appropriate modifications to the SWC.

NOTE 3 Some four-point strap-type tie-downs are wheelchair-specific, and are designed to be used with only one particular model of wheelchair. Care should be taken when selecting appropriate tie-downs, as not all four-point strap-type tie-downs might be suitable for test in accordance with the requirements of this PAS. For example, it might not be possible to attach some wheelchair-specific tie-downs to a SWC and some wheelchair-specific WTORSs include wheelchair occupant restraint anchorages that attach to the wheelchair itself rather than the WAV structure.

6.1 WTORS

6.1.1 For each designated travelling position, a four-point strap-type wheelchair tie-down system shall be fitted.

6.1.2 For each designated travelling position for a wheelchair ≤85 kg, a four-point strap-type WTORS conforming to BS ISO 10542-1:2001 [4] and BS ISO 10542-2:2001 [5] or a four-point strap-type WTORS conforming to BS ISO 10542-1:2012 shall be fitted.

NOTE At the time of publication of this PAS, BS ISO 10542-1:2001 and BS ISO 10542-2:2001 had been recently withdrawn and superseded by BS ISO 10542-1:2012. However, very little WTORS equipment available in the UK has been tested for compliance with BS ISO 10542-1:2012. As such, given that the requirements of BS ISO 10542-1:2001 and BS ISO 10542-2: 2001 are very similar to BS ISO 10542-1:2012, a decision has been made to allow WTORS equipment conforming to either version to be used in this PAS, pending a review no later than two years following the publication of the PAS.

6.1.3 For each designated travelling position for a wheelchair >85 kg, four-point strap-type wheelchair tie-downs shall conform to BS ISO 10542-1:2012 when tested:

a) with the SWC specified in Annex G of this PAS, ballasted to the maximum weight of wheelchair that the WAV is designed to carry, instead of the SWC specified in BS ISO 10542-1:2012, Annex E; and

   NOTE The BS ISO 10542-1:2012 scope covers wheelchairs ≤85 kg. For wheelchairs >85 kg, some adjustments to the mass of the SWC specified in the test method in BS ISO 10542-1:2012 are necessary.

b) with the WTORS fitted such that the position of each actual anchorage point relative to Point P on the SWC is less than 50 mm distant from the position of the corresponding actual anchorage point relative to Point P of the SWC when installed in the vehicle, instead of to the anchorage positions specified in BS ISO 10542-1:2012, Annex A.

   NOTE BS ISO 10542-1:2012 specifies a range of WTORS anchorage locations for wheelchairs ≤85 kg in the dynamic testing of WTORS. However, the precise locations of the WTORS anchorages can significantly affect the outcome of the test, particularly when using a wheelchair >85 kg. For this reason, it is necessary to test the WTORS using the anchorage geometry that is designed for the WAV itself.

6.2 Wheelchair occupant restraint effective anchorage locations

6.2.1 The lateral separation of the two lower effective anchorages for the wheelchair occupant restraint shall be ≥300 mm.

6.2.2 The side view projected angles produced by a line drawn from either point P on the SWC (see Annex G) or the accessibility gauge (see Annex B), when installed in the designated travelling position, to each of the wheelchair occupant restraint lower effective anchorages and the horizontal shall be between 30° and 80°.

NOTE 1 The relationship between Point P and the wheelchair tie-down attachment points, the rear wheels and the ground, is identical on the accessibility gauge and the SWC. Either device may therefore be used for determination of the correct occupant restraint lower anchorage geometry.

NOTE 2 Although angles of between 30° and 80° are permissible, angles between 45° and 75° are preferred, as these give a better occupant restraint geometry.

6.2.3 It shall be possible to position the wheelchair occupant restraint upper effective anchorage at a height of ≥1 100 mm above a horizontal plane passing through the contact points of the rear tyres of the SWC with the WAV floor.

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[4] Withdrawn

[5] Withdrawn

NOTE This may be achieved either by fitting an adjustable height upper anchorage, or by positioning a fixed upper anchorage at a height of ≥1 100 mm. Current best practice is to allow a range of adjustment in height so as to permit the upper anchorage to be adjusted to provide a good fit for the diagonal belt across the wheelchair user's shoulder, for a variety of wheelchair and wheelchair occupant sizes. Where an adjustable upper anchorage is provided it is required that it can be adjusted to a height of ≥1 100 mm but if possible a range of adjustment between 1 000 mm and 1 250 mm is desirable.

6.2.4 The lateral distance from a vertical plane passing through the longitudinal centre line of the SWC, when secured in the travelling position designated by the WAV manufacturer, to the upper effective anchorage shall be ≥140 mm.

6.2.5 The wheelchair occupant restraint effective anchorage locations shall be determined in accordance with Annex B (**B.3.16**).

6.3 Recommendations for four-point wheelchair tie-down anchorage locations

NOTE 1 The effective anchorage points for wheelchair tie-downs attached to the front of a wheelchair should be located laterally, between 300 mm and 810 mm apart.

NOTE 2 A lateral spacing of front tie-down anchorages towards the outer limits of the recommended range of positions provides enhanced wheelchair stability when the WAV is in motion.

NOTE 3 The effective anchorage points for tie-downs attached to the rear of the wheelchair should be located laterally, between 300 mm and 566 mm apart.

NOTE 4 When attached to the tie-down points on the SWC described in Annex G, or the accessibility gauge positioned in the designated travelling position, the tie-downs attached to the rear of the wheelchair should ideally make an angle with the horizontal, when viewed from the side, of between 30° and 45° and the tie-downs attached to the front of the wheelchair should make an angle with the horizontal, when viewed from the side, of between 40° and 60°.

NOTE 5 Consideration should be given to WTORS manufacturers' installation instructions. In particular, consideration should be given to potential adverse effects on both the wheelchair and the tie-down equipment as a result of working outside the recommended range of tie-down positions, or of positioning the tie-down anchorages with excessive asymmetry.

NOTE 6 The terms "front" and "rear" apply to the WAV. For a forward-facing wheelchair, therefore, the "front" tie-downs are those attached to the front of the wheelchair and located closest to the front of the WAV. For a rearward-facing wheelchair, the "front" tie-downs would be those attached to the rear of the wheelchair but would be located closest to the front of the WAV.

6.4 Strength of WTORS anchorages

6.4.1 WTORS anchorages shall be tested for strength in accordance with:

a) Annex C (dynamic test), for a WAV designed for the carriage of a wheelchair of ≤200 kg in a forward-facing direction; or

b) Annex E (static test), for a WAV designed for the carriage of a wheelchair of ≤85 kg in a forward-facing direction; or

c) Annex F (static test), for a WAV designed for the carriage of a wheelchair in a rearward-facing direction.

6.4.2 When tested in accordance with Annex C, or Annex E, or Annex F, the following requirements shall be met.

a) The SWC shall remain in an upright position in the WAV.

b) The WTORS anchorages shall not become detached from the WAV.

NOTE Permanent deformation, including partial rupture or breakage of any anchorage or surrounding area, need not constitute failure.

6.4.3 In addition, when tested in accordance with Annex C, the anthropomorphic test device (ATD) shall be retained in the seat of the SWC.

6.5 Back and head support for WAVs for the carriage of rearward-facing wheelchairs

NOTE The strength requirements for the back and head support for a rearward-facing wheelchair occupant closely mirror those currently applicable to accessible buses, and are primarily intended to provide comfort and stability for a rearward-facing wheelchair occupant rather than crash protection.

6.5.1 Location and dimensions

6.5.1.1 Rearward-facing wheelchair spaces shall be provided with a back and head support at the forward end of the wheelchair space (i.e. between the back of the wheelchair and the front of the WAV).

6.5.1.2 The back and head support shall be located with its vertical centre line within 25 mm of the centre line of the wheelchair space. The centre line of the wheelchair space shall be taken to be a line parallel to the longitudinal median plane of the WAV, located equidistant from each of the tie-down effective anchorage points for the rear of the wheelchair.

6.5.1.3 The back and head support shall be fitted at an angle between 4° and 8° to the vertical, with the lower edge positioned closer to the rear of the WAV than the top edge.

6.5.1.4 At any height ≥500 mm and ≤1 000 mm above the floor of the wheelchair space lying directly below the back and head support, the width of the back and head support shall be ≥240 mm.

6.5.1.5 At no point shall the width of the back and head support be <170 mm.

6.5.1.6 The height of the lower edge of the back and head support shall be ≤450 mm above the floor of the wheelchair space lying directly below it.

NOTE The dimensions of the back and head support should be determined in accordance with Annex H so as to be suitable for the maximum size of wheelchair that the WAV manufacturer stipulates can be carried.

6.5.1.7 When deployed, the surface of the back and head support facing the wheelchair occupant shall be padded and form a flat surface facing the rear of the WAV. Where there are gaps in the surface, they shall not be capable of allowing the complete insertion of a spherical probe of (60 ± 1) mm diameter.

6.5.2 Strength and energy absorption performance

6.5.2.1 Any part of the padded surface of the back and head support located above a horizontal plane 300 mm above the surface on which the rear wheels of the wheelchair rest, shall conform to the impact performance requirements of either UN/ECE Regulation 21 [12] or Directive 74/60/EC [13] in respect of energy absorption.

NOTE 1 UN/ECE Regulation 21 [12] and Directive 74/60/EC [13] are considered equivalent and interchangeable. Depending on the approval route used by the WAV manufacturer, they are not always mandatory. In order for a WAV to conform to this PAS, this requirement is always applicable regardless of the approval route.

NOTE 2 EC Regulation 661/2009 (the "General Safety Regulation") [5] repeals Directive 74/60/EC [13] and all its amending directives. However, some levels of approval in the UK still accept compliance with the Directive rather than the

Regulation. For this reason, references to the Directive have not been removed in the revision of this PAS.

6.5.2.2 When tested in accordance with Annex F, no part of the head and back support shall exhibit permanent deformation.

7 User manual

7.1 General

The WAV manufacturer shall produce a user manual for the WAV, which shall include as a minimum:

a) basic information as specified in **7.2**;

b) the WAV technical specification as specified in **7.3**;

c) operational guidance as specified in **7.4**.

7.2 Basic information

Basic information shall include:

a) WAV make and model name;

b) base vehicle make and model name (for WAVs manufactured through the conversion of a base vehicle);

c) either the approval route used for the WAV, where an approval is obtained, or the statement "post-registration", where there is no approval covering the completed WAV;

d) type of WAV (AWAV or UWAV);

e) terms and conditions of the conversion warranty;

f) table of fuses, bulbs and relays added or modified during conversion, including their location and rating;

g) details of any specialist conversion replacement parts and information about how to source these; and

h) claims of conformity with this PAS, i.e. PAS 2012-1.

7.3 WAV technical specification

The WAV technical specification shall include at least the items specified in Table 1.

Table 1 **WAV technical specification** *(1 of 2)*

Feature	Parameter	Value	References
Wheelchair access entrance	Width (mm)		**B.3.1**
	Height (mm)		**B.3.2**
Designated travelling position	Width (mm)		**B.3.3**
	Length (mm)		**B.3.4**
(This data is to be provided for each designated travelling position)	Wheelchair space gradient (degrees)		**B.3.5**
	Wheelchair occupant maximum seated eyeline height (mm)		**B.3.7**
	Internal roof height (mm)		**B.3.8**
	Maximum mass of wheelchair that can be carried (kg)		

Table 1 **WAV technical specification** *(2 of 2)*

Feature	Parameter	Value	References
Maximum access dimensions for each designated travelling position)	Width (mm)		**B.3.15**
	Length (mm)		
	Height (mm)		
Ramp (where fitted)	Width (mm)		**B.3.9**
	Length (mm)		**B.3.10**
	Angle with ramp deployed on to road (degrees)		**B.3.11**
	For a side-entry WAV, angle with ramp deployed on to 125 mm pavement (degrees)		
	SWL (kg)		**5.3.5**
	Maximum ramp projection when deployed (mm)		**B.3.13**
Lift platform (where fitted)	Width (mm)		**B.3.12.1**
	Length (mm)		**B.3.12.2**
	Maximum lift projection when deployed (mm)		**B.3.13**
	SWL (kg)		**5.4.5**
Winch (where fitted)	SWL (kg)		**5.6.2**
WAV	Fuel tank capacity (litres)		
	Ground clearance (mm)		**B.3.14**
	Type of spare wheel or puncture repair system fitted		
Accommodation	Maximum seating capacity [A)]		
	Maximum number of designated wheelchair travelling positions		
	"Up-front" wheelchair position available [B)] (Y/N)		
	Maximum number of other passenger seating positions (including driver)		
	Any limitations on seating capacity when carrying an occupied wheelchair		

A) In some WAVs, an occupied wheelchair might only be carried when some of the seats in the WAV are folded away or removed. In others, the maximum combined weight of the wheelchair and occupant might make it impossible to carry a full complement of passengers on conventional seats due to the load carrying limitations of either axle or the WAV as a whole. For this reason, only the maximum possible number of seats and wheelchair spaces is recorded. Note, it might not be possible to operate the WAV with both simultaneously.

B) An "up-front" wheelchair position is a designated travelling position where the wheelchair replaces the front passenger seat.

7.4 Operating and safety instructions

Operating and safety instructions shall be provided for the following where fitted:

a) ramp (including warnings and any limitations imposed by ground conditions and, for a side-entry WAV, any additional precautions required when deploying the ramp on to a road surface rather than the pavement);

b) winch;

c) lift;

d) WTORS;

e) suspension lowering system;

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f) specialist seating; and

g) spare wheel, jack and/or puncture repair system (where different to base vehicle).

8 Miscellaneous provisions

8.1 Product information

The following product information shall be made available:

NOTE This may be through, for example, printed material or on the manufacturer's/retailer's website.

a) WAV model name;

b) the base vehicle make and model name (where applicable);

c) a completed technical specification as set out in Table 1 (see **7.3**); and

d) the approval route used for the WAV, where obtained, or the statement, "post-registration", where some or all of the WAV construction has not been carried out under an approval scheme.

8.2 Repair services

The WAV manufacturer shall offer a repair service either at their manufacturing facility or through an authorized agent.

8.3 Re-call procedure

The WAV manufacturer shall operate a re-call procedure in accordance with the DVSA's *Code of Practice on Vehicle Safety Defects and Recalls* [NR1].

8.4 Complaints procedure

The WAV manufacturer shall have a complaints procedure, which shall be available to customers on request.

8.5 Replacement parts and service information provision

Provision shall be made for replacement parts used in the manufacture of a WAV or conversion of a base vehicle to a WAV to be available for a minimum of 5 years from end of life of a particular model.

NOTE Provision should be made for replacement parts used in the manufacture of a WAV or conversion of a base vehicle to a WAV to be available for a minimum of 10 years from end of life of a particular model. Technical information for repair or replacement should either accompany the replacement parts or be available on request.

8.6 Build records

The WAV manufacturer shall keep build records for each WAV for a period of at least 7 years including:

a) base vehicle VIN number;

b) WAV technical specification (see **7.3**);

c) WAV registration number;

d) WAV manufacturer's identification number;

e) radio code (where applicable);

f) key numbers (where applicable); and

g) key codes or security codes for remote controlled items (e.g. powered doors, ramps, lifts).

8.7 Provision of information to the WAV retailer

The WAV manufacturer shall make available the product information given in **8.1** to the WAV retailer.

NOTE It is recognized that the retailer may or may not be the WAV manufacturer.

9 Claims of conformance

Claims of conformance of a WAV to PAS 2012-1 shall include:

a) the number and date of this PAS, i.e. PAS 2012-1:2015 [6)];

b) the WAV manufacturer's name and address;

c) the make and model of the WAV;

d) the WAV technical specification (see **7.3**);

e) the parts of the WAV that conform to PAS 2012-1:

1) measurement of accessibility dimensions;

2) lowering suspension systems;

3) ground clearance;

4) strength of conventional seat belt anchorages;

5) ramp;

6) lift;

7) winch;

8) strength of wheelchair tie-down and occupant restraint anchorages;

9) strength of ramp, lift or spare wheel mountings; and

10) back and head support strength and energy absorption for rearward-facing wheelchairs.

f) where authorized, the conformity mark of a third-party certification body.

