

Code of practice for selection, use and maintenance of personal fall protection systems and equipment for use in the workplace

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Foreword

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution. This British Standard has been prepared by Technical Committee PH/5.

BS 8437:2005+A1:2012 supersedes BS 8437:2005, which is withdrawn.

The start and finish of text introduced or altered by Amendment No. 1 is indicated in the text by tags **A1** and **A1**. Minor editorial changes are not tagged.

This standard has been produced in response to the need to bring together best practice regarding personal fall protection from a large number of sources including information from manufacturers, from research studies and from training organizations.

The standard applies to the use of personal fall protection systems and equipment in the workplace only, where the prime activity is the work being undertaken. It is not intended to cover, for example, leisure activities or emergency evacuation systems and their procedures. Nevertheless, those engaged in other activities would probably benefit from the advice given in this standard, as many of the principles do apply and offer good practice. This standard is not intended to apply to personal fall protection systems and equipment for use in arboriculture.

The Health and Safety Executive (HSE) commends the use of this British Standard to those who have duties under the Health and Safety at Work etc. Act 1974. This standard was drawn up with the participation of HSE representatives and it will be referred to in the relevant HSE publications.

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

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

WARNING. Those who work at height should never forget that gravity is no respecter of persons. It affects everyone; too many times with disastrous consequences resulting in serious, permanent injuries or death.

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

Compliance with a British Standard cannot confer immunity from legal obligations.

In particular, attention is drawn to the statutory regulations listed in Clause 4.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 140, an inside back cover and a back cover.

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Introduction

Falls from a height are one of the largest causes of death and injury in the workplace. It is therefore essential that measures are taken to protect workers against falls from a height. These can include measures taken at the design stage, for example in the design of a new building, collective fall protection measures such as barriers and guard rails, and the use of personal fall protection systems and equipment. It is equally essential that the fall protection measures adopted are appropriate to the particular situation, that any fall protection system or equipment is correctly maintained and that users have appropriate training.

If a person working at a height, for example on a roof-top or tower, suffers a fall such that they lose contact with the surface on which they are supported, for example by stumbling over an edge, they will almost certainly hit the ground, or any intervening obstruction, with sufficient force to cause severe or fatal injuries. The severity of the injuries will be determined by the person's impact velocity, which will depend on the height of the fall, the nature of the impact surface and the part of the body that strikes the surface. The injuries are actually caused by the forces resulting from the rapid rate of deceleration of the body at impact.

NOTE A fall of 3.05 m (10 ft) takes only 0.8 s, giving no time for the person falling to react, and results in an impact velocity of 7.74 m/s (17.3 mph).

The severity of injury does not only depend on the height of the fall. While serious or fatal injuries can result from impact from a high fall onto a solid surface, they can also result from the following:

- impact from a relatively short fall onto, or through, a fragile surface;
- a head-first impact from a relatively short fall;
- a relatively short fall into water or a hazardous substance.

The present standard deals with personal fall protection systems in the context of a hierarchy of fall protection measures. It provides details of the types of fall protection systems and equipment available and gives guidance on their selection, use and maintenance, and on the training of users.

1 Scope

This British Standard gives recommendations and guidance on the selection, use and maintenance of personal fall protection systems and equipment for use in the workplace to prevent and/or to arrest falls from a height, including systems and equipment suitable for use in rescue. It also gives guidance on rescue of persons working at a height, in the event of an accident.

It is intended for use by employers, employees and self-employed persons who use personal fall protection systems and equipment. It is also intended for use by designers, e.g. architects and structural engineers, including those who are responsible for the design of safe access routes on buildings and structures, by those who commission work at a height, e.g. building owners and contractors, and by those involved in training persons for work at a height.

The standard is not applicable to collective fall protection systems, for example work platforms and fall arrest nets. It is not intended to apply to personal fall protection systems and equipment for use in leisure activities or in professional or private sports activities. It is also not intended to apply to personal fall protection systems and equipment for use in arboriculture.

NOTE 1 A discussion of the basic principles of fall protection is given in Annex A.

NOTE 2 Recommendations and guidance on the use of rope access methods are given in BS 7985.

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.

BS 7985: [A1](#) 2009 [A1](#), *Code of practice for the use of rope access methods for industrial purposes*.

BS EN 353-1, *Personal protective equipment against falls from a height: guided type fall arresters including a rigid anchor line*.

BS EN 353-2, *Personal protective equipment against falls from a height: guided type fall arresters including a flexible anchor line*.

