

Specification for

Rearward-facing restraint systems for infants, for use in road vehicles

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Committees responsible for this British Standard

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- Automobile Association
- Baby Equipment Hirers' Association
- British Retail Consortium
- BSI Testing Services
- Child Accident Prevention Trust
- Consumer Policy Committee of BSI
- Consumers' Association
- Department of Transport
- Department of Transport (Transport Research Laboratory)
- ICE (Ergonomics)
- Ministry of Defence
- Motor Industry Research Association
- National Automobile Safety Belt Association
- Royal Automobile Club
- Royal Society for the Prevention of Accidents
- Society of Motor Manufacturers and Traders Limited
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Foreword

This British Standard has been prepared by Technical Committee AUE/7, at the request of the Department of Transport.

This standard specifies requirements for restraining systems for carrying infants up to a mass of 13 kg in road vehicles. Because of their physical structure and their need for prolonged rest, babies are best carried in a semi-reclined position, facing the rear of the vehicle. Young children can be carried in a similar mode or in systems meeting other British Standards and international regulations, such as BS 3254-2:1991 and ECE Regulation No. 44.

This edition of BS AU 202 differs from its predecessor in a number of important respects. Most notably, it defines two mass groups and sets out specifications for rear-facing systems for each group: up to 10 kg (group 0 devices) and up to 13 kg (group 0 + devices). Devices of either group can be used on the front or rear seat of most road vehicles, as recommended by the manufacturer of the restraint system. The specifications, test arrangements and test methods have been extensively revised in order to align this edition of the standard closely with the 03 revision of ECE Regulation No. 44.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 58, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This British Standard specifies requirements for rearward-facing infant restraint systems suitable for general use in most vehicles and designed for use with an adult seat belt which carries a BSI Kitemark, an “E” mark or an “e” mark. It also specifies requirements for rearward-facing infant carriers for infants with special needs as a result of either a physical or mental handicap.

This standard applies to infant restraint systems designed for either of two mass ranges: group 0 devices for infants up to 10 kg; and group 0 + devices for infants up to 13 kg.

2 References

2.1 Normative references

This British Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on the inside back cover. For dated references, only the edition cited applies: any subsequent amendments to or revisions of the cited publication apply to this British Standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this British Standard, the following definitions apply.

3.1

infant restraint system

a combination of infant carrier, straps and adjusters, designed to be secured in a road vehicle by an approved adult seat belt¹⁾

3.2

group 0 device

an infant restraint system for infants up to a mass of 10 kg

3.3

group 0 + device

an infant restraint system for infants up to a mass of 13 kg

3.4

special-needs restraint

an infant restraint system designed for infants who have special needs as a result of either a physical or mental handicap

3.5

infant carrier

that part of the infant restraint system intended to accommodate the infant in a rearward-facing semi-recumbent position

3.6

strap

a flexible component designed to restrain the infant or infant carrier and to transmit forces to the vehicle structure either directly or indirectly

3.7

harness

a belt assembly comprising, as a minimum, shoulder restraints restraints and crotch strap. It may also include a lap strap

3.8

crotch strap

a strap, or series of straps, which is attached to the infant carrier and the buckle and is positioned to pass between the infant's thighs

3.9

lap strap

a strap which, either in the form of a complete belt or in the form of a component of such a belt, passes across the front of, and restrains, the infant's pelvic region

3.10

emergency release

a device that can be quickly and easily operated to release the infant from the vehicle with or without the infant carrier

NOTE The emergency release may incorporate the adjuster.

3.11

enclosed emergency release

a device designed in such a way that it is not possible to release the buckle using a test sphere of diameter of 40 mm

3.12

non-enclosed emergency release

a device designed in such a way that it is possible to release the buckle using a test sphere of diameter of 40 mm

¹⁾ An approved seat belt is one that carries a BSI Kitemark, an “E” mark or an “e” mark.

3.13 retractor

a device designed to accommodate a part or the whole of a strap

3.14 automatically-locking retractor

a retractor which allows the strap to be extracted only by voluntary intervention by the user

3.15 emergency-locking retractor

a retractor which does not restrict the belt-wearer's freedom of movement in normal driving conditions and which locks automatically in an emergency when actuated, for example, by deceleration of the vehicle

3.16 adjuster

a device, through which a strap passes, enabling the restraint or its attachments to be adjusted to the physique of the wearer. The adjuster may be part of the buckle or may be a retractor

3.17 quick adjuster

an adjuster which can be operated by one hand in one continuous movement

3.18 lock-off device

a device which locks and prevents movement of one section of the webbing of an adult safety belt relative to another section of the webbing of the same belt

3.19 composite material

a material composed of several layers of similar or different materials held together continuously by cementing, bonding, cladding or welding

NOTE If the holding together of the materials is not continuous (e.g. in the case of sewing, high-frequency welding, riveting) and samples of each component material can therefore be taken individually, the material is not considered to be a composite material.

4 General

4.1 Design and construction

4.1.1 The restraint system shall satisfy the requirements of this standard when the system is in any intended position.

For special-needs restraints, the primary means of restraint shall satisfy the requirements of this standard when the system is in any intended position, without the use of any additional restraining devices which may be present.

4.1.2 The restraint system shall support the infant's head.

4.1.3 If the restraint can be set in an inclined position, it shall be possible to thus set it without manual readjustment of the straps. A deliberate hand-action shall be required in order to put the restraint in the inclined position.

4.1.4 The infant restraint system shall be designed, or capable of adjustment, so that the torso line of the 3.4 kg manikin specified in Annex A is less than 45° to the horizontal when the system is resting on a horizontal surface.

4.1.5 All straps of the restraint shall be so placed that they cannot cause discomfort to the wearer in normal use or assume a dangerous configuration. The distance between the shoulder-straps in the vicinity of the neck shall be at least the width of the neck of the appropriate manikin.

4.1.6 The assembly shall not subject weak parts of the infant's body (abdomen, crotch, etc.) to excessive stresses. The design shall be such that compression loads shall not be imposed on the crown of the infant's head in the event of a collision.

4.1.7 The restraint system shall not exhibit any sharp edges or protrusions.

4.1.8 The restraint system shall be designed so that, when correctly installed in the vehicle, it does not subject weak parts of the infant's body (abdomen, crotch, etc.) to the supplementary inertial forces that it sets up.

4.1.9 Devices which lock the adult seat belts to the restraint system shall be permanently attached to the restraint system.