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6) Marking PAS 2012-1:2015 on or in relation to a product represents an organization's declaration of conformity, i.e. a claim by or on behalf of the organization that the product meets the requirements of the PAS. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.

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Annex A (normative) Torsion test for a structurally modified WAV

A.1 Principle

A base vehicle is subject to a torsional loading, and accurate measurements of the induced deflection are taken across a predetermined pair of transverse diagonals located close to the modified area of the base vehicle structure (e.g. the rear door or tailgate aperture). The same base vehicle is then converted to a WAV and subjected again to the same loadings and measurements. The measurements taken before and after the conversion are compared.

A.2 Apparatus

A.2.1 *Set of test weights* that can be distributed about the vehicle's seats and load area to allow the vehicle to be loaded up to its GVW

A.2.2 *Means of measuring the changes in length of the diagonals selected in* ***A.4.6*** to an accuracy of ±0.2 mm with a repeatability of ±0.2 mm

NOTE This measurement should be made with a minimum resolution of 0.01 mm.

A.2.3 *Set of scales* with an accuracy and repeatability of at least ±1.0 kg and a resolution of 1.0 kg, or less, on which each wheel of the vehicle can be supported and the weight on each wheel determined

A.3 Test specimen

A.3.1 The test specimen shall consist of one unmodified base vehicle. This base vehicle shall be subjected to the loading and measurements specified in **A.4**, before being converted to a WAV and once again subjected to the same loading and measurements.

A.3.2 The base vehicle shall be presented for each test with all trim and equipment normally carried.

NOTE Such as a spare wheel, jack and wheel brace, if fitted, all seats, doors and glazing.

A.3.3 Tyre pressures for the measurements taken before conversion shall be set to the base vehicle manufacturer's recommended settings for full-load operation. Tyre pressures for the measurements taken after conversion shall be set to the WAV manufacturer's recommended settings for full-load operation.

A.4 Procedure

A.4.1 Place the vehicle with one wheel on each of four calibrated weighing pads set up on a flat and level floor.

A.4.2 Load the vehicle to between 90% and 100% of its GVW as declared by the WAV manufacturer.

NOTE 1 The GVW for the base vehicle and the WAV might be different, hence the final GVW of the WAV is used in both cases, rather than the GVW of the base vehicle before modification, and the GVW of the WAV after modification.

In order to achieve this, place a mass of (75 ± 5) kg in each seating position and the remainder of the mass in the luggage area(s), distributed so as to even out the weight on each wheel of a particular axle as far as possible. Record the weight on each of the weighing pads.

NOTE 2 Few vehicles carry exactly the same weight on each wheel of each axle when fully loaded. It might be necessary to distribute the mass representing the luggage in such a way as to obtain weights on each wheel of the same axle that are as close to being equal as can be achieved, without adding any additional mass.

A.4.3 Remove the laden vehicle from the weighing pads and place on flat and level ground.

A.4.4 Open all doors (including rear door(s), hatch or tailgate) to their maximum open position.

A.4.5 Roll the vehicle (1.0 ± 0.5) m backwards and forwards to settle the suspension.

A.4.6 Choose four points, A, B, C and D on the bodyshell such that they lie:

a) as close as is practicable to a vertical, transverse plane closest to the area of the base vehicle that contains the greatest structural modification;

b) as close as practicable to the four diagonally opposite corners of the vehicle cross section closest to the transverse, vertical plane;

c) in positions that are not altered or removed as part of the conversion process.

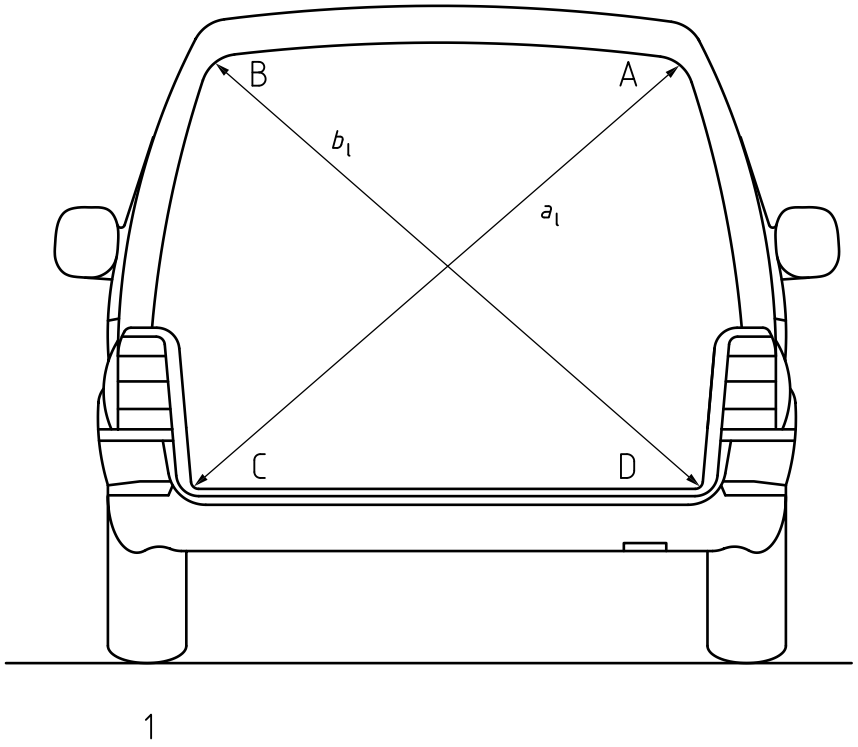
NOTE 1 Figure A.1 shows a typical WAV where the wheelchair entrance is at the rear of the vehicle. For a WAV where the most significant structural modification is not located at the rear of the vehicle (for example, a WAV equipped with a wheelchair entrance at the side), the transverse, vertical plane passing through the area of the WAV containing the most significant structural modifications might be located part way along the length of the WAV.

NOTE 2 It might be necessary to carefully remove door seals or trim panels to locate suitable points.

*NOTE 3 It should be possible to accommodate a straight line between each diagonally opposite pair of points in order to best allow the measurements in **A.4.8** and **A.4.10** to be taken accurately.*

*NOTE 4 As the measurements in **A.4.11** are taken with all doors on the side of the vehicle closed and the windows open, the points should be selected such that the measuring equipment can be used without opening any of these doors. This is particularly important in WAVs where the most significant structural modification is not at the rear of the vehicle.*

Figure A.1 **Initial measurement points across vehicle cross section closest to the area containing the main structural modifications**



Key

1	ground
a_l	length between points A and C with the vehicle on level ground
b_l	length between point B and D with the vehicle on level ground
A, B, C, D	permanently marked points on body

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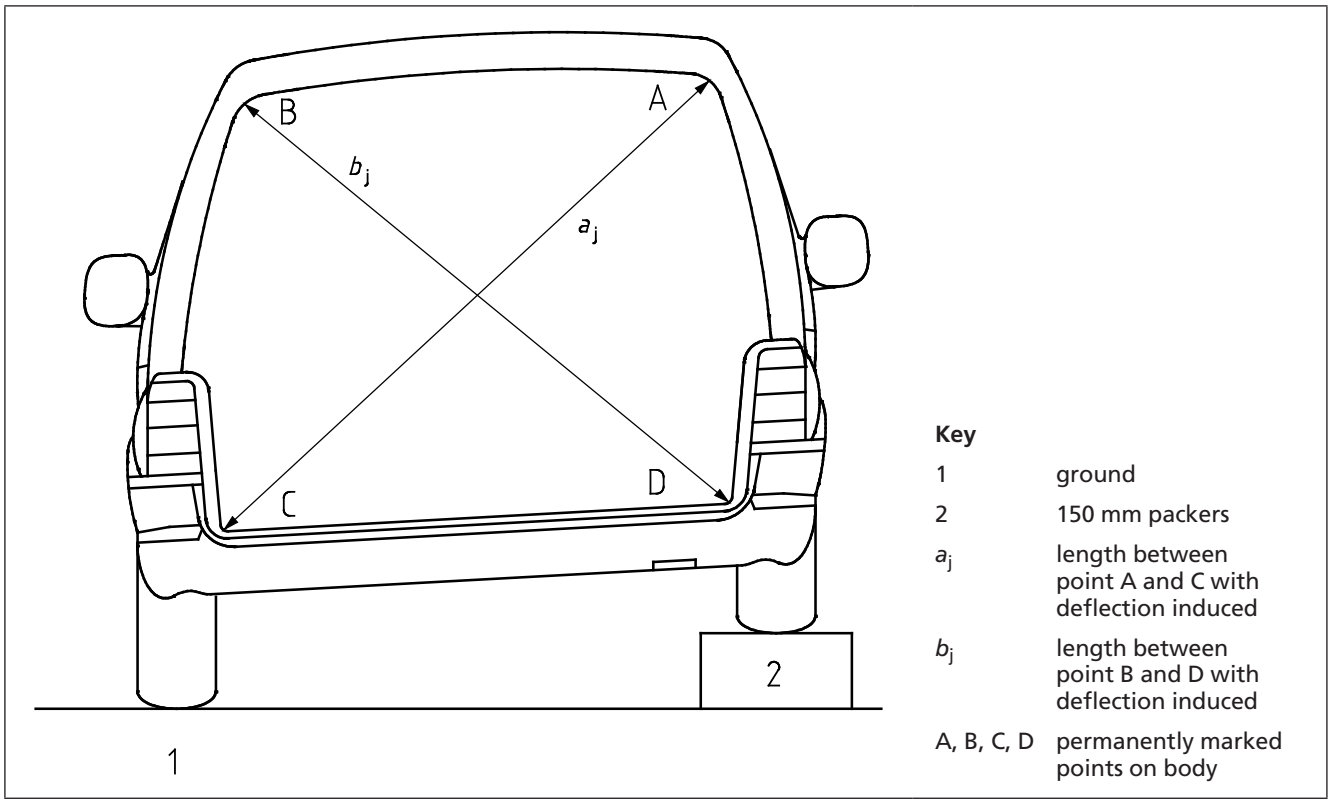
A.4.7 Apply a small and permanent mark (such as a centre punch impression) at each of the points A, B, C and D.

A.4.8 Record the distances A to C and B to D to ±0.2 mm.

A.4.9 Close all side doors and leave the rear tailgate, hatch or doors open. Open all windows that can be opened. Jack one front corner of the vehicle up and place packers between that front wheel and the ground to a height of (150 ± 5) mm. Repeat this operation for its diagonally opposite rear wheel and the ground.

A.4.10 Record the distances A to C and B to D to ±0.2 mm as illustrated in Figure A.2 and compare the measurements with those taken in **A.4.8.**

Figure A.2 **Measurement points across vehicle cross section closest to the area containing the main structural modifications with deflection induced**



A.4.11 Return the vehicle to the ground, roll it (1.0 ± 0.5) m backwards and forwards to settle the suspension and repeat the measurements to assess the level of permanent deformation, if any.

A.4.12 Unload the base vehicle and take it away for conversion.

A.4.13 After converting the base vehicle to a WAV, repeat steps **A.4.1** to **A.4.11** using:

a) the points, A, B, C and D assigned in **A.4.6**;

b) the mass and mass distribution applied in **A.4.2** ±5 kg;

c) the side-to-side mass distribution on the rear axle achieved in **A.4.2** ±5 kg;

d) the same two diagonally opposite wheels as used in **A.4.9**.

A.5 Expression of results

NOTE The difference in torsional stiffness before and after conversion is denoted by the change in each of the distances between the condition where the vehicle is resting on all four wheels and the condition where it rests on two diagonally opposite wheels.

A.5.1 Calculate the change in length between the level and jacked conditions in both the base vehicle and the WAV using Equations A.1, A.2, A.3 and A.4 (in mm):

$$\Delta a_b = a_{lb} - a_{jb} \quad \text{(A.1)}$$

$$\Delta a_w = a_{lw} - a_{jw} \quad \text{(A.2)}$$

$$\Delta b_b = b_{lb} - b_{jb} \quad \text{(A.3)}$$

$$\Delta b_w = b_{lw} - b_{jw} \quad \text{(A.4)}$$

where:

a_{lb} is the length between point A and C for the level base vehicle (in mm);

a_{jb} is the length between point A and C for the jacked base vehicle (in mm);

a_{lw} is the length between point A and C for the level WAV (in mm);

a_{jw} is the length between point A and C for the jacked WAV (in mm);

b_{lb} is the length between point B and D for the level base vehicle (in mm);

b_{jb} is the length between point B and D for the jacked base vehicle (in mm);

b_{lw} is the length between point B and D for the level WAV (in mm);

b_{jw} is the length between point B and D for the jacked WAV (in mm).

A.5.2 Calculate the percentage difference in deflection between the WAV and the base vehicle using Equations A.5 and A.6 (in %):

$$a_d = [(\Delta a_w - \Delta a_b)/\Delta a_b] \times 100 \quad \text{(A.5)}$$

$$b_d = [(\Delta b_w - \Delta b_b)/\Delta b_b] \times 100 \quad \text{(A.6)}$$

where:

a_d is the percentage difference in deflection between points A and C from the level base vehicle test specimen to the WAV test specimen (in %);

b_d is the percentage difference in deflection between points B and D from the base vehicle test specimen to the WAV (in %);

A.5.3 Average the readings obtained in **A.5.2** to obtain an average percentage difference across both diagonals [$(a_d + b_d)/2$ in %].

NOTE A tolerance of ±50% is allowed on this average percentage difference, i.e. if the WAV is weaker, the average deflection of the WAV should be ≤1.5 times greater than the base vehicle.

A.6 Test report

The test report shall include as a minimum:

a) reference to this standard, i.e. PAS 2012-1:2015;

b) reference to the test;

c) date(s) of the test(s);

d) name and address of the WAV manufacturer;

e) VIN of the test specimen;

f) name(s) and address(es) of the testing organization;

g) type and model of base vehicle;

h) test results achieved including:

1) the weight on each wheel for the test recorded in **A.4.2**;

2) the wheels that were raised during the test (e.g. right front and left rear);

3) the measurements a_{lb}; a_{jb}; a_{lw}; a_{jw}; b_{lb}; b_{jb}; b_{lw}; and b_{jw};

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4) the percentage difference in deflection between the base vehicle and the WAV calculated in **A.5.3**;

5) a brief description, including drawings and photographs of the structural modifications made to the vehicle and a brief description of material(s) used and fastening technology (or technologies).

Annex B (normative) Method of measurement for WAV dimensions

B.1 Principle

Key accessibility dimensions and manoeuvrability criteria are determined by means of an accessibility gauge.

NOTE This is especially important in WAVs where the occupied wheelchair needs to be manoeuvred into its designated travelling position within the WAV.

B.2 Apparatus

B.2.1 *Accessibility gauge*, in accordance with Figure B.1 to Figure B.3 with a mass of (70 ± 5) kg.

NOTE Accessibility gauge minimum and maximum measuring dimensions are given in Table B.1.