BS EN 354, *Personal protective equipment against falls from a height — Lanyards.*

BS EN 355, *Personal protective equipment against falls from a height — Energy absorbers.*

BS EN 358:2000, *Personal protective equipment for work positioning and prevention of falls from a height — Belts for work positioning and restraint and work positioning lanyards.*

BS EN 360, *Personal protective equipment against falls from a height — Retractable type fall arresters.*

BS EN 361, *Personal protective equipment against falls from a height — Full body harnesses.*

BS EN 362, *Personal protective equipment against falls from a height — Connectors.*

BS EN 363, *Personal protective equipment against falls from a height — Fall arrest systems.*

BS EN 795:1997, *Protection against falls from a height — Anchor devices — Requirements and testing.*

BS EN 813, *Personal protective equipment for the prevention of falls from a height — Sit harnesses.*

BS EN 892:1996, *Mountaineering equipment — Dynamic mountaineering ropes — Safety requirements and test methods.*

BS EN 1497, *Personal fall protection equipment — Rescue harnesses.*

BS EN 1891:1998, *Personal protective equipment for the prevention of falls from a height — Low stretch kernmantel ropes.*

ISO 1140:1990, *Ropes — Polyamide — Specification.*

ISO 1141:1990, *Ropes — Polyester — Specification.*

3 Terms and definitions

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

3.1 body-holding devices

3.1.1

full body harness

body-holding device primarily for fall arrest purposes, i.e. a component of a fall arrest system which comprises straps, fittings, buckles or other elements, suitably arranged and assembled to support the whole body of a person and to restrain the wearer during a fall and after the arrest of a fall

NOTE 1 Adapted from BS EN 361:2002.

NOTE 2 A full body harness may be incorporated into a garment.

3.1.2

sit harness

body-holding device comprising straps, fittings and buckles or other elements in the form of a waist belt with a low attachment element and connected supports encircling each leg, suitably arranged to support the body of a conscious person in a sitting position

NOTE 1 A sit harness may be fitted with shoulder straps and/or may be incorporated into a garment.

NOTE 2 Adapted from BS EN 813:1997.

3.2 anchorages

3.2.1

anchor

fixture or place for the secure attachment of anchor lines or persons

NOTE An eyebolt is an example of a fixture and a steel beam is an example of a place.

3.2.2

anchor point

part of an anchor to which other equipment in a personal fall protection system is attached

3.2.3**anchor device**

element, or series of elements or components, of a personal fall protection system, which incorporates an anchor point or anchor points

NOTE Adapted from BS EN 795:1996.

3.2.4**structural anchor**

element or elements, permanently secured to a structure, to which an anchor device or equipment for personal fall protection can be attached

NOTE Adapted from BS EN 795:1996.

3.3 connectors**3.3.1****connector**

openable device used to connect components, which enables the user to link himself/herself directly or indirectly to an anchor point

3.3.2**karabiner**

connector, formed as a complete loop, with a spring loaded gate often safeguarded in the closed position by a screwed sleeve or automatic locking device

NOTE A karabiner in which the gate is safeguarded in the closed position by a screwed sleeve is known as a “screwgate karabiner”.

3.3.3**screwlink connector**

connector that is closed by a threaded sleeve which is the load-bearing part of the connector when fully screwed up

NOTE Also known as a “maillon rapide” (pronounced my-yon rapeed) or a “quicklink”.

3.3.4**gate**

part of a connector which can be moved to open it

NOTE 1 Sometimes referred to as a “keeper”.

NOTE 2 A gate can move, for example, by pivoting about a hinge (known as a hinged gate), or by a sliding motion (known as a sliding gate) or by a screw motion (known as a screw-motion gate).

NOTE 3 The term “gate” is sometimes also used to refer to the opening in the connector.

3.4**anchor line**

flexible or rigid line connected at least at one end to a reliable anchor to provide, as part of a personal fall protection system, a means of fall protection or support

3.5 anchor line devices**3.5.1****anchor line device**

device which accompanies the user along an anchor line

3.5.2**traveller**

anchor line device which travels in the broadly horizontal plane on a horizontal anchor line system and is intended to act as a mobile anchor point

3.5.3**guided type fall arrester**

anchor line device with a fall arrest and self-locking function, which travels along an anchor line without requiring manual adjustment by the user, during upward or downward changes of position

3.6

lanyard

connecting element or component of a personal fall protection system consisting of flexible material with at least two ready-to-use terminations, with or without an adjustment device

NOTE 1 This includes round slings.