4.1.10 If the infant restraint is designed for more than one infant, each restraint system shall be fully independent with regard to load transfer and adjustments.

4.1.11 The main load-bearing contact point between the infant restraint system and the adult seat belt shall not be less than 150 mm from the Cr axis when measured with the infant restraint system on the dynamic test seat specified in B.1. This shall apply to all adjustment configurations.

4.1.12 There shall be side wings with a depth of minimum 90 mm measured from the median of the surface of the backrest. These side wings shall start at the horizontal plane passing through point A defined in Annex C, and shall continue to the top of the seat back.

NOTE Upwards from a point 90 mm below the top of the side wing, the depth of the side wing may be gradually reduced. (See Figure C.1.)

4.1.13 The head impact area defined in Annex C shall comprise energy-absorbing material with a peak acceleration of less than 60 g when measured in accordance with Annex D.

NOTE The energy-absorbing material may be an integral part of the infant restraint system.

4.1.14 When tested in accordance with Annex E, the metal parts of the restraint system shall show, to the unaided eye, no corrosion and no signs of deterioration likely to impair the proper functioning of the restraint system.

4.2 Performance

4.2.1 Overturning

When the infant restraint system is tested in accordance with Annex F, the manikin shall not fall out of the system. When the test seat is in the upside-down position, the head of the manikin shall not move more than 300 mm from its original position in a vertical direction relative to the test seat.

4.2.2 Dynamic tests

4.2.2.1 When tested in accordance with Annex G, the infant restraint system shall conform to **4.2.2.2** to **4.2.2.7**.

4.2.2.2 For group 0 restraint systems, the head of the manikin shall not pass beyond the planes BA, AD and DE shown in Figure 1. For group 0 + restraint systems, the infant restraint system shall not contact the steel tube shown in Figure 1.

4.2.2.3 No part of the infant restraint system which is helping to keep the manikin in position shall break, and no buckles or locking system shall release.

4.2.2.4 The manikin, excluding its limbs, shall be retained within the system. At no time during the frontal-impact test described in **G.3** shall the torso line of the manikin create an angle of less than 20° to the horizontal.

4.2.2.5 The resultant chest acceleration of the 9 kg and 11 kg manikins during each test shall not exceed 55 g for more than a total period of 3 ms.

4.2.2.6 The vertical component of the acceleration of the 9 kg and 11 kg manikins from the abdomen towards the head shall not exceed 30 g for more than a total period of 3 ms during each test.

4.2.2.7 The high-speed film results of the tests, or the bubble film detector, shall show no signs of penetration of the abdomen of the manikins caused by any part of the restraint system and no riding up of any lap strap onto the chest.

4.2.3 Toxicity

The toxicity of materials used in the manufacture of the restraint system and accessible to the restrained infant shall conform to BS 5665-3:1989. The manufacturer of the restraint system shall provide a written declaration of conformity.

NOTE Tests confirming the validity of the declaration may be carried out at the discretion of the test authority.

4.2.4 Flammability

When determined in accordance with Annex H, the burning rate of each sample of the materials used to manufacture the restraint system shall not exceed 250 mm/min, unless the total area of the material is less than 300 cm² and its total volume is less than 100 cm³. The manufacturer of the restraint system shall provide a written declaration of conformity.

NOTE Tests confirming the validity of the declaration may be carried out at the discretion of the test authority.

5 Emergency release, adjusters and other rigid parts

5.1 Attachment and release of components

The design of any separable parts shall be such that either:

- a) they cannot be put together incorrectly; or
- b) their connection other than as intended will result in the components separating again under a force of not more than 22 N, or will not adversely affect their function.

5.2 Emergency release

5.2.1 General

The means of releasing an infant shall be so positioned that its function and method of operation are obvious to a rescuer in an emergency. It shall be easy to operate and to grasp.

NOTE 1 For special-needs restraints, it is recognized that the additional restraining devices will restrict the speed at which an infant can be installed and removed. However, the additional devices should be designed to release quickly so far as possible.

NOTE 2 For special-needs restraints, the requirements of **5.2.2** to **5.2.7** apply only to the emergency release on the primary means of restraint.

5.2.2 Release of the infant

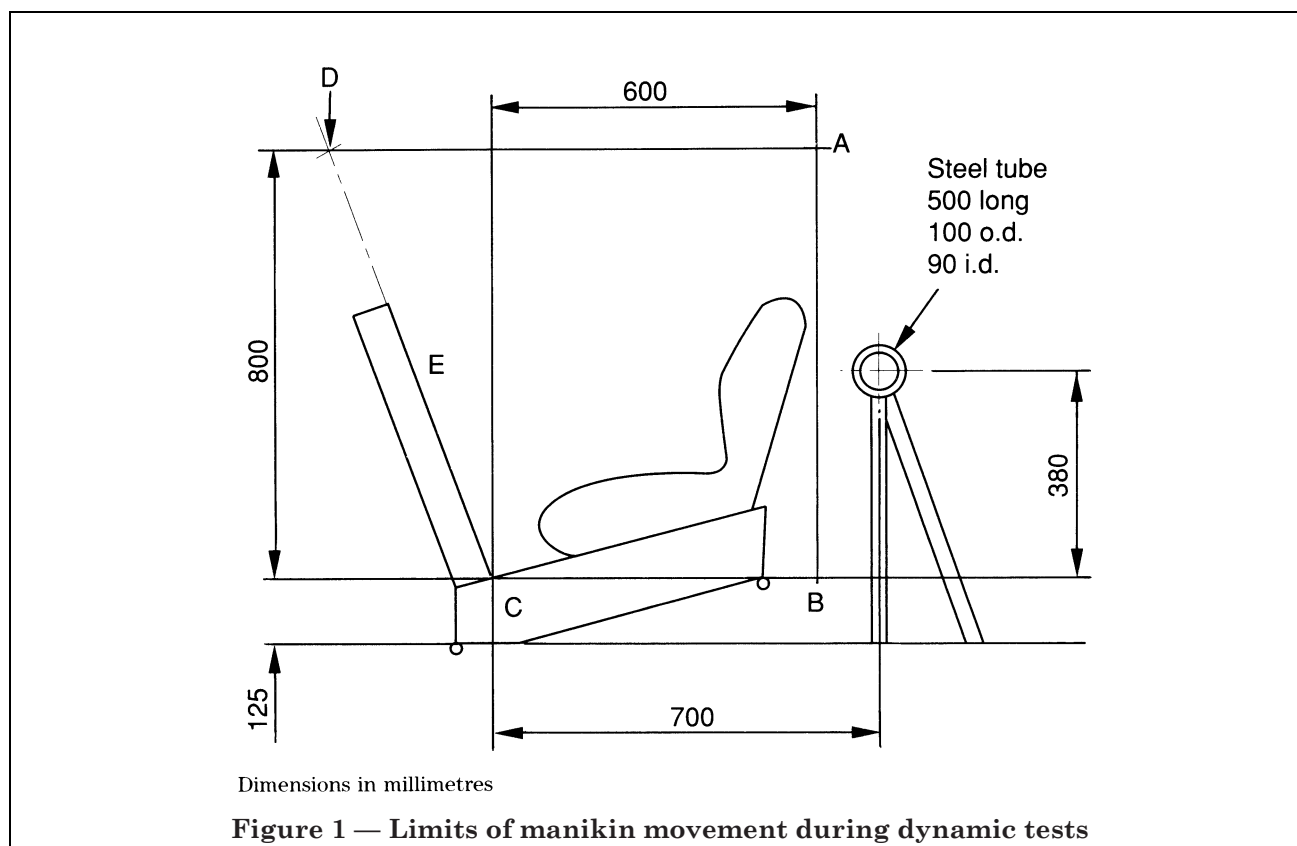
The restraint system shall be so designed and constructed that the infant is easily and quickly installed.