Table B.1 **Accessibility gauge minimum and maximum measuring dimensions**

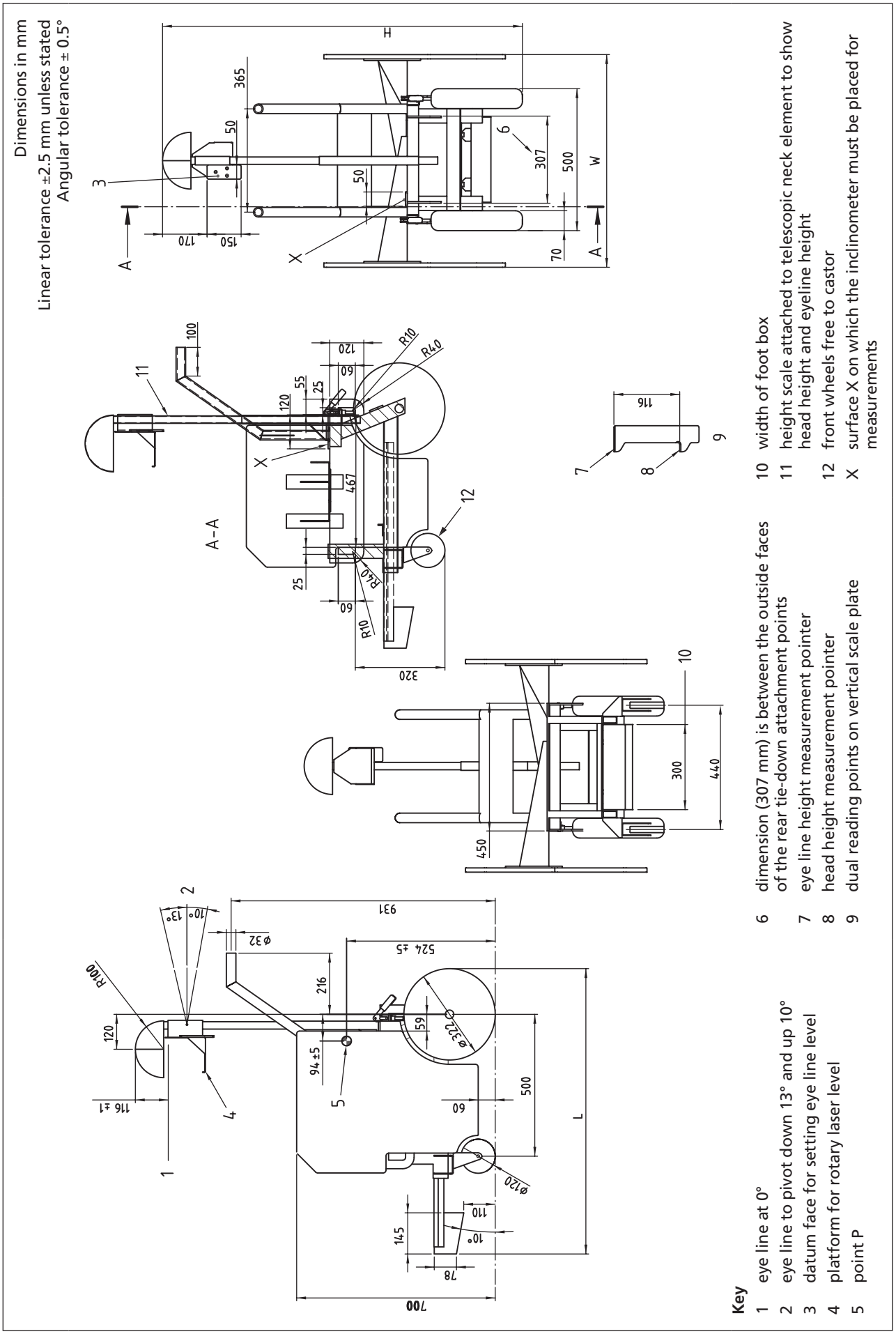
Dimension	Symbol	Minimum value mm	Symbol	Maximum value mm
Accessibility gauge length	L_{min}	775	L_{max}	1 350
Accessibility gauge width	W_{min}	500	W_{max}	830
Accessibility gauge height	H_{min}	975	H_{max}	1 550

B.2.2 *Inclinometer*

B.2.3 *Tape measure and measurement equipment*, capable of recording the positions and angles of the WTORS

B.2.4 *Plumb line*

Figure B.1 **Accessibility gauge dimensions**



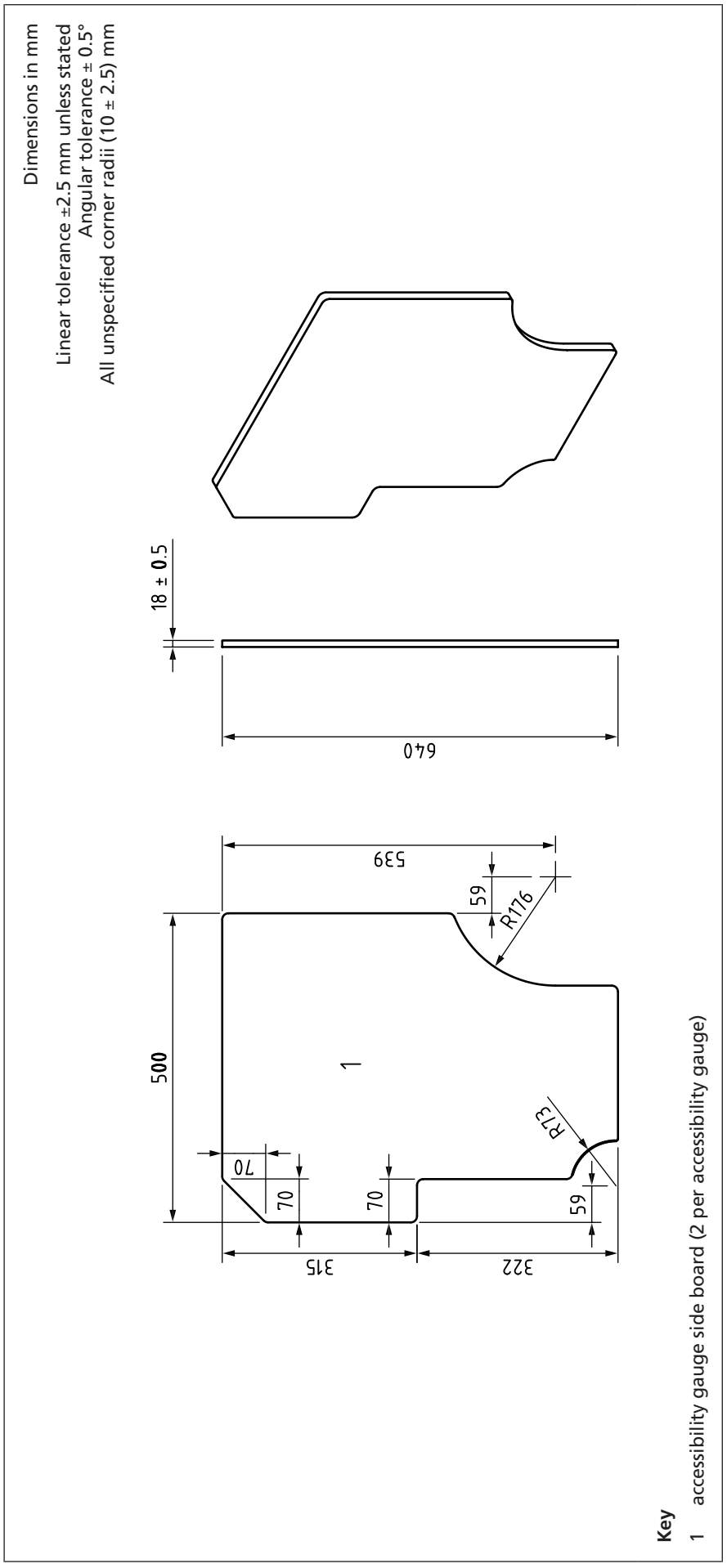
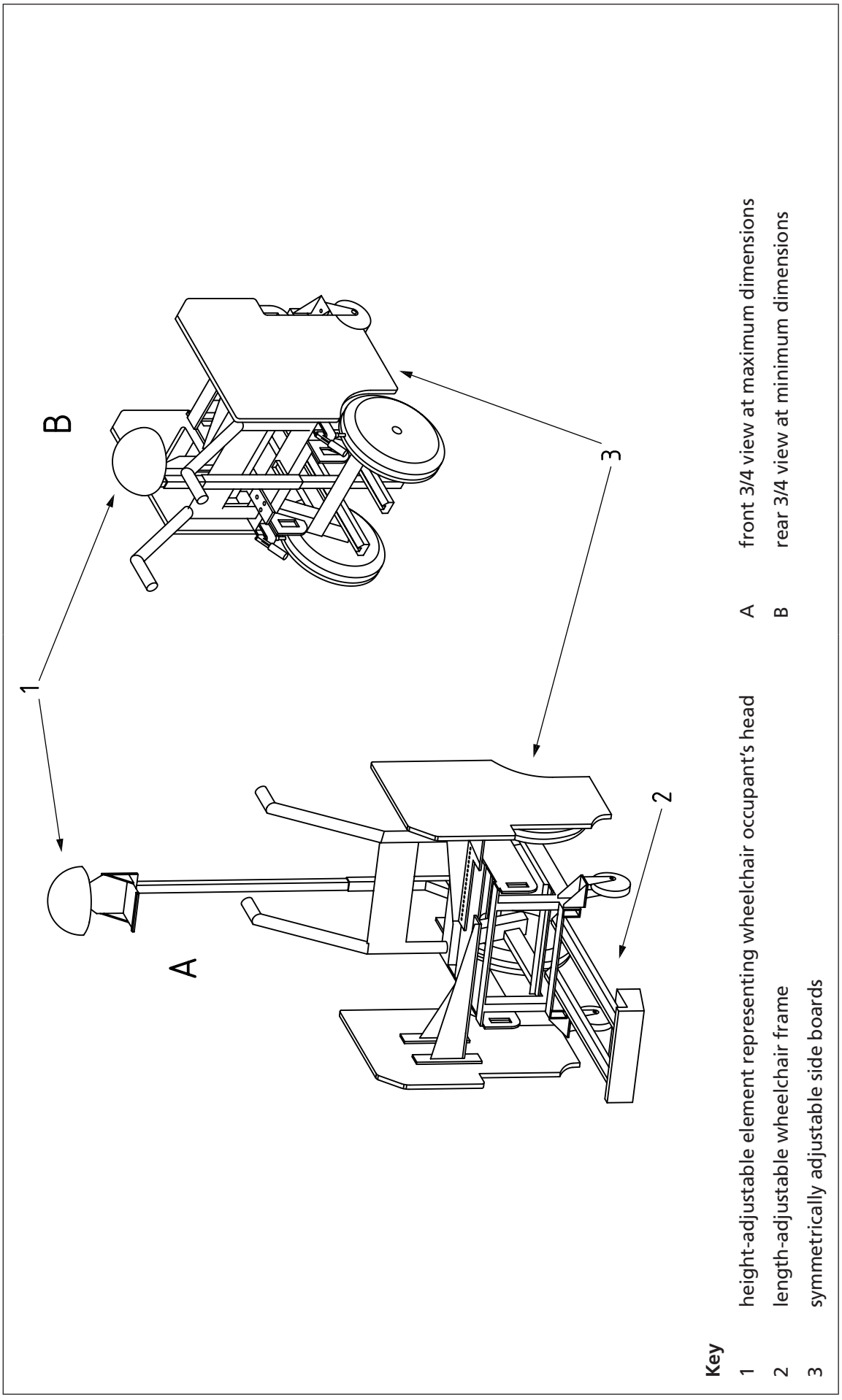


Figure B.2 **Accessibility gauge – Side board dimensions**



Key

1 height-adjustable element representing wheelchair occupant's head

2 length-adjustable wheelchair frame

3 symmetrically adjustable side boards

A front 3/4 view at maximum dimensions

B rear 3/4 view at minimum dimensions

Figure B.3 **Accessibility gauge – General arrangement**

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B.3 Procedure

B.3.1 Wheelchair access entrance width

B.3.1.1 Wheelchair access entrance ≤830 mm wide

B.3.1.1.1 Adjust the accessibility gauge length to L_{min} (780 ± 5) mm, width to W_{min} (505 ± 5) mm and height to H_{min} (980 $^{+25}_{-5}$) mm. Position the accessibility gauge with the adjustable side boards located in the narrowest area of the wheelchair access entrance.

B.3.1.1.2 Adjust the width, *W*, symmetrically, until one or both side boards are touching any part of the door aperture. Where a measurement is taken between one or more deformable features (e.g. a door seal or item of upholstery), it shall be taken to the first point of contact in each case.

B.3.1.1.3 Record this value as the maximum wheelchair access entrance width for the WAV.

NOTE It might be necessary to reposition the accessibility gauge laterally so as to ensure that both side boards make contact with the door aperture on either side simultaneously.

B.3.1.2 Wheelchair access entrance >830 mm wide

B.3.1.2.1 Adjust the accessibility gauge length to L_{min} (780 ± 5) mm, width to W_{max} (830 ± 5) mm and height to H_{min} (980 $^{+25}_{-5}$) mm. Position the accessibility gauge with the adjustable side boards located in the narrowest area of the wheelchair access entrance. Apply the brakes to the accessibility gauge.

B.3.1.2.2 Using a tape measure or other measuring device, record the shortest distance from each of the side boards to the closest part of the door aperture on each side. Where a measurement is taken between one or more deformable features (e.g. a door seal or item of upholstery), it shall be taken to the first point of contact in each case.

B.3.1.2.3 Add these two measurements to 830 mm and record the total as the maximum wheelchair access entrance width for the WAV.

B.3.2 Wheelchair access entrance height

B.3.2.1 Wheelchair access entrance ≤1 550 mm high

B.3.2.1.1 Adjust the accessibility gauge length to L_{min} (780 ± 5) mm, width to W_{min} (505 ± 5) mm and height to H_{min} (980 $^{+25}_{-5}$) mm.

B.3.2.1.2 Adjust the height, *H*, on the head scale, until any part of the wheelchair occupant's head element of the accessibility gauge touches the top of the door aperture as the accessibility gauge is pushed through the wheelchair access entrance. Where a measurement is taken between one or more deformable features (e.g. a door seal or headlining), it shall be taken to the first point of contact in each case.

B.3.2.1.3 Record this value as the maximum wheelchair access entrance height for the WAV.

B.3.2.2 Wheelchair access entrance >1 550 mm high

B.3.2.2.1 Adjust the accessibility gauge length to L_{min} (780 ± 5) mm, width to W_{min} (505 ± 5) mm and height to H_{max} (1 550 ± 5) mm. Position the accessibility gauge such that the gap between the top of the head and the aperture is at a minimum. Apply the brakes to the accessibility gauge.

B.3.2.2.2 Using a tape measure or other measuring device, record the shortest distance from the top of the head element to the closest part of the door aperture above it. Where a measurement is taken between one or more deformable features (e.g. a door seal or headlining), it shall be taken to the first point of contact in each case.

B.3.2.2.3 Add this measurement to 1 550 mm and record the total as the maximum wheelchair access entrance height for the WAV.

B.3.3 Designated travelling position width

B.3.3.1 Designated travelling positions ≤830 mm wide

B.3.3.1.1 Adjust the accessibility gauge length to L_{min} (780 ± 5) mm, width to W_{min} (505 ± 5) mm and height to H_{min} (980 $^{+25}_{-5}$) mm. Position the accessibility gauge in the designated travelling position ±25 mm.

B.3.3.1.2 Adjust the width, *W*, until either or both side boards make contact with any other part of the WAV. Where a measurement is taken between one or more deformable features (e.g. an item of upholstery), it shall be taken to the first point of contact in each case.

B.3.3.1.3 Record this value as the maximum designated travelling position width for the WAV.

NOTE The WAV manufacturer may declare a smaller width if desired, for example, to allow more space within the WAV for other occupants on conventional seats.

B.3.3.2 Designated travelling positions >830 mm wide

B.3.3.2.1 Adjust the accessibility gauge length to L_{min} (780 ± 5) mm, width to W_{max} (830 ± 5) mm and height to H_{min} (980 $^{+25}_{-5}$) mm. Position the accessibility gauge in the designated travelling position ±25 mm. Adjust the width, *W*, to the maximum value of 830 mm.