NOTE 2 A lanyard may be made, for example, from synthetic fibre rope, wire rope, chain or webbing.

3.7

energy absorber

component or set of components in a fall arrest system, designed to minimize the impact force generated in a fall

NOTE Also known as a “shock absorber”.

3.8

retractable type fall arrester

fall arrest device with an encased flexible, extendable lanyard, that has a self-braking and locking function and an automatic return facility for the lanyard into the casing

NOTE 1 An energy dissipating function may be incorporated in the device itself or an energy absorber may be incorporated in the lanyard.

NOTE 2 Adapted from BS EN 360:2002.

3.9 loads

3.9.1

working load limit (WLL)

maximum load that can be lifted by an item of equipment under conditions specified by the manufacturer

3.9.2

safe working load (SWL)

maximum working load of an item of equipment under specified conditions, as designated by a competent person

NOTE The competent person may be the user.

3.9.3

maximum rated load

maximum mass, in kilograms, of personnel, including tools and equipment carried, that may be supported by a component of a personal fall protection system, as specified by the manufacturer

3.9.4

minimum rated load

minimum mass in kilograms of personnel, including tools and equipment carried, that may be supported by a component of a personal fall protection system, as specified by the manufacturer

3.9.5

minimum breaking load

minimum load at which an item of equipment breaks when it is tested new, under specific conditions

3.9.6

proof load

test load applied to verify that an item of equipment does not exhibit permanent deformation or other defect under that load, at that particular time

3.10

competent person

designated person suitably trained or qualified by knowledge and practical experience to enable the required task or tasks to be carried out properly

4 Legislation

4.1 General

Attention is drawn to the following acts and regulations, and HSE approved codes of practice (ACoP) and guidance.

Health and Safety at Work etc. Act 1974.

^{A1} Construction (Design and Management) Regulations 2007 (CDM Regulations) SI 2007/320 and ACoP *Managing health and safety in construction* (HSE L144). ^{A1}

^{A1} Work at Height Regulations 2005 SI 2005/735 (WAHR) as amended by the Work at Height (Amendment) Regulations 2007 SI 2007/114, and guidance (HSE INDG 401 REV1). ^{A1}

^{A1} *Text deleted* ^{A1}

Construction (Head Protection) Regulations 1989 SI 1989/2209.

Electricity at Work Regulations 1989.

Health and Safety (First Aid) Regulations 1981.

Lifting Operations and Lifting Equipment Regulations 1998 (LOLER) SI 1998/2307 and ACoP and Guidance *Safe use of lifting equipment* 1998 (HSE L113).

Management of Health and Safety at Work Regulations 1999 (MHSW Regulations) SI 1999/3242 and ACoP *Management of health and safety at work* (HSE L21).

Personal Protective Equipment Regulations 2002 SI 2002/1144.

Personal Protective Equipment at Work Regulations 1992 (PPE) SI 1992/2966 and amendments, and guidance document *Personal protective equipment at work* 1992 (HSE L25).

Provision and Use of Work Equipment Regulations 1998 (PUWER) SI 1998/2306 and ACoP *Safe use of work equipment* (HSE L22).

Workplace (Health, Safety and Welfare) Regulations 1992 SI 1992/3004 as amended and ACoP *Workplace health, safety and welfare* (HSE L24).

4.2 The Health and Safety at Work etc. Act 1974

The Health and Safety at Work etc. Act 1974 places general duties on employers, clients, contractors, owners, the self-employed and employees. Many regulations have been made under this act, which expand on these duties, some dealing specifically with particular issues such as first aid and protection of eyes. Other regulations have been made under the act, which bring into force the requirements of EC directives. These regulations, for example the Management of Health and Safety at Work Regulations 1999, require a risk assessment (see HSE document *Five steps to risk assessment* [1]). They highlight the duties of clients, owners and designers of structures to ensure that, so far as is reasonably practicable, any work to be carried out in the workplace can be performed safely. It is the duty of every employer to ensure that they comply with all legal safety requirements relating to the type of work being undertaken and to work in the particular location concerned.

4.3 The Management of Health and Safety at Work Regulations 1999

The Management of Health and Safety at Work Regulations 1999 require employers, in entrusting tasks to employees, to take account of their capabilities as regards health and safety.

4.4 The Personal Protective Equipment at Work Regulations 1992

The Personal Protective Equipment at Work Regulations 1992 require employers to provide suitable personal protective equipment, which includes some protective clothing. The Personal Protective Equipment at Work Regulations 1992 also require any employee to use any personal protective equipment provided in accordance with both any training and any instructions.