It shall be possible either:

- a) to remove the infant, with the infant carrier, from the vehicle by release of the adult seat belt or other single means of emergency release; or
- b) to remove the infant from the infant carrier by a single means of emergency release.

NOTE A clip connection between the shoulder straps of a harness belt is deemed not to conform to **5.2.2 a)** or **5.2.2 b)**.

In the case of an infant restraint system in which the infant is restrained by means of a belt assembly comprising a lap strap and shoulder restraints without a retractor, each shoulder restraint and lap strap shall be capable of movement relative to each other during the procedures described in **5.2.2 a)** and **5.2.2 b)**.



5.2.3 Engagement of the release mechanism

It shall not be possible for the emergency release to be left in a partially closed position nor to exchange the parts of the emergency release inadvertently when it is being locked. The emergency release shall lock only when all parts are engaged.

5.2.4 Dimensions

The emergency release shall be operated by pressure on a button or on a similar device. The surface to which this pressure is applied shall have:

- for enclosed devices, an area of not less than 450 mm^2 with a width of not less than 15 mm;
- for non-enclosed devices, an area of 250 mm^2 and a width of not less than 10 mm.

An emergency release in contact with the infant shall not be narrower than 25 mm.

The emergency release button or device shall be coloured red and the adjacent area shall not be red.

5.2.5 Release force

The force required to open the emergency release of a restraint system which is in the condition described in J.2.1 a), shall not exceed 80 N when tested in accordance with J.2.2 to J.2.5.

The force required to open an emergency release which is in the condition described in J.2.1 b), shall lie within the range 40 N to 60 N when tested in accordance with J.2.3 to J.2.4.

When not under tension, the emergency release shall remain closed whatever its position.

5.2.6 Strength

When tested in accordance with Annex K, no part of the emergency release, adjacent straps or adjusters shall break or become detached.

5.3 Adjusters

5.3.1 General

The range of adjustment shall be sufficient to permit correct adjustment of the infant restraint system throughout the mass group for which the system is intended.

All adjusters shall be quick adjusters and shall be easy to reach when the infant restraint system is correctly installed and the infant is in position.

5.3.2 Operating force

When tested in accordance with Annex L, the force required to operate a manual adjuster shall not exceed 50 N. The adjuster shall not break nor become detached.

5.3.3 Strap slippage

When tested in accordance with Annex M, the amount of strap slippage shall not exceed 25 mm for one adjuster, and the sum of the slippage for both adjusters shall not exceed 40 mm.

5.3.4 Adjuster mounted directly on the infant carrier

As well as conforming to 5.3.1 to 5.3.3, an adjuster mounted directly on the infant carrier shall function correctly after completing all the tests of Annex N.

5.4 Lock-off devices

5.4.1 General

The lock-off device shall be permanently attached to the infant restraint system. It shall not impair the durability of the adult belt and shall not prevent the rapid release of the infant. It shall cover the full width of the webbing in the installed condition.

5.4.2 Webbing slippage

When tested in accordance with Annex P, the amount of slippage of the webbing shall not exceed 25 mm.

5.5 Retractors

5.5.1 General

If the infant restraint system incorporates retractors, only automatically-locking retractors or emergency-locking retractors shall be used.

5.5.2 Automatically-locking retractors

5.5.2.1 The strap of a safety belt equipped with an automatically-locking retractor shall not unwind by more than 30 mm between locking positions of the retractor. After a rearward movement of the wearer, the belt shall either remain in its initial position or return to that position automatically on subsequent forward movement of the wearer.

5.5.2.2 If the retractor is part of a lap belt, the retracting force of the strap shall be not less than 7 N, measured as described in Q.1.

If the retractor is part of a chest restraint, the retracting force of the strap shall be not less than 2 N nor more than 7 N, measured as described in Q.1.

5.5.2.3 After completing the tests described in Q.2.1 and Annex E, the retractor shall continue to operate correctly and to conform to 5.5.2.1 and 5.5.2.2.

5.5.3 Emergency-locking retractors

5.5.3.1 When tested in accordance with Q.3, the retractor shall meet the following requirements.

- a) It shall lock before the deceleration of the vehicle reaches 0.45 g. The amount of strap extraction occurring before the retractor locks shall not exceed 50 mm, starting at the length of unwinding specified in Q.3.1.
- b) It shall not lock if the strap acceleration is less than 0.8 g, measured in the axis of strap extraction. Locking shall not occur during the 50 mm of strap extraction starting at the length of unwinding specified in Q.3.1.
- c) It shall not lock when its sensing device is tilted by not more than 12° in any direction from the installation position specified by the manufacturer.
- d) It shall lock when its sensing device is tilted by more than 27° in any direction from the installation position specified by the manufacturer.

5.5.3.2 Where the operation of the retractor depends on an external signal or power source, the retractor shall lock automatically upon failure or interruption of that signal or power source.