B.3.3.2.2 Using a tape measure, or other suitable measuring device, record the shortest, perpendicular distance from any part of the outer surface of either of the boards, to any part of the WAV. Where a measurement is taken between one or more deformable features (e.g. an item of upholstery), it shall be taken to the first point of contact in each case.

B.3.3.2.3 Using the value obtained in **B.3.3.2.2** calculate the maximum wheelchair space width for the WAV as follows:

$$W = (d \times 2) + 830 \qquad \text{(B.1)}$$

where

W is the width of the wheelchair space (in mm);

d is the measurement obtained in **B.4.3.2.2** (in mm).

NOTE The WAV manufacturer may declare a smaller width if desired, for example, to allow more space within the WAV for other occupants on conventional seats, or in cases where the WAV is intended to accommodate more than one wheelchair side-by-side.

B.3.3.3 WAVs designed to accommodate more than one occupied wheelchair

B.3.3.3.1 Determine the width of the first designated travelling position in accordance with **B.3.3.1** or **B.3.3.2**.

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B.3.3.3.2 Determine the width of the second and subsequent designated travelling position(s):

a) for the first wheelchair space width being ≤830 mm, by positioning the accessibility gauge, adjusted to the maximum width obtained in **B.3.3.2.1** in the first designated travelling position and using a second accessibility gauge in the next designated travelling position according to the procedure in **B.3.3.1** or **B.3.3.2**;

b) for the first wheelchair space width being greater than 830 mm, by temporarily marking out the area of the first designated travelling position, blocking off that area and using the accessibility gauge in the next designated travelling position according to the procedure in **B.3.3.1** or **B.3.3.2**.

B.3.3.3.3 Record the value of the maximum designated travelling position width for second WAV (and subsequent, if necessary), wheelchair to be accommodated in the WAV.

NOTE The WAV manufacturer may declare a smaller width if desired, for example, to allow more space within the WAV for other designated travelling positions.

B.3.4 Wheelchair space length

B.3.4.1 Designated travelling positions ≤1 350 mm long

B.3.4.1.1 Adjust the accessibility gauge length to L_{min} (780 ± 5) mm, width to W_{min} (505 ± 5) mm and height to H_{min} (980 $^{+25}_{-5}$) mm.

B.3.4.1.2 If any of the WAV's seats form the forward boundary of the wheelchair space, and those seats are adjustable, place those seats in the middle of their range of longitudinal travel ±5 mm, and the middle of their vertical range of adjustment (if adjustable) ±5 mm. Set the seat back angle (if adjustable) of each seat to (20 ± 5)° to the vertical.

NOTE The large tolerance on the seat back angle allows it to be measured using simple equipment (e.g. a protractor or adjustable combination square placed simply against the intersection between the rear of the seat cushion and the bottom of the backrest).

B.3.4.1.3 Position the accessibility gauge in the designated travelling position ±25 mm.

B.3.4.1.4 Increase the length, *L*, of the accessibility gauge until the first point of contact between any part of the foot element of the accessibility gauge, and any part of the WAV. Where a measurement is taken between one or more deformable features (e.g. a door seal or item of upholstery), it shall be taken to the first point of contact in each case.

B.3.4.1.5 Record this value as the maximum wheelchair space length for the WAV.

NOTE The WAV manufacturer may declare a smaller length if desired, for example, to allow more space within the WAV for other occupants on conventional seats or for a second wheelchair.

B.3.4.2 Designated travelling positions >1 350 mm long

B.3.4.2.1 Adjust the accessibility gauge length to L_{min} (780 ± 5) mm, width to W_{min} (505 ± 5) mm and height to H_{min} (980 $^{+25}_{-5}$) mm.

B.3.4.2.2 If any of the WAV's seats form the forward boundary of the wheelchair space, and those seats are adjustable, place those seats in the middle of their range of longitudinal travel ±5 mm, and the middle of their vertical range of adjustment (if adjustable) ±5 mm. Set the seat back angle (if adjustable) of each seat to (20 ± 5)° to the vertical.

NOTE The large tolerance on the seat back angle allows it to be measured using simple equipment (e.g. a protractor or adjustable combination square placed simply against the intersection between the rear of the seat cushion and the bottom of the backrest).

B.3.4.2.3 Position the accessibility gauge in the designated travelling position ±25 mm.

B.3.4.2.4 Adjust the length, *L*, of the accessibility gauge to the maximum of 1 350 mm.

B.3.4.2.5 Using a tape measure, or other suitable measuring device, record the smallest horizontal distance, parallel to the longitudinal centre line of the accessibility gauge, from any part of the top, front edge of the foot element on the accessibility gauge, to the first point of contact with any part of the WAV lying ahead of it. Where a measurement is taken between one or more deformable features (e.g. a door seal or item of upholstery), it shall be taken to the first point of contact.

B.3.4.2.6 Add the distance obtained in **B.3.4.2.5** to 1 350 mm, and record the result as the maximum wheelchair space length for the WAV.

NOTE The WAV manufacturer may declare a smaller length if desired, for example, to allow more space within the WAV for other occupants on conventional seats or for a second wheelchair.

B.3.4.3 WAVs designed to accommodate more than one wheelchair

B.3.4.3.1 Determine the length of the first designated travelling position in accordance with **B.3.4.1** or **B.3.4.2**.

B.3.4.3.2 Determine the length of the second and subsequent designated travelling position(s):

a) for the first wheelchair space length being ≤1 350 mm, by positioning the accessibility gauge, adjusted to the maximum length obtained in **B.3.4.1.5** in the first designated travelling position and using a second accessibility gauge in the next designated travelling position according to the procedure in **B.3.4.1** or **B.3.4.2**;

b) for the first wheelchair space length being >1 350 mm, by temporarily marking out the area of the first designated travelling position, blocking off that area, and using the accessibility gauge in the next designated travelling position according to the procedure in **B.3.4.1** or **B.3.4.2**.

B.3.4.3.3 Record the value of the maximum designated travelling position length for second wheelchair to be accommodated in the WAV.

NOTE The WAV manufacturer may declare a smaller length if desired, for example, to allow more space within the WAV for other designated travelling positions.

B.3.5 Wheelchair space gradient

B.3.5.1 With the WAV laden to its mass in running order, its tyre pressures set to the minimum values recommended by the WAV manufacturer and parked on level ground, apply the handbrake. Where a lowering suspension system is fitted, set the suspension height to the normal running position.

B.3.5.2 Adjust the accessibility gauge length to L_{min} (780 ± 5) mm, width to W_{min} (505 ± 5) mm and height to H_{min} (980 $^{+25}_{-5}$) mm.

B.3.5.3 Position the inclinometer on surface X, parallel to the longitudinal median plane of the accessibility gauge.

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B.3.5.4 Either:

a) without placing any additional mass, other than that of the accessibility gauge and inclinometer, on any part of the WAV, position the accessibility gauge in the designated travelling position ±25 mm; or

b) without placing any additional mass, other than that of the accessibility gauge and inclinometer, on any part of the WAV, position the accessibility gauge such that its rear wheels rest within 100 mm of the top of the ramp and apply the brakes. Arrange supports under the WAV to prevent further changes in ride attitude, and then place the accessibility gauge in the designated travelling position.

NOTE In some large WAVs, it might not be possible to position the accessibility gauge in the designated travelling position and take the inclinometer reading without placing additional mass in the WAV. This might then result in a change of ride attitude, leading to an incorrect inclinometer reading. Method b) allows personnel to enter the WAV once the mass of the accessibility gauge has been added, without further changes in ride attitude.

B.3.5.5 Record the inclinometer reading at this point, in degrees, as the wheelchair space gradient in the longitudinal plane.

B.3.5.6 Repeat for each designated travelling position.

B.3.6 Maximum internal floor slope

B.3.6.1 With the WAV laden to its mass in running order, its tyre pressures set to the minimum values recommended by the WAV manufacturer and parked on level ground, apply the handbrake. Where a lowering suspension system is fitted, place the WAV in the lowered position.

B.3.6.2 Adjust the accessibility gauge length to L_{min} (780 ± 5) mm, width to W_{min} (505 ± 5) mm and height to H_{min} (980 $^{+25}_{-5}$) mm.

B.3.6.3 Position the inclinometer on surface X, parallel to the longitudinal median plane of the accessibility gauge.

B.3.6.4 Starting with the rear wheels of the accessibility gauge resting on the point of intersection of the ramp or lift and the WAV floor, either:

a) without placing any additional mass, other than that of the accessibility gauge and inclinometer, on any part of the WAV, manoeuvre the accessibility gauge, in (100 ± 25) mm increments, to each designated travelling position, recording the reading on the inclinometer at each interval; or

b) without placing any additional mass, other than that of the accessibility gauge and inclinometer, on any part of the WAV, arrange supports under the WAV to prevent further changes in ride attitude, and then manoeuvre the accessibility gauge in (100 ± 25) mm increments to each designated travelling position, recording the reading on the inclinometer at each interval.

NOTE In some large WAVs, it might not be possible to position the accessibility gauge in the designated travelling position and take the inclinometer reading without placing additional mass in the WAV. This might then result in a change of ride attitude, leading to an incorrect inclinometer reading. Method b) allows personnel to enter the WAV once the mass of the accessibility gauge has been added, without further changes in ride attitude.

B.3.6.5 Record the maximum value obtained in **B.3.6.4** as the maximum internal floor angle.

B.3.7 Maximum seated eyeline height

B.3.7.1 General

B.3.7.1.1 With the WAV laden to its mass in running order, its tyre pressures set to the minimum values recommended by the WAV manufacturer and parked on level ground, place the accessibility gauge in the first designated travelling position and remove all additional weight from the WAV apart from the accessibility gauge. Where a lowering suspension system is fitted, set the suspension height to the normal running position.

B.3.7.1.2 Ensure that the rotating laser is level. Close all doors in front or either side of the designated travelling position. Place the sun visors in their stowed positions.

B.3.7.1.3 Adjust the angles of any seat backrests within the 180° forward field of view of the accessibility gauge to between 15° and 20°. Place any adjustable head restraints in their lowest positions.

NOTE The large tolerance on the seat back angle allows it to be measured using simple equipment (e.g. a protractor or adjustable combination square placed simply against the intersection between the rear of the seat cushion and the bottom of the backrest.

B.3.7.2 Forward-facing travelling positions with eyeline height ≤1 434 mm

B.3.7.2.1 Adjust the height, *H*, until the beam from the laser level touches the highest part of the transparent area of the windscreen within the field of vision ahead of the laser, or until the head element of the accessibility gauge touches the WAV roof lining, whichever occurs first. Record this height dimension, using the eyeline height scale on the accessibility gauge.

B.3.7.2.2 Repeat for each forward-facing designated travelling position.

B.3.7.3 Rearward-facing travelling positions with eyeline height ≤1 434 mm

B.3.7.3.1 Close all doors that are rearward of the designated travelling position, and stow the ramp, lift, or any other equipment that might impinge on the view to the rear from the travelling position.

B.3.7.3.2 Adjust the height, *H*, until the beam from the laser level touches the highest part of the transparent area of any window or rear screen within the 180° field of vision ahead of the laser (i.e. towards the rear of the WAV), or until the head element of the accessibility gauge touches the WAV roof lining, whichever occurs first.

B.3.7.3.3 Record this height dimension using the eyeline height scale on the accessibility gauge.

B.3.7.3.4 Repeat for each rearward-facing designated travelling position.

B.3.7.4 Any travelling position with eyeline height >1 434 mm

Any designated travelling position (forward or rearward-facing) where the eyeline height exceeds 1 434 mm shall be recorded as "Greater than 1 434 mm" in the WAV's technical specification.

B.3.8 Wheelchair space headroom

B.3.8.1 Designated travelling positions ≤1 550 mm high

B.3.8.1.1 Adjust the accessibility gauge length to L_{min} (780 ± 5) mm, width to W_{min} (505 ± 5) mm and height to H_{min} (980 $^{+25}_{-5}$) mm. Position the wheelchair in its designated travelling position.

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B.3.8.1.2 Adjust the height, *H*, until contact is made with any part of the WAV. Where a measurement is taken between one or more deformable features (e.g. a fabric headlining), it shall be taken to the first point of contact.

B.3.8.1.3 Record this value of *H* as the maximum internal roof height for the WAV.

B.3.8.1.4 Repeat for each designated travelling position.

B.3.8.2 Any travelling position with headroom >1 550 mm

Any designated travelling position (forward or rearward-facing) where the headroom exceeds 1 550 mm shall be recorded as "Greater than 1 550 mm" in the WAV's technical specification.

B.3.9 Ramp width

B.3.9.1 Using the tape measure, determine the minimum width of the deployed ramp at any point along its length between the ground and the WAV floor. Where a measurement is taken between one or more deformable features (e.g. a door seal), it shall be taken to the first point of contact in each case.

B.3.9.2 Record this value as the ramp width when deployed.

NOTE The minimum ramp width is likely to be determined by the side guards or items protruding from the inner surfaces of the side guards (e.g. bolt heads, hinges) or by features on the WAV as the ramp crosses the door aperture (such as the door seals).

B.3.10 Ramp length

B.3.10.1 With the WAV parked on level ground, deploy the ramp. For a ramp of adjustable length, deploy the ramp to its maximum length.

B.3.10.2 Using a tape measure, measure the distance along the centre line of the working surface of the ramp, from its outermost extremity to the top of the last movable element before the WAV floor.

B.3.10.3 Record this value as the ramp length when deployed.

B.3.11 Ramp angle

B.3.11.1 With the WAV laden to its mass in running order, its tyre pressures set to the minimum values recommended by the WAV manufacturer and parked on level ground, apply the handbrake. Where a lowering suspension system is fitted, place the WAV in the lowered position. Deploy the ramp on to the ground. For a ramp of adjustable length, deploy the ramp to its maximum length.

B.3.11.2 Adjust the accessibility gauge length to L_{min} (780 ± 5) mm, width to W_{min} (505 ± 5) mm and height to H_{min} (980 $^{+25}_{-5}$) mm.

B.3.11.3 Position the inclinometer on surface X, parallel to the longitudinal median plane of the accessibility gauge.

B.3.11.4 Starting with all 4 wheels of the accessibility gauge resting on the ground, without placing any additional mass, other than that of the accessibility gauge and inclinometer, on any part of the WAV, manoeuvre the accessibility gauge in (100 ± 25) mm increments, from the ground until the front wheels rest on the point of intersection of the ramp and the WAV floor, recording the reading on the inclinometer at each interval.

B.3.11.5 Record the maximum value obtained in **B.3.11.4** as the maximum ramp angle.

B.3.11.6 For a side-entry WAV, repeat the process with the ramp deployed on to a surface (125 ± 5) mm above the ground. Record this value as the ramp gradient for the WAV with the ramp deployed on to a 125 mm pavement.

NOTE For a side-entry WAV, the ramp is normally deployed on to a pavement, but can also, in some circumstances, be deployed on to the road surface. The angle is therefore measured both from the ground, and also from a surface (125 ± 5) mm above the ground, which represents the pavement. For a rear-entry WAV, the ramp angle only needs to be measured from the ground.

B.3.12 Lift platform

B.3.12.1 Width

B.3.12.1.1 Raise the lift platform above the ground until any automatic features to prevent the wheelchair rolling off are fully engaged.

B.3.12.1.2 Using the tape measure, measure the minimum width of the deployed lift platform. Where a measurement is taken between one or more deformable features (e.g. a door seal), it shall be taken to the first point of contact in each case.

B.3.12.1.3 Record this value as the minimum lift width.

NOTE The minimum lift platform width is likely to be determined by the guards or items protruding from the inner surfaces of the guards (e.g. bolt heads, hinges) or by features on the WAV if the lift platform crosses the door aperture (such as the door seals).