4.5 The Work at Height Regulations 2005 (as amended)

4.5.1 Organization and planning

The Work at Height Regulations  2005 (as amended)  (Regulation 4) require that work at height be properly planned, appropriately supervised and carried out in a manner which is safe. This includes planning for emergencies and rescue. In addition, employers have a duty to ensure that work at a height is carried out only when the weather conditions do not jeopardize the health or safety of persons involved in the work.

4.5.2 Avoidance of risks from work at a height

The Work at Height Regulations  2005 (as amended)  (Regulation 6) require every employer to take account of a risk assessment under the MHSW Regulations (Regulation 3). Work is not to be carried out at height where this risk can be avoided. Where work has to be carried out at a height, it is to be undertaken from an “existing place of work”, where there is no risk of a fall occurring and no additional work equipment is needed (e.g. a roof with an existing parapet). Where an existing place of work cannot be used, work equipment is to be provided to prevent any person falling a distance liable to cause personal injury. Where the risk of a fall cannot be eliminated, work equipment is to be used to minimize the distance and consequences of any fall or, where it is not reasonably practicable to minimize the distance, work equipment is to be used to minimize the consequences of any fall. Where none of the above can be achieved, other work equipment can be used, which has to be supplemented by other measures, e.g. instructions, supervision and training, to minimize the likelihood of a fall occurring in the first place.

4.5.3 General principles for selection of work equipment for work at height

The Work at Height Regulations  2005 (as amended)  (Regulation 7) require collective protection measures to be given priority over personal protection measures. When selecting work equipment for use in work at height, the following have to be taken into account:

- the working conditions and the risks to the safety of persons at the place where the work equipment is to be used;
- in the case of work equipment for access and egress, the distance to be negotiated;
- the distance and consequences of a potential fall;
- the duration and frequency of use;
- the need for easy and timely evacuation and rescue in an emergency;
- any additional risk posed by the use, installation or removal of that work equipment or by evacuation and rescue from it.

4.5.4 Fragile surfaces

The Work at Height Regulations  2005 (as amended)  (Regulation 9) require that that no person at work passes across or near (or works on, from or near) a fragile surface where it is reasonably practicable to carry out work safely, and under appropriate ergonomic conditions, without their doing so. Otherwise, platforms, coverings, guard rails or similar means of support or protection have to be provided and used, so that any foreseeable loading is supported by such supports or borne by such protection. Where the risk of a fall remains, measures have to be taken to minimize the distance and consequences of the fall.

4.5.5 Inspection of work equipment

The Work at Height Regulations  2005 (as amended)  (Regulation 12) require that work equipment exposed to conditions causing deterioration which is liable to result in dangerous situations is inspected:

- a) at suitable intervals; and
- b) each time that exceptional circumstances which are liable to jeopardise the safety of the work equipment have occurred.

See Clause 13.

4.6 Construction (Design and Management) Regulations 2007

Where the CDM Regulations apply, there is a requirement for a construction-phase health and safety plan and a health and safety file. These are required, where applicable, to contain information concerning the safety aspects of work at height in construction work and should be made available to those planning work at height. When construction work has been completed, there could be a need to update the health and safety file. 

4.7 HSE Guidance documents

Two parts of the HSE's revised series of health and safety guidance for the construction industry, *Health and Safety in Construction* [2] and *Health and Safety in Roof Work* [3], provide valuable information in a simple but comprehensive form. The guidance covers such topics as organizing the site, the essentials of health and safety, and health and safety management and the law. Following the guidance is not a statutory requirement. However, the guidance provides sufficient information to enable the user to ensure that they comply with the law.

A1 Text deleted A1

5 Fundamental principles

5.1 Hazard identification and risk assessment, and hierarchy of protective measures

5.1.1 The primary objective is to so organize, plan and manage the work that there will be an adequate margin of safety to minimize risk, with a goal of no incidents.

5.1.2 The Management of Health and Safety at Work Regulations require that before fall protection systems are employed for a particular job, employers carry out a hazard identification and risk assessment (see **6.1**) and set out clear requirements for all aspects of the work. In addition, the work should be carefully assessed to ensure that the method of access is appropriate to the quality of the work required.

5.1.3 Regarding the risk of a fall from a height, the measures that can be taken need to be considered in order (see **6.2**, which gives a hierarchy of fall protection measures).