5.5.3.3 If one of the sensitivity factors of a multiple-sensitivity emergency-locking retractor relates to strap extraction, locking shall have occurred at a strap acceleration of 1.5 g, measured in the axis of strap extraction when tested in accordance with Q.3.

5.5.3.4 If the retractor is part of a lap belt, the retracting force of the strap shall be not less than 7 N, measured as described in Q.1.

If the retractor is part of a chest restraint, the retracting force of the strap shall be not less than 2 N nor more than 7 N, measured as described in Q.1.

5.5.3.5 After completing the tests described in Q.2.2, Annex E and Annex R, the retractor shall continue to operate correctly and to conform to 5.5.3.1 to 5.5.3.4.

5.5.3.6 If nylon 6 is used in the construction of the retractor, the retractor locking mechanism shall conform to 5.5.3.1 after testing in accordance with 7.8 of BS 3254-1:1988 (as amended by Amendment No. 1).

6 Straps

6.1 Width

The minimum width of the straps shall be 25 mm, measured as described in S.5.

6.2 Strength after room conditioning

When two straps are conditioned in accordance with T.2 and then tested in accordance with Annex S, the breaking load of each strap shall be not less than 3.6 kN, and the difference between the breaking loads of the two samples shall not exceed 10 % of the greater of the two breaking loads measured.

6.3 Strength after special conditioning

When two straps are conditioned in accordance with one of the provisions of T.3 to T.7 and then tested in accordance with Annex S, the breaking load of each strap shall be not less than 3.6 kN nor less than 75 % of the average of the two loads measured.

6.4 Strap retention

It shall not be possible to pull the complete strap through any adjusters, buckles or anchoring points.

7 Information

7.1 Labels on packaging

Labels bearing the following information shall be clearly visible on the outside of the packaging of the restraint system.

NOTICE

1) This is a “universal”^a infant restraint system. It is approved for general use in vehicles and it will fit most, but not all, car seats.

2) A correct fit is likely if the vehicle manufacturer has declared in the vehicle handbook that the vehicle is capable of accepting a “universal” infant restraint system for this age group.

3) This infant restraint system has been classified as “universal” under more stringent conditions than those which applied to earlier designs which do not carry this notice.

4) If in doubt, consult the infant restraint system manufacturer, the vehicle manufacturer or the retailer.

^a A “universal” infant restraint system is intended to be suitable for use on most vehicle seat positions, in particular those which have been assessed according to Annex 13, Appendix 2, of the Consolidated Resolution on the Construction of Vehicles (R.E.3), document TRANS/WP. 29/78/Amendment 6, as being compatible with such a category of child seats.

Only suitable if the approved vehicles are fitted with lap^a/3-point^a/static^a/retractor^a safety belts, approved to ECE Regulation No. 16 or other equivalent standards.

For babies from birth to 10^a/13^a kg (28^a lb)

In no circumstances should this infant restraint be used in seating positions where an airbag is installed.

^a Delete as appropriate.

For special-needs restraints, the following additional label shall be affixed to the outside of the packaging.

This special-needs restraint is designed to give extra support to children who have difficulty in sitting correctly in conventional seats. Always consult your doctor to make sure that this restraint system is suitable for your child.

The address from which the user can obtain further information on fitting the infant restraint system in specific cars shall be given on the outside of the packaging.

7.2 Instructions for installation and use

Each infant restraint system shall be accompanied by instructions for installation and use, illustrated with clear drawings and/or photographs.

These instructions shall include:

- a) advice on the best location for fitting the restraint system;
- b) instructions for installation;
- c) an instruction that the rigid items and plastic parts of an infant restraint system should be so located and installed that they are not liable, during normal use of the vehicle, to become trapped by a movable seat or in a door of the vehicle;
- d) the mass range of the infant for which the restraint system is designed;
- e) the following wording stating the type of the safety belt to be used:

Only suitable for use on vehicle seats fitted with lap²⁾/3-point²⁾/static²⁾/retractor²⁾ safety belts, approved to ECE Regulation No. 16 or other equivalent standards.
- f) instructions for correct use, clearly illustrated by photographs and/or drawings;
- g) in the case of restraint systems that can be used both forward- and rearward-facing, a clear warning to keep the restraint rearward-facing until the infant’s mass is greater than a stated limit, or until some other dimensional criterion is exceeded;
- h) the method of operating the buckle, adjusters and lock-off devices, if fitted;
- i) a recommendation that any straps holding the restraint to the vehicle should be tight, that any straps restraining the infant should be adjusted to the infant’s body, and that straps should not be twisted;
- j) a recommendation that the restraint should be changed when it has been subject to violent stresses in an accident;

²⁾ Delete as appropriate.

- k) instructions for cleaning;
- l) a general warning to the user concerning the danger of making any alterations or additions to the restraint system without the approval of the system manufacturer, and the danger of not following closely the installation instructions provided by the system manufacturer;
- m) a warning that plastic and metal fittings may become very hot when exposed to the sun, and a recommendation that the system be covered to prevent such heating when the vehicle is left unattended in sunny weather;
- n) a recommendation that infants are not left in their restraint system unattended;
- o) a recommendation that any luggage or other objects liable to cause injuries in the event of a collision be properly secured;
- p) a strong warning not to use the infant restraint in seating positions where an airbag is installed;
- q) advice on how to obtain the greatest benefit from the restraint system.

8 Marking

8.1 Each infant restraint system shall be clearly and indelibly marked with the following:

- a) either:
 - 1) the name or trade mark of the system manufacturer; or
 - 2) the name or trade mark of the manufacturer's agent;
- b) the number and date of this British Standard, i.e. BS AU 202b:1995;
- c) the upper limit of the mass of the infant for which it is intended.

8.2 A label bearing the following words shall be attached in a prominent position on the infant restraint system and shall be visible when the system is correctly installed in the vehicle.

“EXTREME HAZARD. Do not use in passenger seats equipped with airbags.”

NOTE For systems designed for use both forward- and rearward-facing, additional words may be added to this label to explain that this warning only applies when the system is used in its rearward-facing mode.

Restraint systems approved only for rearward-facing use shall also bear a label stating the following.

“WARNING. Only use facing rearwards.”

8.3 A separate label bearing the following words shall be attached in a prominent position on the system.

“CAUTION. Metal and plastic fittings can become hot in direct sunlight. Cover when appropriate. Avoid contact with skin.”