B.3.12.2 Length

Raise the lift platform above the ground until any automatic features to prevent the wheelchair rolling off are fully engaged. Using the tape measure, determine the minimum length of the deployed lift platform available to support passengers and/or wheelchairs at any point across its width. Record this as the lift platform length.

B.3.13 Maximum ramp or lift projection when deployed

B.3.13.1 With the WAV parked on level ground, determine which face of the WAV contains the wheelchair access entrance. With all doors closed, using a plumb line, or similar device, establish the outermost point of the WAV and mark a point vertically below it on the ground. Where a lowering suspension system is fitted, place the WAV in the lowered position.

NOTE For a rear-entry WAV with a tailgate, this is likely to be the outermost projection of the rear bumper. For a side entry WAV, this is likely to be the outer edge of the door mirror.

B.3.13.2 Deploy the ramp or lift on to the ground. For a ramp of adjustable length, deploy the ramp to its maximum length. Using a tape measure, record the distance perpendicular to the face of the WAV, between the centre of the outboard end of the ramp or lift and the point on the ground determined in **B.3.13.1**.

B.3.13.3 Record this value as the maximum ramp or lift projection when deployed.

B.3.13.4 Where the outermost end of the deployed ramp or lift does not extend beyond the outermost point on the face of the WAV, record the ramp or lift projection as "zero".

B.3.14 Ground clearance

B.3.14.1 Place the WAV, laden to its mass in running order, on level ground. Adjust the tyre pressures to the minimum values recommended by the WAV manufacturer. Roll the test specimen (1.0 ± 0.5) m backwards and forwards to settle the suspension. Apply the handbrake.

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B.3.14.2 Using a sliding block, (120 $^{+0}_{-1}$) mm high, or a similar item, verify that the minimum clearance between the ground and any point on the WAV, disregarding any suspension component capable of moving relative to the WAV structure, is ≥120 mm.

B.3.14.3 By progressively adding shims of increasing thickness to the sliding block, repeat **B.3.14.2** until contact is made with a part of the WAV, disregarding any contact with any suspension component capable of moving relative to the WAV structure.

B.3.14.4 Record this value as the ground clearance of the WAV with a tolerance of $^{+0}_{-6}$.

B.3.15 Maximum access dimensions

*NOTE The purpose of this set of measurements is to provide a practical set of key dimensions that can be readily used to allow prospective users to compare different WAVs. These dimensions should be used in conjunction with the detailed dimensions obtained in **B.3.1** to **B.3.13** of this PAS and which are recorded in the WAV's technical specification. By the nature of this assessment, the dimensions are limited to those of the smallest "bottleneck" at any point between the ground and the designated travelling position. For example, the maximum access height is likely in most WAVs to be dictated by the height of the entrance, even though the headroom in the wheelchair space might be greater. Similarly, the maximum access width and/or length might be limited not by the length or width of the wheelchair space, but by the length and width of some other part of the WAV that needs to be passed through, in order to reach the wheelchair space. As the measurements are intended to be used as a comparative guide, individual wheelchair users might find that a WAV with one or more maximum access dimensions that are smaller than the dimensions of their own occupied wheelchair, depending on their particular circumstances, is acceptable (e.g. a wheelchair user who is able to temporarily lower their head when passing through an entrance could find a WAV with a maximum accessibility height less than their own height when seated in their wheelchair acceptable).*

B.3.15.1 WAV designed to accommodate one wheelchair

B.3.15.1.1 The WAV manufacturer shall nominate a maximum accessibility length, width and height for the designated travelling position.

NOTE In some WAVs, particularly those where a degree of manoeuvring of the wheelchair is required in order to reach the designated travelling position, the maximum length of wheelchair that can be manoeuvred into the designated travelling position may be increased at the expense of reduced wheelchair width, or vice versa. For this reason, it is left to the WAV manufacturer to nominate the combination of dimensions that they feel are best suited to the application. The purpose of the following subclauses is to determine whether a wheelchair of the dimensions stipulated, can be manoeuvred to and from the designated travelling position.

B.3.15.1.2 Adjust the width, *W*, the length, *L*, and the height, *H*, of the accessibility gauge to the dimensions nominated in **B.3.15.1.1**. For a designated travelling position in which one or more of the nominated dimensions exceeds the accessibility gauge maximum, the accessibility gauge shall be adjusted to its maximum for that dimension.

B.3.15.1.3 Starting from the ground immediately before the deployed ramp or lift, manoeuvre the accessibility gauge into the designated travelling position and attach the wheelchair tie-downs.

B.3.15.1.4 Remove the tie-downs and manoeuvre the accessibility gauge back out of the WAV and on to the ground.

NOTE It is permissible to lift the front wheels of the accessibility gauge during this operation, and to perform multiple point turns if necessary.

B.3.15.2 WAV designed to accommodate more than one wheelchair

B.3.15.2.1 The WAV manufacturer shall nominate a maximum accessibility length, width and height for each designated travelling position.

B.3.15.2.2 Starting with the first designated travelling position, adjust the width, *W*, the length, *L*, and the height, *H*, of the accessibility gauge to the dimensions for that designated travelling position, nominated in **B.3.15.2.1**.

B.3.15.2.3 For a designated travelling position in which one or more of the nominated dimensions exceeds the accessibility gauge maximum, the accessibility gauge shall be adjusted to its maximum for that dimension.

B.3.15.2.4 Starting from the ground immediately before the deployed ramp or lift, manoeuvre the accessibility gauge into the designated travelling position and attach the wheelchair tie-downs.

B.3.15.2.5 Remove the tie-downs and manoeuvre the accessibility gauge back out of the WAV and on to the ground.

NOTE It is permissible to lift the front wheels of the accessibility gauge during this operation, and to perform multiple point turns if necessary.

B.3.15.2.6 For the next designated travelling position, either:

a) position an accessibility gauge, adjusted to the dimensions used in **B.3.15.2.2** into the first designated travelling position and apply the brake; or

b) for a first designated travelling position with one or more dimensions greater than any of the maxima on the accessibility gauge, temporarily mark out and block off an area of the dimensions used in **B.3.15.2.2** in the first designated travelling position.

NOTE The tie-downs need not be attached to the accessibility gauge, or taken into account when marking out the blocked-off area.

B.3.15.2.7 Adjust the width, *W*, the length, *L*, and the height, *H*, of an accessibility gauge to the dimensions for the second designated travelling position, nominated in **B.3.15.2.1**. For a designated travelling position in which one or more of the nominated dimensions exceeds the accessibility gauge maximum, the accessibility gauge shall be adjusted to its maximum for that dimension.

B.3.15.2.8 Starting from the ground immediately before the deployed ramp or lift, manoeuvre the accessibility gauge into the second designated travelling position and attach the wheelchair tie-downs.

B.3.15.2.9 Remove the tie-downs and manoeuvre the accessibility gauge back out of the WAV and on to the ground.

NOTE It is permissible to lift the front wheels of the accessibility gauge during this operation, and to perform multiple point turns if necessary.

B.3.15.2.10 Repeat the verification process for each subsequent designated travelling position.

B.3.16 WTORS effective anchorage locations

B.3.16.1 Adjust the accessibility gauge length to L_{min} (780 ± 5) mm, width to W_{min} (505 ± 5) mm and height to H_{min} (980 $^{+25}_{-5}$) mm. Position the accessibility gauge in the designated travelling position ±25 mm, and attach the tie-downs. Attach the wheelchair occupant restraint equipment to its anchorages on the WAV structure.

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B.3.16.2 Record the following measurements:

a) the lateral separation of the lower effective anchorages for the wheelchair occupant restraint;

b) the side view projected angles produced by a line drawn from point P on the accessibility gauge to each of the wheelchair occupant restraint lower effective anchorages and the horizontal;

c) the height of the wheelchair occupant restraint upper effective anchorage above a horizontal plane passing through the contact points of the rear tyres of the accessibility gauge with the WAV floor;

   1) for an adjustable upper effective anchorage, in its highest and lowest positions;

   2) for a fixed upper effective anchorage, in its fixed position;

d) the lateral distance from a vertical plane passing through the longitudinal centre line of the accessibility gauge to the upper effective anchorage, when the upper anchorage hangs freely from the anchorage point on the WAV;

e) the side view projected angles produced by a line drawn from each of the wheelchair tie-down effective anchorages to their attachment points on the accessibility gauge and the horizontal;

f) the lateral separation of each pair of rear tie-down effective anchorages;

g) the lateral separation of the front tie-down effective anchorages;

h) the longitudinal distance between each of the rear tie-down effective anchorages and a theoretical transverse line joining each of the front tie-down effective anchorages.

B.3.17 Determination of back and head support geometry

B.3.17.1 Adjust the accessibility gauge length to L_{min} (780 ± 5) mm, width to W_{min} (505 ± 5) mm and height to H_{min} (980 $^{+25}_{-5}$) mm. Position the accessibility gauge in the designated travelling position ±25 mm and note the position of the contact points of its rear tyres on the WAV floor. Remove the accessibility gauge.

B.3.17.2 Record the following measurements:

a) the minimum width of the back and head support;

b) the installation angle, relative to the vertical, of the back and head support;

c) the height of the top of the back and head support above the horizontal plane containing the contact points of the rear tyres of the accessibility gauge with the WAV floor;

d) any offset between a longitudinal, vertical plane passing through the centre of the back and head support, and a longitudinal plane passing through the centre of the designated travelling position.

NOTE 1 For the purposes of this measurement, the longitudinal plane passing through the centre of the designated travelling position is taken as a longitudinal vertical plane passing through a point equidistant from each of the rear wheelchair tie-down effective anchorage points.

NOTE 2 For the purposes of this measurement, the rear tie-downs are those that attach to the rear of the wheelchair.

B.4 Test report

The test report shall include all the dimensions determined in **B.3** and a record of each of the nominated maximum access dimensions successfully verified in **B.3.15**.

Annex C (normative)

Dynamic strength test for ramp, lift and spare wheel mountings and WTORS anchorages for forward-facing wheelchairs ≤200 kg

NOTE 1 For testing the strength of a ramp, lift and spare wheel mounting, either Annex C (a dynamic test) or Annex D (a static test) is acceptable as a means of satisfying the requirements of this PAS.

*NOTE 2 See Note 1 to Clause **6**.*

NOTE 3 This test method has been based on the test method for frontal impact given in BS ISO 10542-1:2012.

NOTE 4 Tie-down anchorages for wheelchairs ≤85kg may also be tested to the requirements of this Annex.

C.1 Principle

A SWC is secured in a WAV structure complete with WTORS and WTORS anchorages. Any ramp, lift and/or spare wheel, can be tested either at the same time as the WTORS anchorages or individually as a separate test. An anthropomorphic test device (ATD) is secured in the SWC using the WTORS provided and the WAV is then mounted on the sled of an impact simulator in a forward-facing configuration.

The sled platform is subjected to a defined acceleration/deceleration-time pulse to achieve a defined horizontal velocity change (Δv) in order to determine the strength of the WTORS anchorages and of the mountings for the ramp, lift and spare wheel, where fitted.

C.2 Apparatus

C.2.1

Impact simulator that includes the following:

a) an impact sled with a flat, horizontal, structurally rigid platform on which the WAV structure can be mounted;

b) a means to drive the impact sled through a change in velocity of (48 $^{+2}_{-0}$) km/h;

c) a means to accelerate and/or decelerate the impact sled and WAV structure such that the processed sled acceleration- and/or deceleration-time pulse:

   1) falls within the shaded area of Figure C.1;

   2) exceeds 20 g for a cumulative time period of ≥15 ms;

   3) exceeds 15 g for a cumulative time period of ≥40 ms; and

   4) has a duration of ≥75 ms from t_0 to t_f; where t_0 is the time at the beginning of the deceleration and t_f indicates the time at the end of deceleration pulse.

d) a Hybrid III 50th percentile ATD with an approximate total mass of 77.7 kg;

e) a SWC conforming to Annex G.

C.2.2 *Acceleration measurement equipment*, to measure the horizontal acceleration and/or deceleration of the impact sled in the direction of travel at a sampling rate in accordance with BS ISO 6487, and with a precision of ±0.5 g.

C.2.3 *Velocity measurement equipment*, to measure the horizontal velocity change (Δv) of the impact sled during the impact with a precision of ±0.5 km/h.

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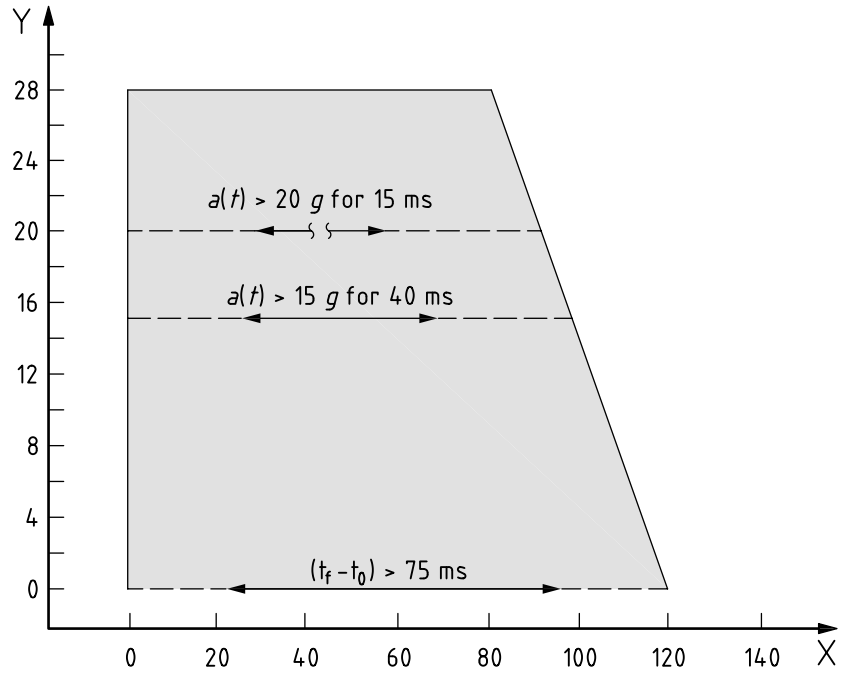
Figure C.1 **Acceleration/deceleration-time pulse**



X = time, ms

Y = deceleration, *g*

The acceleration/deceleration of the impact sled shall be within the shaded area and exceed the indicated levels for the specified continuous (unbroken arrows) and cumulative (broken arrows) time periods.

C.2.4 *Signal filtering equipment*, to filter analogue transducer signals using a low-pass filter in accordance with BS ISO 6487, including:

a) pre-filtering of all transducer signals to Channel Class 1 000 (–4 dB at 1 650 Hz) prior to digitizing at 10 000 Hz; and

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

C.3 Test specimen preparation

C.3.1 The test specimen shall consist of one WAV structure, representative of the completed WAV in respect of its WTORS anchorages. Where the mountings for a ramp, lift and/or spare wheel are to be tested, they shall also be fitted in their designated positions within the WAV structure using the fastening methods and materials designated by the WAV manufacturer.

NOTE Any ramp, lift and/or spare wheel, can be tested either at the same time as the WTORS anchorages or individually as a separate test.

C.3.2 A new and unused WTORS, including all fittings, fasteners and anchorages supplied with the WTORS system kit shall be fitted to the WAV structure.

C.3.3 The test specimen shall be secured to the impact sled in such a way as to reproduce the ride attitude of the WAV when laden to its mass in running order ±2°.

C.3.4 The method used to secure the WAV during the test shall not be such as to strengthen the WTORS anchorages nor lessen the deformation of the WAV structure in an area within 200 mm of any WTORS anchorage.

NOTE The WAV structure should rest on supports arranged approximately in line with the axis of the wheels. The WAV structure should, wherever possible, be attached to the impact sled by means of its suspension attachment points.

C.4 Procedure

C.4.1 Add or remove weights from the weight carrier on the SWC until its mass is equal to the maximum mass of wheelchair that the WAV is designed to carry ±3 kg.