5.2 Principles of selection of personal fall protection systems and equipment

5.2.1 Use of CE marking

When it is planned to use CE marking as a criterion for purchasing equipment, it is essential to ensure that the marking is for goods appropriate to the intended use (see **7.1.2**).

5.2.2 Use of standards

Equipment should be selected that conforms to standards relevant to the intended use (see **7.1.3**).

5.2.3 Types of fall protection systems and equipment to be considered

If, after the hazard identification and risk assessment (see **6.1**), and with due consideration of the hierarchy of protective measures (see **6.2**), it is decided that it is necessary to choose personal fall protection equipment, it is then necessary to choose the correct type of personal fall protection system and equipment to be used (see Clause 7).

The types of personal fall protection systems and equipment available are as follows.

- a) *Restraint (travel restriction) systems and equipment*, which restrict the user's travel so that access is not possible to zones where the risk of a fall from a height exists (see **7.2.2**).
- b) *Work positioning systems and equipment*, which enable the user to be held in a partly or entirely supported position (see **7.2.3**).
- c) *Rope access systems*, which employ two separately secured lines, one as the means of support and the other as a safety back-up, for access or egress to and from the workplace, both lines being attached to the user's harness (see **7.2.4**).

NOTE Rope access systems can be used for work positioning.

- d) *Fall arrest systems and equipment*, which act to arrest a fall and which are used in situations where, if the user loses controlled physical contact with the working surface, there will be a free fall (see **7.2.5**).

5.2.4 Limits of equipment use

It is essential that limits of equipment use are observed, as follows.

- Equipment designed exclusively for restraint should not be used for work positioning or as fall arrest equipment.
- Equipment designed exclusively for work positioning should not be used as fall arrest equipment.

It should be noted however, that some equipment is designed to be multi-purpose, e.g. for both work positioning and fall arrest, or to allow the attachment or connection of other components in order to meet the requirements for a category of work other than the one for which it was primarily designed.

5.2.5 *Compatibility of equipment*

When selecting equipment, it is essential for purchasers to ensure that components in any system are compatible and that the safe function of any one component is not adversely affected by, and does not interfere with, the safe function of another, or of the system. Sometimes this is not obvious, so it is important to check with the supplier or the manufacturer. Sometimes, the only way to be sure is to carry out a system performance test.

5.3 Principles of use of personal fall protection systems and equipment

5.3.1 *Competency of users*

It is essential that users are competent in the use of their personal fall protection systems and equipment and have a suitable attitude for working at a height.

Users should have sufficient professional or technical training, knowledge and actual experience to enable them to:

- carry out their assigned duties at the level of responsibility allocated to them;
- understand fully any potential hazards related to the work and the equipment to be used;
- detect any technical defects or omissions in that work and equipment, recognize any implications for health and safety from those defects or omissions, and be able to take remedial action to deal with these.

Users should also be competent to check their personal fall protection system and equipment for defects before every use.

5.3.2 *Training and assessment of users*

It is essential that users are suitably trained and assessed for competency in the use of their personal fall protection systems and equipment for the particular intended application (see Clause 15). They should also be trained and assessed in the pre-use checking of their equipment (see 5.3.6).

NOTE BS 8454 gives recommendations and guidance for training providers to enable them to ensure that training for work at height is delivered to a high standard, in a safe, controlled environment by competent and experienced staff. 

5.3.3 *Users' knowledge of equipment*

Under the Personal Protective Equipment at Work Regulations 1992, the manufacturer of the equipment is required to supply product information. This information should be read and thoroughly understood by the user before using the equipment. Time should be allowed for this in the planning of the work. This also applies to replacement equipment, because changes might have been made to the original specification or advice given. Knowledge of the strengths and weaknesses of equipment can help to avoid misuse. This knowledge can be enhanced by training and by studying the information provided with the product and other technical brochures and catalogues.

5.3.4 *Compatibility of equipment in use*

When assembling equipment into a system, the user should check that the components in the system are compatible and that the safe function of any one component is not adversely affected by, and does not interfere with, the safe function of another, or of the system.

5.3.5 *Pre-use examination of equipment new to the user*

Before new or used equipment is used for the first time by a particular user, that user should ensure that it is appropriate for the intended application, that it operates correctly, and that it is in good condition. Before using a harness for the first time, it is recommended that the user is assisted in carrying out a comfort and adjustability test in a safe place, in accordance with the procedure given in Annex B, to ensure that the harness is the correct size, has sufficient adjustment and is of an acceptable comfort level for the intended use, including suspension. It should be noted however, that the test described in Annex B is suitable only for belts with sub-pelvic support, sit harnesses and full body harnesses. It should not be applied to belts without sub-pelvic support or to chest harnesses.