8.4 Restraint systems to be used with adult seat belts shall be clearly and indelibly marked with the following additional information:

- a) the types of adult seat belt with which they can be used, e.g. lap and diagonal, and/or lap; and
- b) the correct routing of the webbing used to secure the system in the vehicle, indicated as specified in **8.5**.

The marking specified in **8.5** shall be visible when the infant is in the restraint and the restraint is in the vehicle.

8.5 The routes of the seat belt for forward- and rearward-facing modes shall be clearly distinguished on the product by colour-coding. The routes of the lap and shoulder sections of the seat belt shall be distinguished on the product by colour-coding and/or words. The colour of the seat belt route for rearward-facing installation shall be blue. If the restraint system is also approved for forward-facing use, the seat belt route for this mode shall be coloured red. The same colours shall be used on any labels on the restraint system that illustrate the methods of use.

Annex A (normative) Manikins

NOTE 3.4 kg, 9 kg and 11 kg manikins described in technical drawings³⁾ produced by the TNO (Road-Vehicles Research Institute) have been found suitable for use in the tests specified in this standard.

A.1 3.4 kg manikin

A.1.1 General

The manikin shall consist of a head, torso, arms and legs as a single unit and shall be provided with a close-fitting stretch cotton/polyester suit.

A.1.2 Construction

A.1.2.1 Head

The head shall be made from a polyurethane foam moulding covered by a PVC skin and shall be permanently attached to the torso.

A.1.2.2 Torso, arms and legs

The torso, arms and legs shall be a single moulding of sorbothane covered with a PVC skin. The spine shall consist of a steel spring.

A.1.3 Mass and dimensions

NOTE These masses and dimensions are based on those of a fiftieth percentile newborn baby.

A.1.3.1 Mass

The mass of the components of the manikin shall be as given in Table A.1.

Table A.1 — Mass of components of the 3.4 kg manikin

Component	Mass kg
Head and neck	0.7
Torso	1.1
Arm (× 2)	0.5
Leg (× 2)	1.1
Total	3.4 ± 0.1

A.1.3.2 Principal dimensions

The principal dimensions, as shown in Figure A.1, shall be as given in Table A.2.

A.1.4 Mechanical properties

A.1.4.1 When the stiffness of each shoulder is tested in accordance with **A.1.5.1**, the lateral deflection of the plunger from the point of first contact with the shoulder shall be at least 30 mm.

A.1.4.2 When the leg joint stiffness is tested in accordance with **A.1.5.2**, the force required to bend the hips until the face of the plunger is 85 mm above the support plane shall not exceed 70 N.

A.1.5 Methods of testing mechanical properties

A.1.5.1 Shoulder stiffness

Place the manikin on its back on a horizontal surface and support the torso on one side to prevent lateral movement (see Figure A.2).

Using a 40 mm diameter flat-faced plunger, apply a load exerting a force of 150 N, horizontally at right angles to the manikin's superior-inferior axis.

Ensure that the axis of the plunger is on the moulding line of the manikin's shoulder and adjacent to point A on the shoulder (see Figure A.2).

Measure the lateral deflection of the plunger from the point of first contact with the shoulder.

Repeat the test on the other shoulder, reversing the support.

A.1.5.2 Leg joint stiffness

Place the manikin on its back on a horizontal plane (see Figure A.3) and strap the lower legs together, bringing the inside of the knees into contact.

Apply a vertical load over the knees with a 35 mm × 95 mm flat-faced plunger. Ensure that the centre line of the plunger is over the highest point of the knees.

Apply sufficient force to the plunger to bend the hips until the face of the plunger is 85 mm above the support plane. Ensure that the legs do not touch any surface during the test. Note the force applied.

A.2 9 kg manikin

A.2.1 General

The manikins shall consist of a metal and polyester skeleton with polyamide and cast polyurethane body components.

NOTE See Figure A.4 for an exploded view of a typical 9 kg manikin, and Table A.3 for a list of components.

A.2.2 Construction

A.2.2.1 Head

The head shall be made of polyurethane and shall be reinforced by metal strips.

A.2.2.2 Vertebrae

A.2.2.2.1 Neck vertebrae

The neck shall be made of five rings of polyurethane containing a core of polyamide elements. The atlas-axis block shall be made of polyamide.

³⁾ Available from TNO (Road-Vehicles Research Institute), Schoemakerstraat 97, P.O. Box 6033, 2600 JA Delft, The Netherlands.