C.4.2 Position the SWC within the WAV structure in the travelling position designated by the WAV manufacturer.

C.4.3 Secure the SWC in the WAV structure using the WTORS provided.

C.4.4 Position the ATD in the SWC sitting upright and symmetrical about the wheelchair reference plane, with the pelvis and buttocks as far back on the wheelchair seat as possible, and the hands resting on the ATD's thighs.

C.4.5 Secure the ATD in the SWC using the wheelchair occupant restraint supplied with the WAV.

NOTE The tension in the pelvic belt should be adjusted so as to achieve a snug fit.

C.4.6 Subject the loaded impact sled to a horizontal velocity change of $(48\ ^{+2}_{-0})$ km/h using an acceleration/deceleration-time pulse in accordance with Figure C.1.

C.4.7 Activate the impact sled and start the recording equipment.

C.4.8 Record a description of any deformation or partial rupture of, or in the vicinity of any anchorage, ramp, lift or spare wheel mounting point.

C.4.9 Record the position and attitude of the SWC and the ATD.

C.5 Test report

The test report shall include as a minimum:

a) reference to this standard, i.e. PAS 2012-1:2015;

b) reference to the test, i.e. "Dynamic strength test for ramp, lift and spare wheel mountings and WTORS anchorages for forward-facing wheelchairs ≤200 kg";

c) date(s) of the test(s);

d) name or trademark, and address of the WAV manufacturer;

e) name(s) and address(es) of the testing organization;

f) make and model of base vehicle (if applicable);

g) make and model of WAV;

h) a note of the make and model of WTORS equipment fitted for the test;

i) drawings and photographs of the WTORS anchorages, including a material specification;

j) the mass of the SWC used for the test;

k) test results achieved including:

   1) a description of any deformation or partial rupture of, or in the vicinity of any anchorage, ramp, spare wheel or lift mounting following the test (see **6.4.2**);

   2) a description of any intrusion into the wheelchair space by any ramp or lift during the test;

   3) a record of whether or not the release mechanisms for a ramp or lift were still operable after the test.

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Annex D (normative) Static strength test for ramp, lift and spare wheel mountings

NOTE For testing the strength of a ramp, lift and spare wheel mounting, either Annex C (a dynamic test) or Annex D (a static test) is acceptable as a means of satisfying the requirements of this PAS.

D.1 Principle

A WAV ramp, lift, or spare wheel, mounted within the WAV, is subject to static test forces to determine the strength of its mounting under simulated crash conditions.

D.2 Apparatus

D.2.1 *Equipment*, capable of applying a force equal to 20 times the mass of the heaviest item (ramp, lift, or spare wheel) fitted to the WAV, for a period of 0.2 s and recording those forces at a rate of ≥100 Hz.

NOTE A seat belt anchorage test rig capable of performing tests to either UN/ECE Regulation 14 [3] or Directive 76/115/EC [4] would be suitable.

D.3 Test specimen

The test specimen shall consist of one WAV structure, representative of the completed WAV in respect of its ramp, lift, spare wheel (the test items), and any of their relevant supporting structures.

NOTE Not all of these items are fitted in all WAVs.

D.4 Procedure

D.4.1 The test specimen shall be secured to the test rig (**D.2.1**) in such a way as to reproduce the ride attitude of the WAV when laden to its mass in running order ±2°.

D.4.2 The method used to secure the WAV structure during the test shall not be such as to strengthen the attachment points of any of the items under test, nor lessen the deformation of the WAV structure in an area within 200 mm of any of those attachment points.

NOTE The WAV structure should rest on supports arranged approximately in line with the axis of the wheels. The WAV structure should, wherever possible, be attached to the test rig by means of its suspension attachment points.

D.4.3 Any part of the WAV structure or other features that could obstruct the equipment used to apply the test forces in **D.4.6** shall be removed or cut away prior to the test.

D.4.4 Determine, by measurement or by means of a declaration from the WAV manufacturer, the position of the centre of gravity for each of the test items.

D.4.5 Determine the appropriate test force to be applied to each test item using Equation D.1:

$$F = 20 \times M \times 9.81 \quad \text{(D.1)}$$

where

F is the test force to be applied (in N);

M is the mass of the test item (in kg).

D.4.6 Apply the force(s) calculated according to the formula in **D.4.5** to each of the test items in turn, at the height of the centre of gravity of the test item ±100 mm, in a forward direction, and at an angle of (10 ± 5)° above the horizontal plane for a minimum duration of 0.2 s.

NOTE It is acceptable to apply the test force using an arrangement of straps, chains or similar means, attached to a rigid bar secured behind the test item at its centre of gravity height ±100 mm, provided that any such arrangement does not reinforce the test item to such an extent that the outcome of the test is influenced.

D.4.7 Remove the equipment used to apply the test force(s) and verify that, following the test:

a) each test item remains attached to the WAV structure; and

b) for a ramp or lift, any mechanisms to release the ramp or lift are still capable of functioning.

NOTE Deformation, partial rupture or breakage of any mounting and the surrounding area need not constitute failure.

D.5 Test report

The test report shall include as a minimum:

a) reference to this standard, i.e. PAS 2012-1:2015;

b) reference to the test, i.e. "Static strength test for ramp, lift and spare wheel mountings";

c) date(s) of the test(s);

d) name or trademark, and address of the WAV manufacturer;

e) WAV manufacturers identification number;

f) name(s) and address(es) of the testing organization;

g) type and model of base vehicle;

h) a list of test items within the WAV structure and a note of their locations;

i) the mass of each test item;

j) the location of the centre of gravity relative to a specified datum;

k) photos of each test item before and after the test;

l) drawings of each test item;

m) test results achieved including:

   1) the force applied to each test item for a period of ≥0.2 s;

   2) a description of the condition of each item and its mountings following the test;

   3) a record of whether or not the release mechanisms for a ramp or lift were still operable after the test.

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Annex E (normative) Static strength test for WTORS anchorages for forward-facing wheelchairs ≤85 kg

*NOTE See Note 1 to Clause **6**.*

E.1 Principle

A WAV structure complete with WTORS anchorages, is subjected to forces applied to its WTORS anchorages to determine their strength.

E.2 Apparatus

E.2.1 *Test rig,* capable of securing a WAV structure and applying forces to it of ≥25 kN at one point and ≥13.5 kN at two points simultaneously, for a period of 0.2 s and recording those forces at a rate of ≥100 Hz

NOTE A seat belt anchorage test rig capable of performing tests to either UN/ECE Regulation 14 [3] or Directive 76/115/EC [4] would be suitable.

E.2.2 *SWC*, capable of withstanding the forces described in **E.2.1** without permanent deformation. The SWC seat height, tie-down anchorage positions and wheelbase shall conform to Annex G

*NOTE For this static strength test, the SWC only has to conform to **E.2.2** and not all of to the requirements specified in Annex G.*

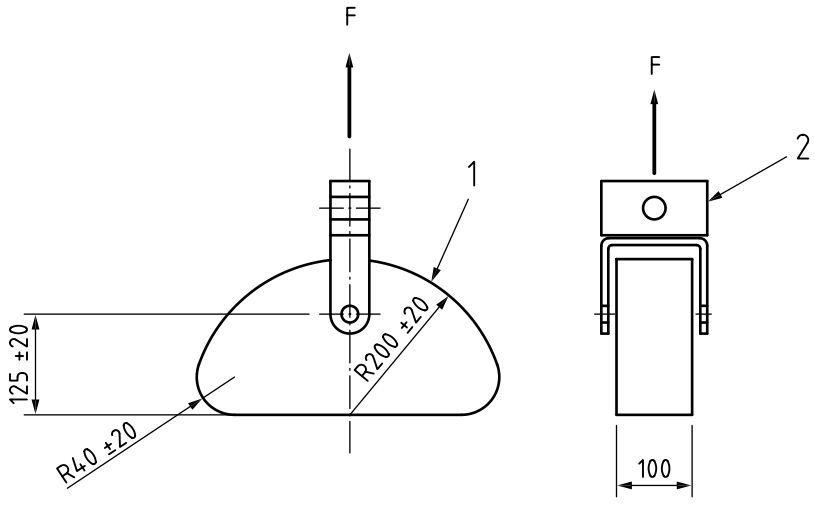
E.2.3 *A set of traction devices*, conforming to the dimensions specified in Figure E.1 and Figure E.2 with which to apply the test loads to the wheelchair occupant restraint anchorages

NOTE Traction devices capable of performing tests to either UN/ECE Regulation 14 [3] or Directive 76/115/EC [4] would be suitable.

Figure E.1 **Torso traction device**

Dimensions in millimetres

All dimensions ±5 mm unless stated



[Source: UN/ECE Regulation 14 [3] (adapted)]

Key

1 cloth-covered foam, thickness (25 ± 10) mm

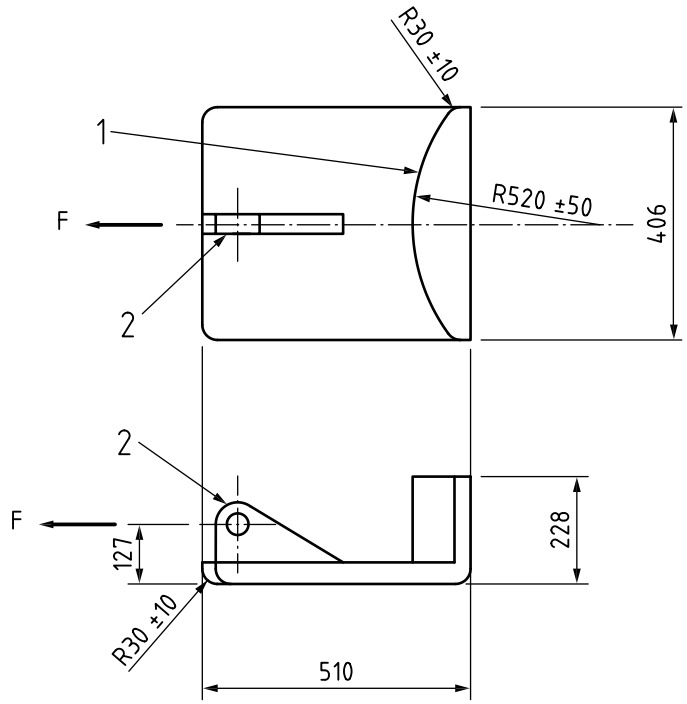
2 bracket to connect traction device to test rig

F direction of applied tractive force

Figure E.2 **Pelvic traction device**

Dimensions in millimetres

All dimensions ±5 mm unless stated



[Source: UN/ECE Regulation 14 [3] (adapted)]

Key

1 cloth-covered foam, thickness (25 ± 10) mm

2 bracket to connect traction device to test rig

F direction of applied tractive force

E.3 Test specimen preparation

E.3.1 The test specimen shall consist of one WAV structure, representative of the completed WAV in respect of its WTORS anchorages.

NOTE Windows and doors may be fitted or not and closed or not. Any fitting normally provided and likely to contribute to the WAV structure may be fitted.

E.3.2 The test specimen shall be secured to the test rig (**E.2.1**) in such a way as to reproduce the ride attitude of the WAV when laden to its mass in running order ±2°.

E.3.3 The method used to secure the WAV structure during the test shall not be such as to strengthen the WTORS anchorages or to lessen the deformation of the WAV structure in an area within 200 mm of any WTORS anchorage.

NOTE The WAV structure should rest on supports arranged approximately in line with the axis of the wheels. The WAV structure should, wherever possible, be attached to the test rig by means of its suspension attachment points.

E.3.4 Any part of the WAV structure or other features that could obstruct the equipment used to apply the test loads in **E.4.7** and **E.4.13** shall be removed or cut away prior to the test.

E.4 Procedure

E.4.1 Position the SWC (**E.2.2**) within the WAV structure in the travelling position designated by the WAV manufacturer.

E.4.2 Secure the SWC in the WAV structure using cables or straps capable of transmitting the load from the SWC, to each anchorage.

NOTE Cables, straps or actual WTORS may be used to secure the SWC to the WAV structure.

E.4.3 Place the traction devices (**E.2.3**) in the SWC and secure them to the WAV structure using cables or straps capable of transmitting the load from the traction device, to each wheelchair occupant restraint anchorage.

NOTE Cables, straps or actual WTORS may be used to secure the SWC to the WAV structure.

E.4.4 Attach the means of applying the test loads to the SWC at its centre of gravity height ±100 mm. For a SWC of a design other than one shown in Annex G, the load shall be applied at a height of (287 ± 100) mm above the surface on which the front wheels of the SWC rest.

E.4.5 Attach the means of applying test loads to each of the traction devices.

E.4.6 Adjust the positions of each of the load application devices such that the test loads are exerted at an angle of (10 ± 5)° above the horizontal plane at the start of the test, in a plane parallel to the median longitudinal plane of the WAV structure and in a forward direction relative to the WAV structure.

E.4.7 Apply the test loads specified in Table E.1, simultaneously to each of the traction devices and the SWC for ≥0.2 s.

E.4.8 The application of the test load shall be achieved in ≤10 s.

Table E.1 **Test loads applied to forward-facing WOTRS anchorages in the forward direction**

Minimum load applied to torso traction device kN	**Minimum load applied to pelvic traction device** kN	**Minimum load applied to SWC** kN
13.5 ± 0.2	13.5 ± 0.2	≥24.5

E.4.9 Record a description of any deformation or partial rupture of, or in the vicinity of any anchorage.

E.4.10 Remove the traction devices and wheelchair occupant restraints from the WAV structure.

E.4.11 Re-configure the WAV structure and/or the loading devices such that the loads can be applied at an angle of (10 ± 5)° above the horizontal plane at the start of the test, in a plane parallel to the median longitudinal plane of the WAV structure and in a rearward direction relative to the WAV structure.

E.4.12 If necessary, re-adjust the tie-downs, wires or straps to reposition the SWC within the WAV structure in the travelling position designated by the WAV manufacturer.

E.4.13 Apply a test load of (≥8.2) kN to the SWC in a rearward direction for ≥0.2 s.

E.4.14 The application of the test load shall be achieved in ≤10 s.

E.4.15 Record a description of any deformation or partial rupture of, or in the vicinity of any anchorage.

E.5 Test report

The test report shall include as a minimum:

a) reference to this standard, i.e. PAS 2012-1:2015;

b) reference to the test, i.e. "Static strength test for WTORS anchorages for forward-facing wheelchairs ≤85 kg";

c) date(s) of the test(s);

d) name or trademark, and address of the WAV manufacturer;

e) name(s) and address(es) of the testing organization;

f) make and model of base vehicle;

g) make and model of WAV;

h) the make and model of WTORS equipment fitted for the test;

i) drawings and photographs of the WTORS anchorages, including a material specification;

j) test results achieved including:

   1) the maximum load applied in a forward direction relative to the WAV structure to each of the traction devices and the SWC during the same 0.2 s period (see **E.4.7**);

   2) the maximum load applied in a rearward direction relative to the WAV structure to the SWC for a 0.2 s period (see **E.4.13**);

   3) a description of any deformation or partial rupture of, or in the vicinity of any anchorage, following the test (see **E.4.9** and **E.4.15**);

   4) the position of the SWC in the WAV structure;

   5) any detachment or separation of the WTORS anchorage from the WAV structure.

Annex F (normative) Static strength test for WTORS anchorages and back and head support for rearward-facing wheelchairs

*NOTE See Note 1 to Clause **6**.*

F.1 Principle

A WAV structure complete with WTORS anchorages and back and head support is subjected to forces to each of these features in order to determine their strength.