5.3.6 *Pre-use checks*

All equipment should be subjected to a pre-use check before each use. Damaged equipment should be taken out of service immediately. (See Clause 13 and Annex C.)

5.3.7 *Detailed inspections*

In addition to pre-use checks, equipment should be subjected to detailed inspections by a competent person in accordance with a predetermined regime. Damaged equipment should be taken out of service immediately. (See Clause 13, Annex C and HSE Guidance document *Inspecting fall arrest equipment made from webbing or rope* [4].)

5.3.8 *Interim inspections*

Interim inspections might be needed between detailed inspections in situations where the risk assessment has identified a hazard that could cause significant deterioration in the equipment, for example paint, chemicals or an acidic or alkaline environment. The need for and frequency of interim inspections will depend on the particular circumstances in which the equipment is to be used.

5.3.9 *Anchor points*

Anchor points should be of adequate strength (see Clause 16).

Wherever possible, anchor points should be above the user so that the anchor line or lanyard is taut or has as little slack as possible. Alternatively, it is permissible for the anchor or anchor point to be below the user, provided that the force on the anchor line connected to the user acts from above. An example of the latter would be on a ridged roof when the user is on the opposite side of the ridge to the anchor point and the anchor line passes over the ridge. This is to minimize the length and effect of any fall; the importance of this cannot be stressed enough. Positioning of anchor points should be such that hazards such as sharp or rough edges and hot surfaces are avoided, as they are very likely to cause damage to tensioned anchor lines and lanyards, particularly those made from textiles, which would cause them to fail on being put under load.

5.4 Principles of maintenance of personal fall protection systems and equipment

The life of the user depends on his or her personal fall protection systems and equipment being maintained properly. Equipment should be kept clean and dry and should be properly stored. Wet equipment should be thoroughly dried before storage. Equipment should not be altered or repaired, unless this has been authorized by the manufacturer. (See Clause 13.)

6 Hazard identification, risk assessment and safety method statement

6.1 General

6.1.1 Hazard identification and risk assessment which have to be carried out before the work commences, as required by the Management of Health and Safety at Work Regulations, has to include consideration of whether or not the proposed method of work would be appropriate in view of the hierarchy of protective measures laid down in the Work at Height Regulations 2005 ^(A1) (as amended) ^(A1) (see 6.2). A safe system of work then needs to be planned including selection of appropriate working methods and equipment, together with competent personnel, and it is recommended that a safety method statement should be prepared (see 6.1.8).

6.1.2 A safety method statement, although not required by law, has proved to be an effective way of producing an action plan for a safe system of work. It is particularly useful in bringing together the assessments of the various hazards which might arise in a particular job. Safety method statements may also be linked to, or form part of, a company's safety policy and procedures, particularly where these do not cover the particular circumstances of the work concerned.

6.1.3 Hazard identification should comprise identification of anything that could cause harm, for example, electrical installations, sharp edges or working from a ladder.

6.1.4 A risk assessment should comprise a careful evaluation of all hazards identified, to determine the level of risk posed by each. Action should be taken to eliminate the hazards. If this is not possible, precautions should be taken to minimize the probability of persons being harmed.

6.1.5 Taking the examples given in 6.1.3 the levels of risk and the precautions that should be taken are as follows.

- Electrical installations pose a high risk of electric shock. The probability of harm should be minimized by ensuring that all potentially “live” components are insulated and metal casings are earthed.
- Sharp edges pose a high risk of laceration injuries and also a high risk of indirectly causing injury through damage to equipment such as lanyards. The probability of harm should be minimized by ensuring that all sharp edges are protected.
- Working from a ladder poses a high risk of a fall from a height. The probability of harm should be minimized by ensuring that the ladder is correctly positioned and secured, and its use limited if necessary.

6.1.6 It is only after such hazard identification and risk assessment has been carried out that the appropriate fall protection equipment and systems can be selected. The hazard identification and risk assessment should be site specific and should be reviewed on a continuous basis, for example, each day or at each change of job.

6.1.7 In the risk assessment, detailed consideration should be given to all possible emergency scenarios and to planning how any necessary rescues would be carried out (see Clause 11).