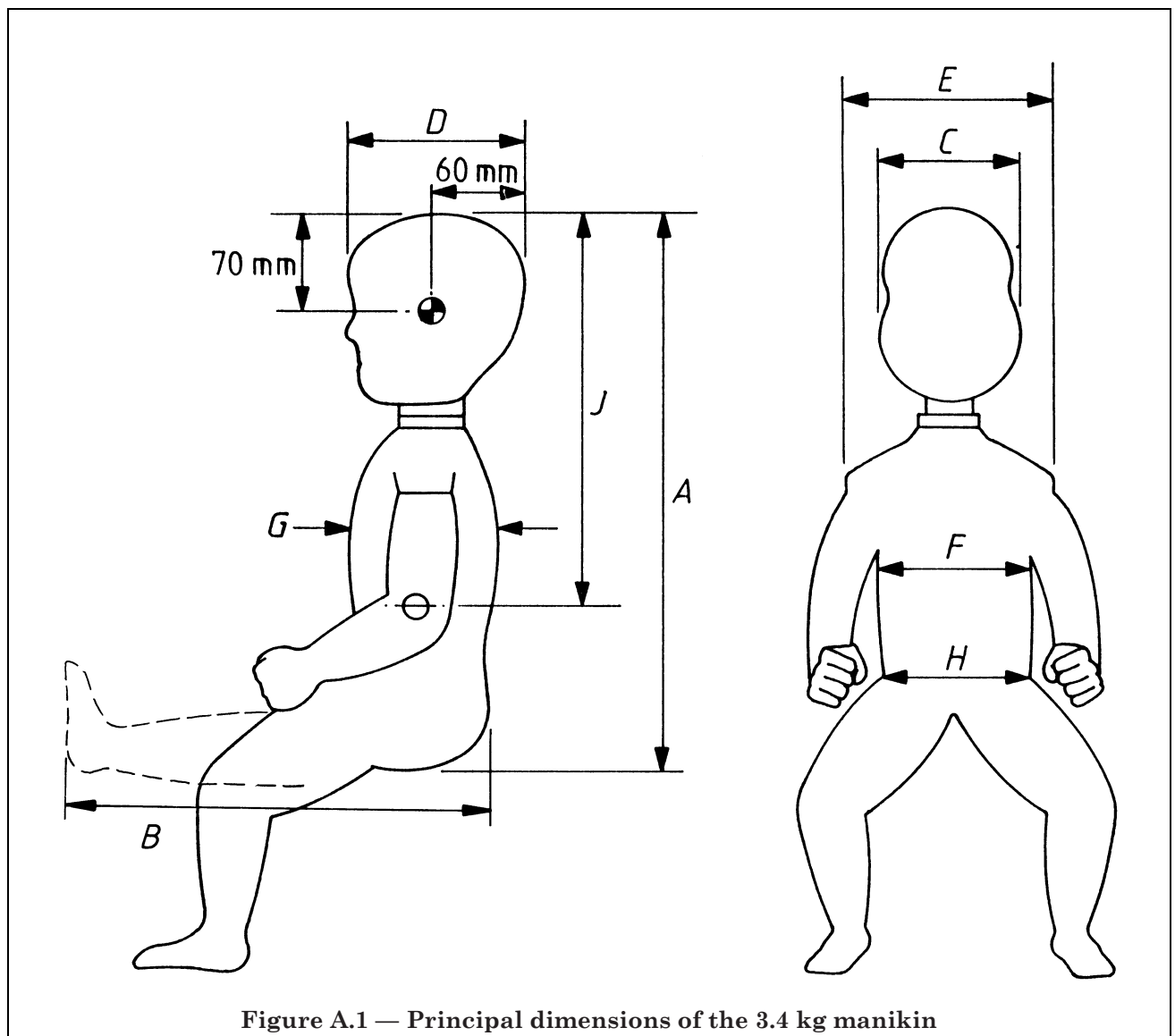
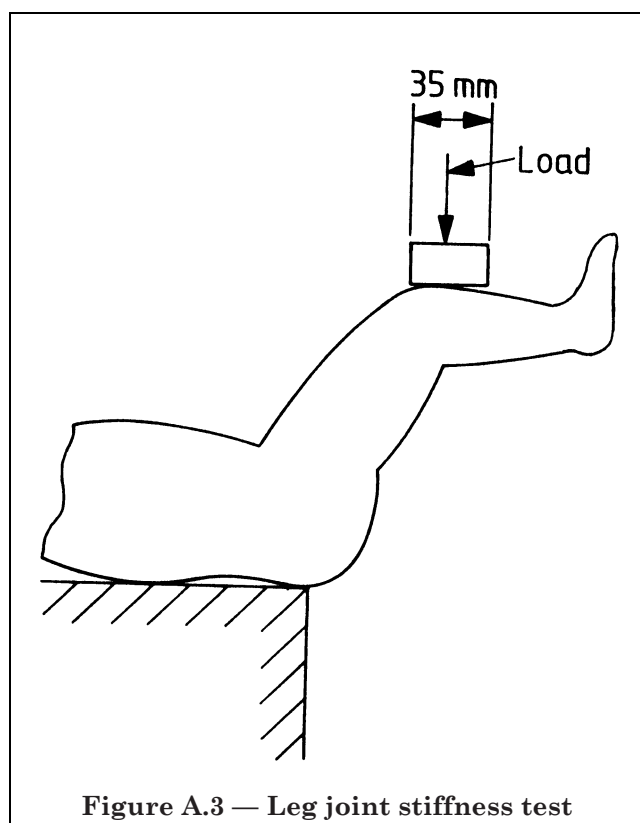
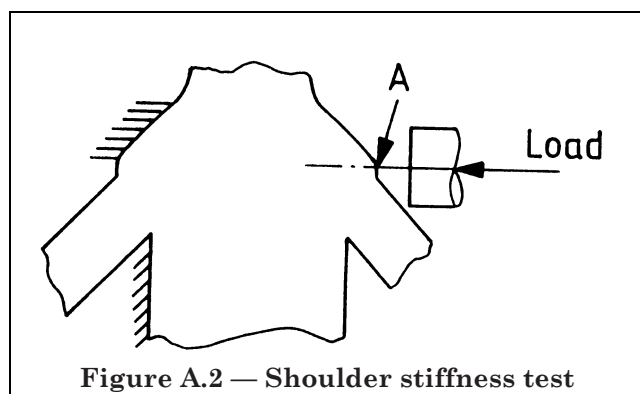


Figure A.1 — Principal dimensions of the 3.4 kg manikin

Table A.2 — Principal dimensions of the 3.4 kg manikin

Reference in Figure A.1	Dimension	Value mm
A	Rump to crown	345
B	Rump to sole (with straight leg)	250
C	Head width	105
D	Head depth	125
E	Shoulder width	150
F	Chest width	105
G	Chest depth	100
H	Hip width	105
J	Centre-of-gravity to crown	235



A.2.2.2.2 Lumbar vertebrae

The five lumbar vertebrae shall be made of polyamide.

A.2.2.3 Chest

A.2.2.3.1 The skeleton of the chest shall consist of a tubular steel frame on which the arm joints shall be mounted. The spine shall consist of a steel cable with four threaded terminals.

A.2.2.3.2 The skeleton of the chest shall be coated with polyurethane. It shall be possible to install measuring equipment in the chest cavity.

A.2.2.4 Limbs

The arms and legs shall be made of polyurethane, reinforced by metal elements in the form of square tubes, strips and plates. The knees and elbows shall be provided with adjustable hinge joints. The joints of the upper arm and upper leg shall consist of adjustable ball and socket joints.

A.2.2.5 Pelvis

A.2.2.5.1 The pelvis shall be made of glass-reinforced polyester coated with polyurethane.

A.2.2.5.2 The shape of the upper side of the pelvis shall match that of a child.

NOTE The shape of the upper side of the pelvis is important for determining sensitivity to abdominal loading.

A.2.2.5.3 The hip joints shall be situated immediately below the pelvis.

A.2.2.6 Assembly

A.2.2.6.1 Neck to chest to pelvis

The lumbar vertebrae and the pelvis shall be threaded on to the steel cable and their tension shall be adjusted by a nut. The neck vertebrae shall be mounted and adjusted in the same way. The steel cable shall not be free to move through the chest and it shall not be possible to adjust the tension of lumbar vertebrae from the neck or vice versa.