F.2 Apparatus

F.2.1 *Test rig,* capable of securing a WAV structure and applying the following forces to it and recording those forces at a rate of ≥100 Hz:

a) a single force of ≥25 kN in a forward direction relative to the WAV structure for a period of ≥0.2 s;

b) a single force of ≥2 kN in a forward direction relative to the WAV structure for a period of ≥2 s;

c) two forces of ≥4.5 kN and one force of ≥8.5 kN simultaneously, in a rearward direction relative to the WAV structure for a period of ≥0.2 s.

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F.2.2 *SWC*, capable of withstanding the forces described in **F.2.1** without permanent deformation. The SWC seat height, tie-down anchorage positions and wheelbase shall conform to Annex G.

*NOTE For this static strength test, the SWC only has to conform to **F.2.2** and not all of the requirements specified in Annex G.*

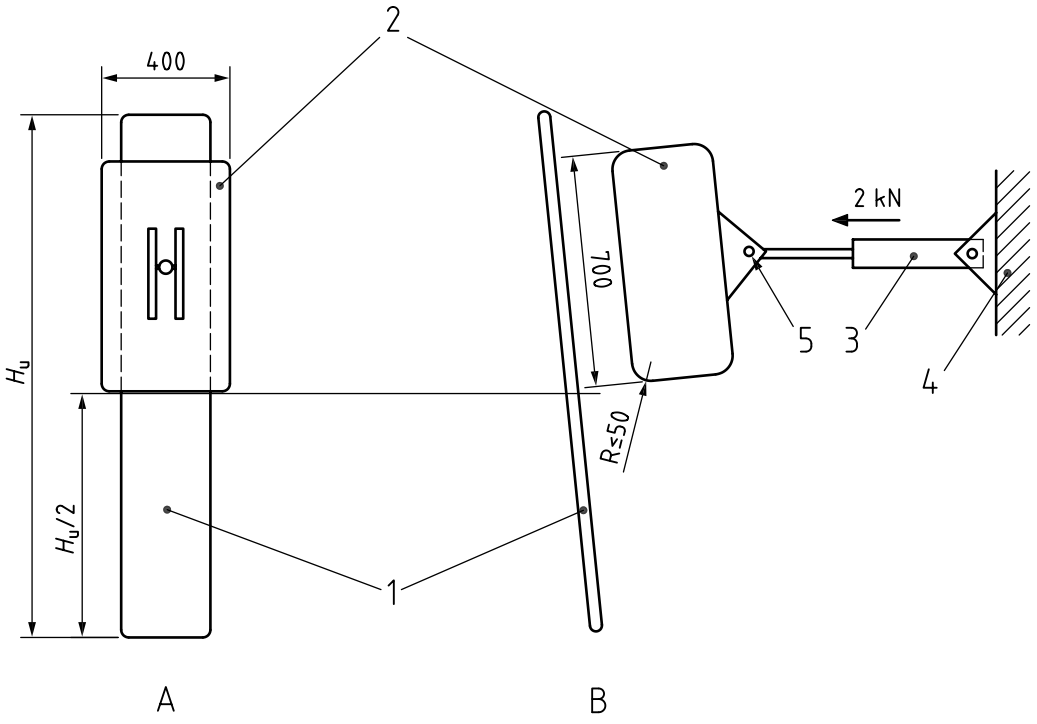
F.2.3 *A set of traction devices*, conforming to the dimensions specified in Figure E.1 and Figure E.2 with which to apply the test loads to the wheelchair occupant restraint anchorages.

NOTE A seat belt anchorage test rig capable of performing tests to either UN/ECE Regulation 14 [3] or Directive 76/115/EC [4] would be suitable.

F.2.4 *Force application block*, conforming to the dimensions specified in Figure F.1, capable of applying the test loads to the occupant's back and head support without permanent deformation.

NOTE The force application block may be made of any material sufficiently rigid to withstand the test loads without permanent deformation.

Figure F.1 **Back and head support test equipment**



Key

A rear view
B side view
1 back and head support under test
2 force application block
3 means of applying test force
4 attachment point for the means of applying the test force
5 pivot assembly to allow force application block to accommodate different backrest angles
H_U height of top of back and head support above WAV floor

F.3 Test specimen preparation

F.3.1 The test specimen shall consist of one WAV structure, representative of the completed WAV in respect of its WTORS anchorages, its back and head support, and any relevant supporting structures.

NOTE Windows and doors may be fitted or not and closed or not. Any fitting normally provided and likely to contribute to the WAV structure may be fitted.

F.3.2 The test specimen shall be secured to the test rig (**F.2.1**) in such a way as to reproduce the ride attitude of the WAV when laden to its mass in running order ±2°.

F.3.3 The method used to secure the WAV structure during the test shall not be such as to strengthen the WTORS anchorages or to lessen the deformation of the WAV structure in an area within 200 mm of any WTORS anchorage or the head and backrest or its supporting structure.

NOTE The WAV structure should rest on supports arranged approximately in line with the axis of the wheels. The WAV structure should, wherever possible, be attached to the test rig by means of its suspension attachment points.

F.3.4 Any part of the WAV structure or other features that could obstruct the equipment used to apply the test loads in **F.4.14** and **F.4.20** shall be removed or cut away prior to the test.

F.4 Procedure

F.4.1 Attach the means of applying the test loads to the force application block (**F.2.4**) and support the block, resting against the WAV's back and head support such that the line created by the intersection of its front and bottom faces is located at a height corresponding to half the height of the head and backrest (HU/2) ±50 mm above the WAV floor (as illustrated in Figure F.1).

NOTE The means of applying the force need not be a hydraulic ram acting directly on the force application block; any method of applying the force to the block may be used.

F.4.2 Adjust the positions of each of the load application devices such that the test loads are exerted horizontally (±5°) at the start of the test, in a plane parallel to the median longitudinal plane of the WAV structure and in a forward direction relative to the WAV structure.

F.4.3 Apply the test load of (2 ± 0.2) kN to the force application block for ≥2 s.

F.4.4 The application of the test load shall be achieved in ≤10 s.

F.4.5 Remove the force application block from the WAV structure.

F.4.6 Record any deformation or failure of the back and head support and any of its supporting structure.

F.4.7 Remove any part of the back and head support and any of its supporting structure that is likely to interfere with the execution or results in **F.4.8** to **F.4.21**.

F.4.8 Position the SWC within the WAV structure in the travelling position designated by the WAV manufacturer.

F.4.9 Secure the SWC in the WAV structure using cables or straps capable of transmitting the load from the SWC, to each anchorage.

NOTE Cables, straps or actual WTORS may be used to secure the SWC to the WAV structure.

F.4.10 Place the traction devices (**F.2.3**) in the SWC and secure them to the WAV structure using cables or straps capable of transmitting the load from the traction device, to each anchorage.

NOTE Cables, straps or actual WTORS may be used to secure the SWC to the WAV structure.

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F.4.11 For an SWC conforming to Annex G, attach the means of applying the test loads to the SWC at its centre of gravity height ±100 mm. For an SWC not conforming to Annex G, the load shall be applied at a height of (287 ± 100) mm above the surface on which the front wheels of the SWC rest.

F.4.12 Attach the means of applying test loads to each of the traction devices.

F.4.13 Adjust the positions of each of the load application devices such that the test loads are exerted at an angle of (10 ± 5)° above the horizontal plane at the start of the test, in a plane parallel to the median longitudinal plane of the WAV structure and in a rearward direction relative to the WAV structure.

F.4.14 Apply the test loads specified in Table F.1, simultaneously to each of the traction devices and the SWC for ≥0.2 s.

Table F.1 **Test loads applied to rearward-facing WOTRS anchorages in the rearward direction**

Minimum load applied to torso traction device kN	**Minimum load applied to pelvic traction device** kN	**Minimum load applied to SWC** kN
4.5 ± 0.2	4.5 ± 0.2	≥8.2

F.4.15 The application of the test load shall be achieved in ≤10 s.

F.4.16 Record a description of any deformation or partial rupture of, or in the vicinity of any anchorage.

F.4.17 Remove the traction devices and wheelchair occupant restraints from the WAV structure.

F.4.18 Re-configure the WAV structure and/or the loading devices such that the loads can be applied at an angle of (10 ± 5)° above the horizontal plane at the start of the test, in a plane parallel to the median longitudinal plane of the WAV structure and in a forward direction relative to the WAV structure.

F.4.19 If necessary, re-adjust the tie-downs, wires or straps to reposition the SWC within the WAV structure in the travelling position designated by the WAV manufacturer.

F.4.20 Apply a test load of (≥24.5) kN to the SWC in a forward direction for ≥0.2 s.

F.4.21 The application of the test load shall be achieved in ≤10 s.

F.4.22 Record a description of any deformation or partial rupture of, or in the vicinity of any anchorage.

F.5 Test report

The test report shall include as a minimum:

a) reference to this standard, i.e. PAS 2012-1:2015;

b) reference to the test, i.e. "Static strength test for WTORS anchorages and back and head support for rearward-facing wheelchairs";

c) date(s) of the test(s);

d) name or trademark, and address of the WAV manufacturer;

e) name(s) and address(es) of the testing organization;

f) make and model of base vehicle (if applicable);

g) make and model of WAV;

h) the make and model of WTORS equipment fitted for the test;

i) drawings and photographs of the WTORS anchorages, including a material specification;

j) drawings and photographs of the back and head support, including material specifications;

k) test results achieved including:

1) the maximum load applied in a rearward direction relative to the WAV structure to each of the traction devices and the SWC during the same 0.2 s period (see **F.4.14**);

2) the maximum load applied in a forward direction relative to the WAV structure to the SWC for a 0.2 s period (see **F.4.20**);

3) the maximum load applied in a forward direction relative to the WAV structure to the back and head support for a 2.0 s period (see **F.4.3**);

4) a description of any deformation or partial rupture of, or in the vicinity of any anchorage, following the test (see **F.4.14** and **F.4.20**);

5) the position of the SWC in the WAV structure;

6) any detachment or separation of the WTORS anchorage from the WAV structure; and

7) any deformation, rupture or failure of the back and head support or its supporting structure (see **F.4.3**).

Annex G (normative)

Surrogate wheelchair (SWC)

NOTE The SWC used for the tests set out in Annex D is broadly based on the BS ISO 10542-1:2012 SWC, with modifications to allow additional weight to be added to its centre of gravity so as to represent wheelchairs heavier than 85 kg.

The SWC shall:

a) be of rigid durable construction, such that there is no permanent deformation of the frame, seat surface or seatback in a 48 km/h 20 g frontal impact test with a 77.7 kg Hybrid III ATD positioned and restrained in the SWC;

b) have a total mass of (85 ± 1) kg in its minimum weight condition;

c) incorporate a rigid weight carrier positioned at its centre of gravity such that its mass can be increased to a maximum of (200 ± 1) kg, in 5 kg or 10 kg increments;

d) conform with the dimensions shown in Figure G.1 through to Figure G.4;

e) allow for adjustment to accommodate components and end fittings of different types of tie-down systems;

f) provide two front securement points and two rear securement points for four-point strap-type tie-downs at the locations indicated in Figure G.1 and with the geometry specified in Figure G.4;

g) have a centre of gravity located (142 ± 25) mm forward of the rear axle and (287 ± 25) mm above the ground plane for the range of frame-to-floor clearance adjustments allowed;

h) have a rigid, flat seat surface, with dimensions as shown in Figure G.3, that is oriented at an angle of (4 ± 1.5)° to the horizontal (front end up), as shown in Figure G.1 and Figure G.3, when the SWC tyres are resting on a flat, horizontal surface and inflated in accordance with k) and l) below;

i) have a rigid seatback with height and width dimensions as indicated in Figure G.2 and Figure G.3 that is oriented at (8 ± 1.5)° to the vertical when the SWC tyres are resting on a flat horizontal surface and inflated in accordance with k) and l);

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j) have a (25 ± 5) mm thick, firm (i.e. Shore A hardness of 60 to 80) rubber pad, with height and width dimensions as indicated in Figure G.1 and Figure G.2, fixed to the front surface of the rigid seatback;

k) have pneumatic front tyres that, when inflated to (320 ± 30) kPa with the unoccupied SWC resting on a flat horizontal surface, have a diameter of (230 ± 10) mm, a width of (75 ± 10) mm, and a sidewall height of (54 ± 5) mm; and

l) have:

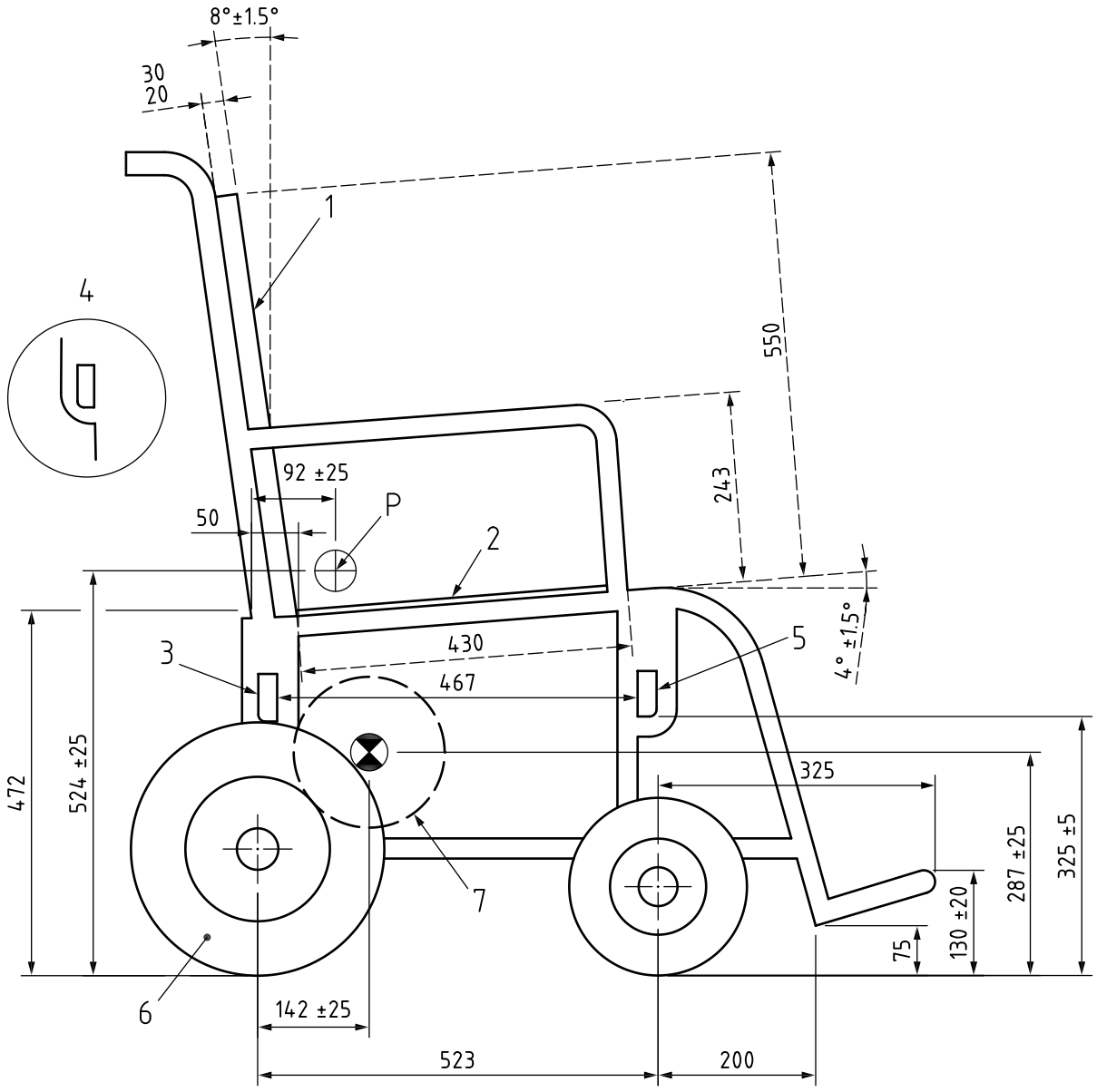
   1) for a SWC weighing ≤85 kg, pneumatic rear tyres that, when inflated to (320 ± 30) kPa with the unoccupied SWC resting on a flat horizontal surface, have a diameter of (325 ± 10) mm, a width of (100 ± 10) mm, and a sidewall height of (70 ± 5) mm;

   2) for a SWC weighing >85 kg, solid rear tyres (or pneumatic rear tyres filled with foam), that, with the unoccupied SWC resting on a flat horizontal surface, have a diameter of (325 ± 10) mm, a width of (100 ± 10) mm, and a sidewall height of (70 ± 5) mm.