6.1.8 A record should be kept of each hazard identified, the assessment of the risk and the action taken to minimize it. For companies with five or more employees this is a legal requirement under the Management of Health and Safety at Work Regulations, but makes good sense for companies of all sizes, as records can provide valuable information and documentary evidence in case of any incident. Taking the examples given in **6.1.3** and **6.1.5**, the records would need to state the following:

- electrical installations: insulation and earthing checked and found to be sound;
- sharp edges: edge protection in place;
- ladders: secured at top and bottom; angle of lean adjusted; use restricted to access only.

6.1.9 It should be ensured that the following actions have been taken and reported in the records:

- a proper hazard identification and risk assessment has been made;
- a check has been made of who and how many people could be affected by each hazard;
- all the obvious and significant hazards have been taken into account;
- reasonable precautions have been taken to minimize the risks;
- the residual risks have been determined and found to be low.

6.1.10 When planning a safe system of work, an employer should consider the following, as early in the planning of the work as possible:

- a) The workplace, in particular:
 - 1) the nature of the workplace including its form, structure, geometry and materials;
 - 2) the nature of the environment in the workplace including any adverse climatic or atmospheric conditions.
- b) The work, in particular:
 - 1) details of the tasks to be carried out including any special risks associated with them;
 - 2) how much space is needed;
 - 3) how long the work is expected to take.
- c) The workers, in particular:
 - 1) their body size;
 - 2) the range of movements they will need to make and the postures they will need to adopt.
- d) The personal fall protection equipment, in particular:
 - 1) who it is for [see item c)];
 - 2) features and limitations of the equipment, including the materials from which it is made and its means of operation.

6.1.11 The Personal Protective Equipment at Work Regulations 1992 require every employer to ensure that:

- a) suitable personal protective equipment is provided;
- b) the items of personal protective equipment are compatible;
- c) an assessment is made to determine whether the personal protective equipment he intends to provide is suitable;
- d) the personal protective equipment is maintained in an efficient state.

6.1.12 As part of the selection of personal fall protection equipment it is recommended that:

- a) field trials be undertaken, with input from those individuals who will use the equipment;
- b) technical information be carefully evaluated; in particular a careful comparison should be made of the methods used for testing the equipment and the planned mode of use.

6.2 Hierarchy of protective measures for people working at a height

The working environment should be as hazard-free as possible, thereby minimizing the risks to workers (see 6.1). This applies particularly to work at height. Each hazard needs to be dealt with in a manner that ideally eliminates the risk, or, if that is not practicable, reduces that risk as far as possible and at least to the highest acceptable level. The Work at Height Regulations 2005 ^[A1] (as amended) ^[A1] (Regulation 6) require a hierarchical approach to the planning of work at height, with collective protective measures to be given priority over personal protective measures, and measures that prevent a fall to be given priority over those that minimize the height and consequences of a fall. This is illustrated in Table 1.

Table 1 — Illustration of hierarchy of protective measures given in the Work at Height Regulations 2005 ^[A1] (as amended) ^[A1]

Priority	Category of work equipment	Highest Lowest	
		Examples of protective measures	
		Collective	Personal
Highest	Work equipment which prevents a fall	Working platforms with barriers Advanced guardrail systems Barriers ^[A1] Mobile elevating work platforms ^[A1] (MEWPs)	Personal fall prevention systems (e.g. valley frames) Personal fall protection equipment (work restraint systems) ^[A1] Text deleted ^[A1]
	Work equipment which minimizes the ^[A1] distance ^[A1] and consequences of a fall	Safety nets at high level (rigged close to the work) Soft landing systems installed close to the work	Other personal fall protection equipment (rope access, work positioning and fall arrest systems) (See Note 2.)
	Work equipment which minimizes the consequences of a fall	Soft landing systems Safety nets rigged at low level (^[A1] ≤ 6 m ^[A1] below the work)	Inflatable injury prevention systems, e.g. air jackets Other personal protective equipment not normally associated with fall protection, e.g. lifejackets for work over water
	Work equipment which does neither (ladders, step ladders, hop-ups, trestles, etc.)	Instruction, supervision and training of users to minimize the risk of them suffering a fall	
Lowest			

NOTE 1 Within each category:—

- a) collective protective measures take priority over personal protective measures;
- b) appropriate work equipment (and its order of priority) needs to be determined by taking into account the work to be undertaken and by considering the risk to those installing, using and removing the equipment and the implications for rescue associated with the work equipment being used.

NOTE 2 The fall factor (see 9.1.3.1) has to be kept as low as possible, with systems with a fall factor of zero being given priority.