A.2.2.6.2 Head to neck

The head shall be mounted and adjusted by means of a bolt and nut through the atlas-axis block.

A.2.2.6.3 Torso to limbs

The arms and legs shall be mounted and adjusted to the torso by means of ball-and-socket joints.

For the arm joints, the ball shall be connected to the torso; for the leg joints, the ball shall be connected to the leg.

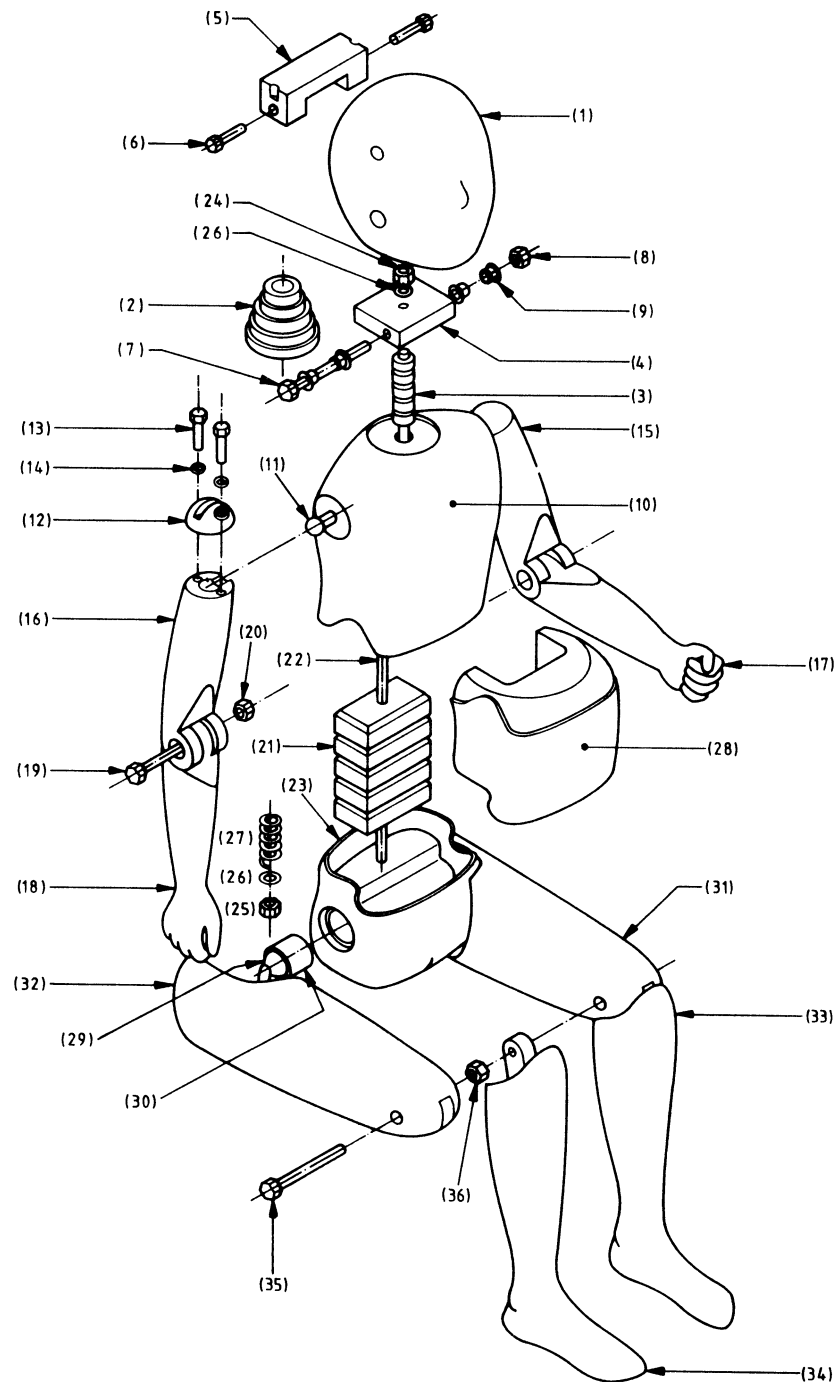


Figure A.4 — Exploded view of 9 kg manikin (For key, see Table A.3)

Table A.3 — List of components of the 9 kg manikin

Reference in Figure A.4	Description	Quantity
1	Head	1
2	Neck elements	5
3	Neck core elements (polyamide)	6
4	Atlas-axis block	1
5	Transducer mounting block	1
6	Transducer mounting block attachment bolt	2
7	Head bolt	1
8	Nut	1
9	Washer	4
10	Upper torso	1
11	Shoulder-joint ball	2
12	Shoulder-joint socket half	2
13	Adjustment bolt for shoulder joint	4
14	Spring washer	4
15	Upper arm, left	1
16	Upper arm, right	1
17	Forearm, left	1
18	Forearm, right	1
19	Elbow-hinge bolt	2
20	Elbow-hinge nut	2
21	Lumbar vertebrae	5
22	Spine cable	1
23	Lower torso	1
24	Adjustment nut for neck	1
25	Adjustment nut for lumbar vertebrae	1
26	Washer	3
27	Spring	1
28	Abdominal insert	1
29	Hip joint ball	2
30	Hip joint adjustment nut	2
31	Upper leg, left	1
32	Upper leg, right	1
33	Lower leg, left	1
34	Lower leg, right	1
35	Knee hinge bolt	2
36	Knee hinge nut	2

A.2.3 Mass and dimensions

NOTE These masses and dimensions are based on those of a child of the fiftieth percentile of age nine months.

A.2.3.1 Mass

The mass of the components of the manikin shall be as given in Table A.4.

Table A.4 — Mass of components of the 9 kg manikin

Component	Mass kg
Head and neck	2.20 ± 0.10
Torso	3.40 ± 0.10
Upper arm ($\times 2$)	0.70 ± 0.05
Lower arm ($\times 2$)	0.45 ± 0.05
Upper leg ($\times 2$)	1.40 ± 0.05
Lower leg ($\times 2$)	0.85 ± 0.05
Total	9.00 ± 0.20

A.2.3.2 Principal dimensions

The principal dimensions, as shown in Figure A.5, shall be as given in Table A.5.