Figure G.1 **Side view of SWC**

Dimensions in millimetres

Tolerances ±5 mm unless otherwise specified



[Source: BS ISO 10542-1:2012 (adapted)]

Key

1 hard rubber backrest

2 rigid seat surface

3 rear wheelchair tied-own attachment point

4 rear wheelchair tie-down attachment point scrap view (see Figure G.4)

5 front wheelchair tie-down attachment point

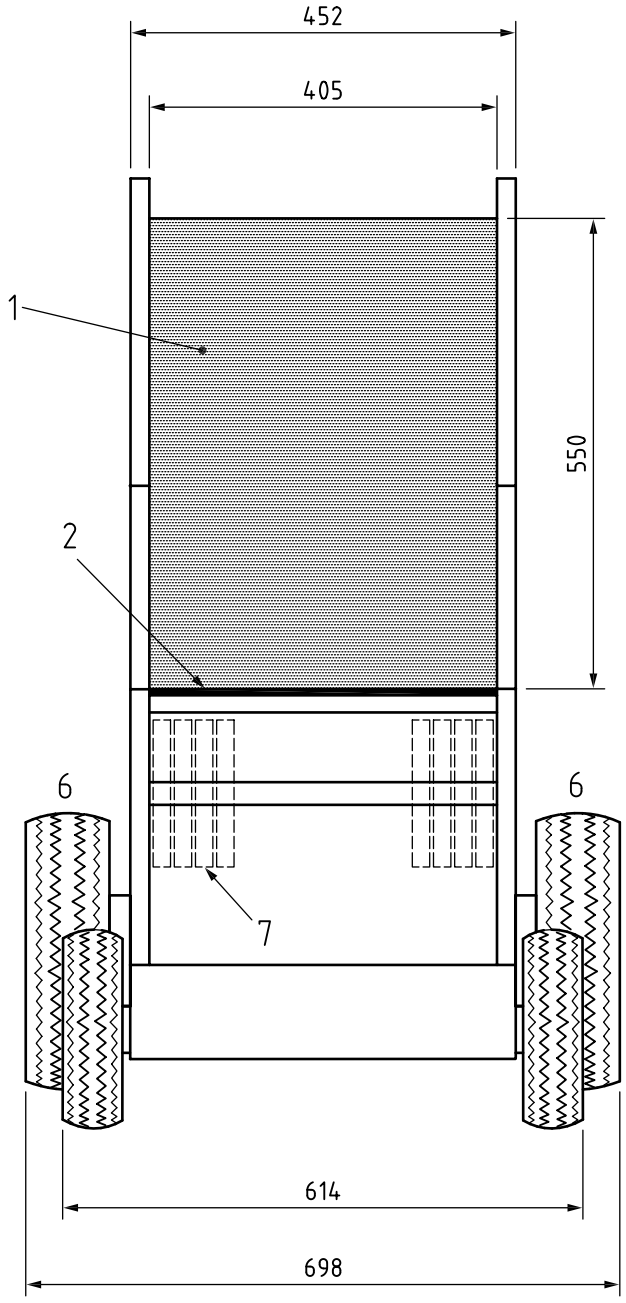
6 rear tyres (solid foam filled for SWC masses above 85 kg)

7 weight carrier at centre of gravity to allow incrementally increasing weight of surrogate from 85 kg to 200 kg

Figure G.2 **Front view of SWC**

Dimensions in millimetres

Tolerances ±5 mm



[Source: BS ISO 10542-1:2012 (adapted)]

Key

1 hard rubber backrest

2 rigid seat surface

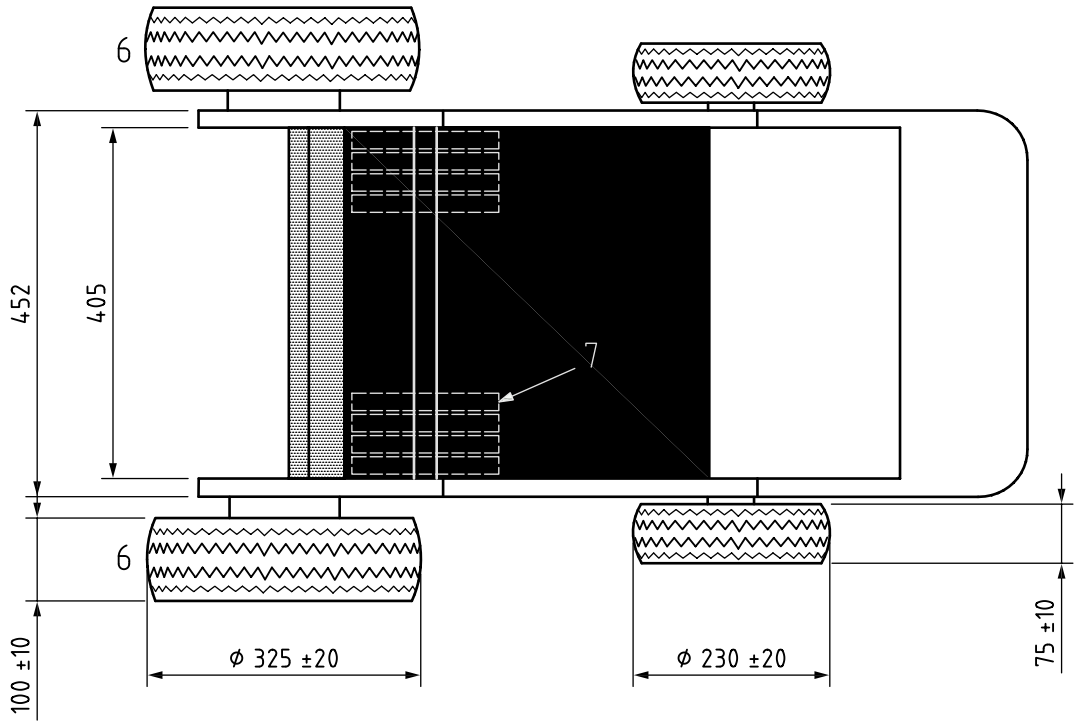
6 rear tyres (solid foam filled for SWC masses above 85 kg)

7 weight carrier at centre of gravity to allow incrementally increasing weight of surrogate from 85 kg to 200 kg

Figure G.3 **Plan view of SWC**

Dimensions in millimetres

Tolerances ±5 mm unless otherwise specified



[Source: BS ISO 10542-1:2012 (adapted)]

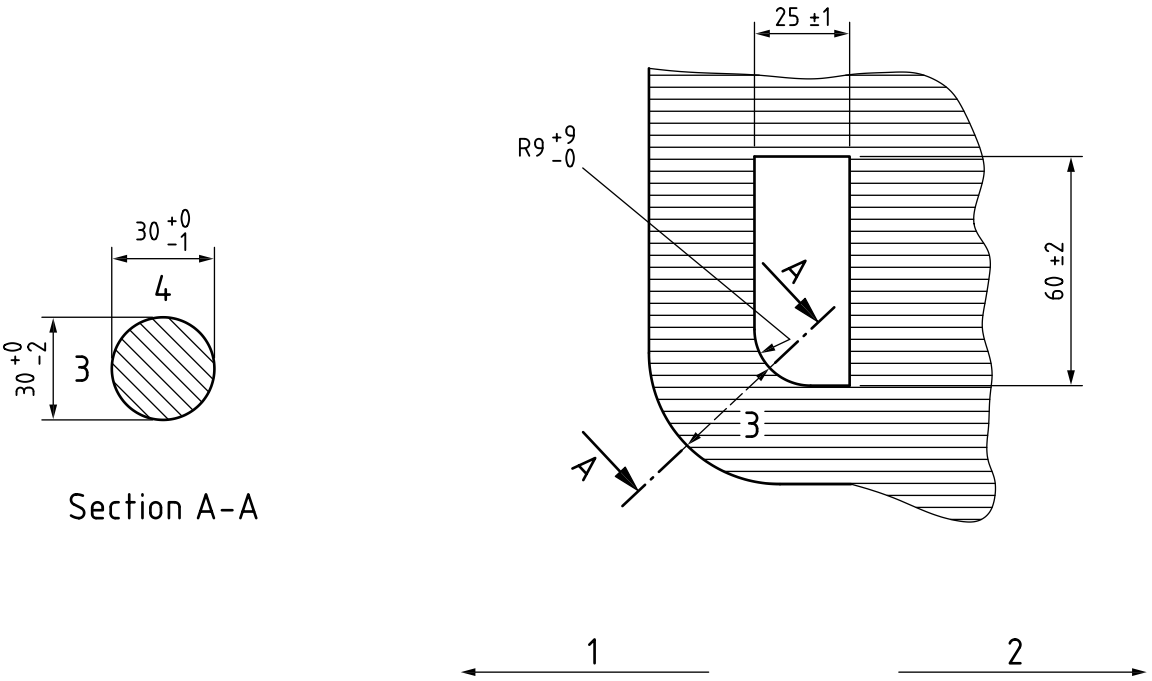
Key

6 rear tyres (solid foam filled for SWC masses above 85 kg)

7 weight carrier at centre of gravity to allow incrementally increasing weight of surrogate from 85 kg to 200 kg

Figure G.4 **Scrap view of rear tie-down attachment point (Item 4, Figure G.1)**

Dimensions in millimetres



Key

1 towards anchor point

2 towards wheelchair

3 measured from inside to outside at the middle of the elbow on the structural part of the securement point

4 measured laterally at the middle of the elbow on the structural part of the securement point

[Source: BS ISO 10542-1:2012 (adapted)]

Annex H (informative)

Dimensional parameters of the back and head support

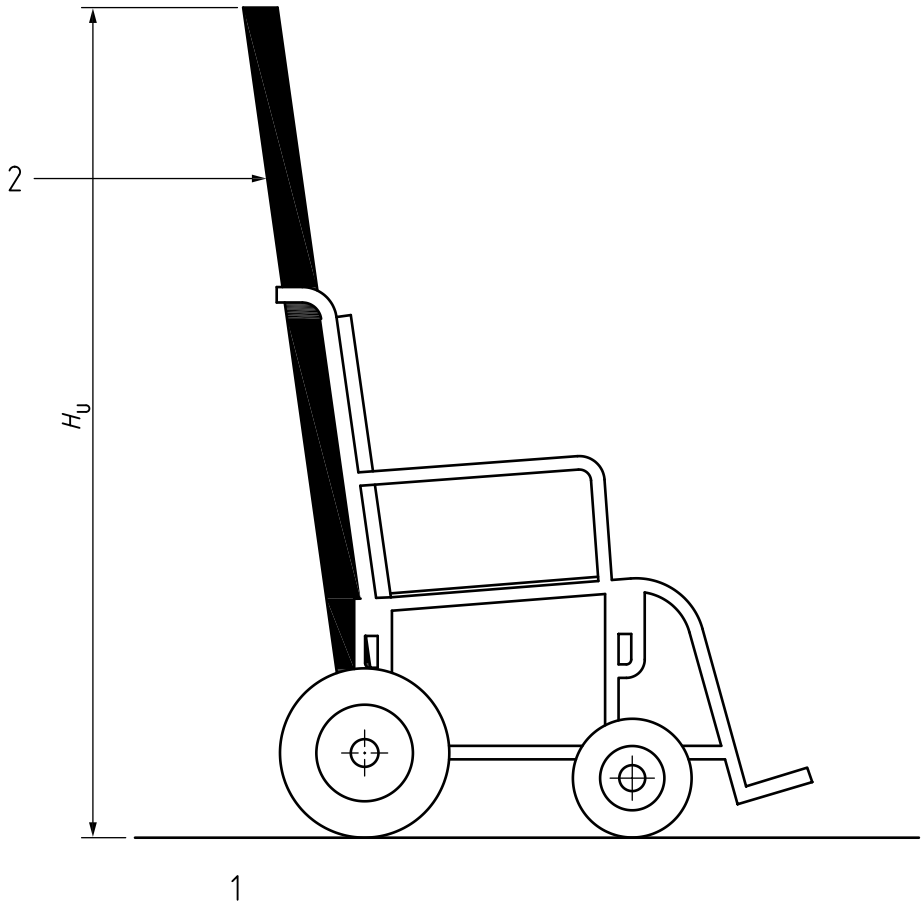
The back and head support are essential in ensuring the comfort and stability of rearward-facing wheelchair users whilst travelling. However, it is recognized that seated wheelchair user head heights and WAV internal heights vary considerably. As such, it is not practicable to specify one size of back and head support that suits all wheelchair users in all WAV types. Table H.1 quotes the appropriate dimensions for 5th, 50th and 95th percentile adult wheelchair occupants.

The size of the back and head support for the maximum occupied wheelchair size that the WAV is stipulated as being capable of carrying should be determined with due regard to the parameters given in Table H.1. Figure H.1 illustrates the vertical dimension denoting the height of the top of the head and back support above the WAV. Figure H.2 shows the width of the head and back support.

Table H.1 **Dimensional parameters of the back and head support**
All dimensions in millimetres

Dimensional parameter	Symbol	5%ile	50%ile	95%ile
Height of top of head support above WAV floor	H_U	1 141	1 291	1 428
Width of backrest (between wheelchair handles)	W	287	357	423

Figure H.1 **Dimensional parameters (side view)**



Key

1 wheelchair space floor

2 back and head support

H_U height of top of head and back support above WAV floor

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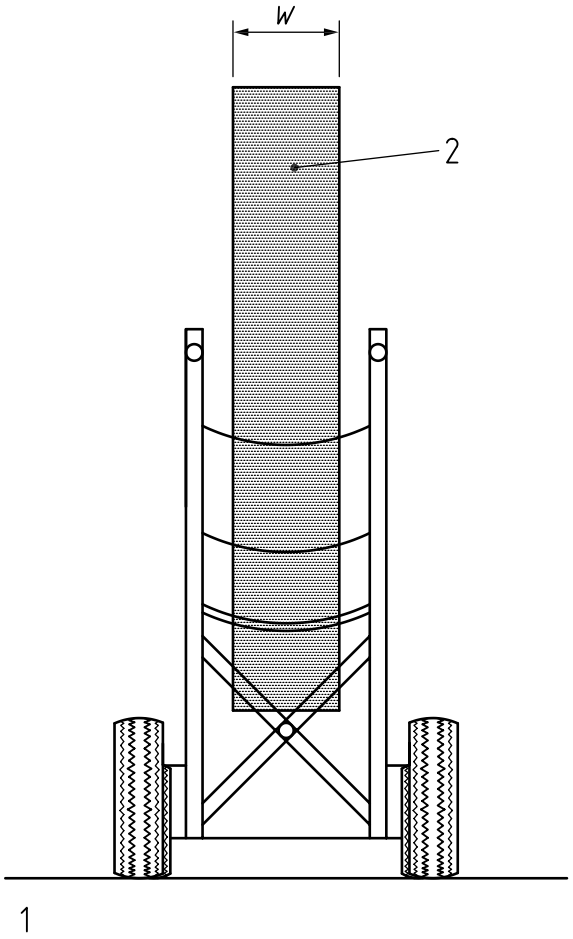
Figure H.2 **Dimensional parameters (rear view)**



Key

1 wheelchair space floor

2 back and head support

W width of back and head support

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