A.2.4 Procedure for adjustment of joints

A.2.4.1 General

In order to achieve reproducible results using the manikins, adjust the friction in the various joints, the tension in the neck and lumbar cables, and the stiffness of the abdominal insert as described in A.2.4.2 to A.2.4.8.

A.2.4.2 Adjustment of the neck cable

Place the torso on its back in a horizontal plane. Mount the complete neck assembly without the head.

Tighten the tensioner nut on the atlas-axis block.

Place a suitable bar or bolt through the atlas-axis block.

Loosen the tensioner nut until the atlas-axis block is lowered by $10 \text{ mm} \pm 1 \text{ mm}$ when a force of 50 N directed downwards is applied to the bar or bolt through the atlas-axis block (see Figure A.6).

A.2.4.3 Atlas-axis joint

Place the torso on its back in a horizontal plane.

Mount the complete neck and head assembly.

Tighten the bolt and adjustment nut through the head and the atlas-axis block with the head in a horizontal position.

Loosen the adjustment nut until the head starts moving (see Figure A.7).

A.2.4.4 Hip joint

Place the pelvis on its front in a horizontal plane.

Mount the upper leg without the lower leg.

Tighten the adjustment nut with the upper leg in a horizontal position.

Loosen the adjustment nut until the upper leg starts moving (see Figure A.8).

Check the hip joints frequently in the initial stages for any “running-in” problems.

A.2.4.5 Knee joint

Place the upper leg in a horizontal position.

Mount the lower leg.

Tighten the adjustment nut of the knee joint with the lower leg in a horizontal position.

Loosen the adjustment nut until the lower leg starts moving (see Figure A.9).

A.2.4.6 Shoulder joint

Place the torso upright.

Mount the upper arm without the lower arm.

Tighten the adjustment nuts of the shoulder with the upper arm in a horizontal position.

Loosen the adjustment nuts until the upper arm starts moving (see Figure A.10).

Check the shoulder joints frequently in the initial stages for any “running-in” problems.

A.2.4.7 Elbow joint

Place the upper arm in a vertical position.

Mount the lower arm.

Tighten the adjustment nut of the elbow with the forearm in a horizontal position.

Loosen the adjustment nut until the forearm starts moving (see Figure A.11).

A.2.4.8 Lumbar cable

Assemble the upper torso, lumbar vertebrae, lower torso, abdominal insert, cable and spring.

Tighten the cable-adjustment nut in the lower torso until the spring is compressed to two-thirds of its unloaded length (see Figure A.12).

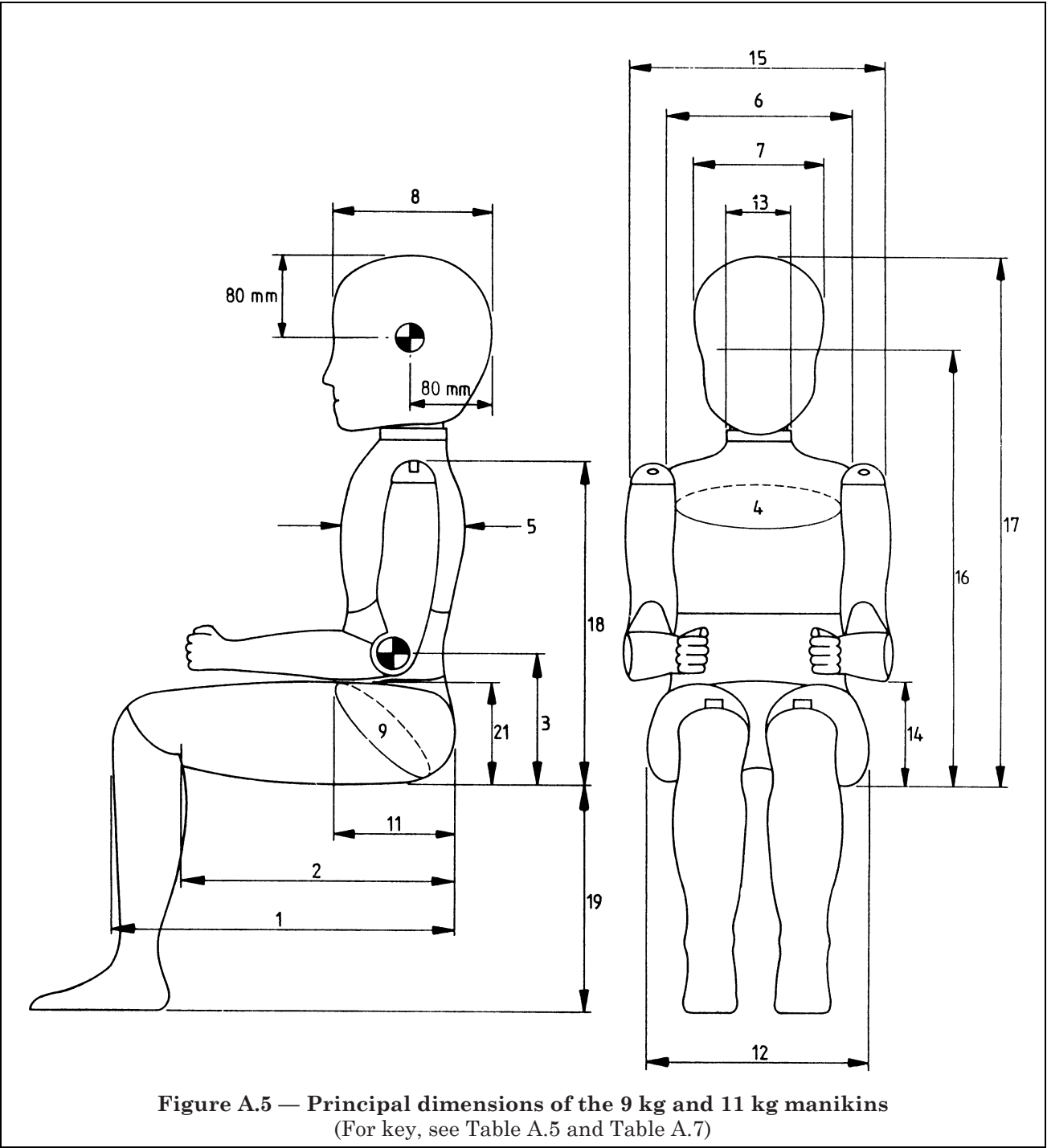


Figure A.5 — Principal dimensions of the 9 kg and 11 kg manikins
(For key, see Table A.5 and Table A.7)