7 Selection of personal fall protection systems and equipment

7.1 General

7.1.1 Risk assessment

Regulation 3 of the Management of Health and Safety at Work Regulations 1999 requires that before equipment is selected or used a risk assessment is carried out for each job for which that equipment is to be used.

7.1.2 CE marking

7.1.2.1 Under the Personal Protective Equipment (EC Directive) Regulations 1992, which are based on the Personal Protective Equipment Directive (89/686/EEC) [5], equipment used for fall protection that is classified under the directive as personal protective equipment (PPE) is required to carry CE marking. This applies to most equipment used for personal fall protection.

7.1.2.2 It is essential not to use CE marking as the sole criterion for purchasing equipment. It is often thought that the CE mark means that the equipment will be suitable for the particular task for which it is being purchased. This is not necessarily the case, as the testing specified in the relevant European standard is often limited to checking the most important parameters under laboratory conditions and therefore might not cover the specific circumstances of use. Therefore, ensuring that the equipment has a CE mark is only one of the factors involved in the selection process. When it is planned to use CE marking as a criterion for purchasing equipment, it is essential to ensure that the marking is for goods appropriate to the intended use. CE marking is mandatory on many different types of product, not just personal protective equipment (PPE). For PPE, there are three different categories, ranging from simple items like protective work gloves (category I) to category III equipment for protection against mortal danger (e.g. harnesses). Most equipment for fall protection is category III.

7.1.2.3 For PPE category III, CE marking indicates that the product has been independently type tested and meets the basic health and safety requirements of the Personal Protective Equipment Directive (89/686/EEC) [5] and the Personal Protective Equipment Regulations 2002. This is certified by an organization, approved by the government, known as a notified body. A notified body also monitors the quality of production, either by random but regular inspections of the manufacturer's quality system (e.g. to BS EN ISO 9001) or by carrying out batch tests. The usual way for manufacturers to ensure that their products meet the requirements of the Personal Protective Equipment Regulations is to have their products tested to a recognized standard, although this is not the only way. The alternative is for equipment to be CE marked to the Personal Protective Equipment Directive (89/686/EEC) [5] via the technical file route as defined in the directive. Category III PPE (see **7.1.2.2**) will always have a four-digit numerical code attached to the CE mark to identify the relevant notified body. A booklet entitled *Personal Protective Equipment: Guidance notes on UK Regulations* [6], published by the Department of Trade and Industry (DTI), provides further details.

7.1.2.4 The prime function of CE marking is to protect against barriers to trade within the European Union. It is not meant to be taken as a mark of quality, although PPE category III is subject to such rigorous controls that this point could be argued otherwise.

7.1.3 Standards

Equipment should be selected that conforms to standards relevant to the intended use. Whenever possible these should be appropriate BS EN standards. In the absence of these, equipment conforming to other standards, e.g. international (ISO), national or trade association standards, may be chosen. If there is doubt about whether or not a particular standard is relevant to the intended use, it is advisable to discuss it with the manufacturer of the equipment. The alternative is to select equipment that has been CE marked to the Personal Protective Equipment Directive (89/686/EEC) [5] via the technical file route (see **7.1.2.3**).

Many standards specify marking of the standard number on the equipment, and this can be valuable to purchasers and users for checking that the equipment is appropriate for the intended use. However, it should be noted that not all standards require marking of the standard number on the equipment; also there might not be a standard for a particular item of equipment. It is also important to note that marking of a standard number on an item of equipment represents a manufacturer's claim of conformity to the standard, it should not be confused with third party certification of conformity.

7.2 Types of personal fall protection systems and equipment

7.2.1 General

If, after the hazard identification and risk assessment, and after consideration of the hierarchy of protective measures (see 6.1 and 6.2), it is decided that personal fall protection equipment is needed, it is then necessary to choose the type of personal fall protection system and equipment to be used. This may be either a system that prevents a fall or one that arrests a fall. Wherever possible, a personal fall protection system that prevents a fall should be used in preference to a fall arrest system.

If a personal fall protection system that prevents a fall is to be used it should be one designed to prevent the user reaching zones where the risk of a fall exists, or one that prevents the onset of a fall. Where it is not practicable to use a system that prevents a fall, then, as a last resort, a fall arrest system should be used.

7.2.2 Restraint (travel restriction) systems

If the objective is to restrict the user's travel so that access is not possible to reach zones where the risk of a fall from a height exists, a restraint system should be used. This may be appropriate fall arrest equipment, work positioning equipment or a simple belt coupled with a lanyard of limited length. The restraint system should be chosen and arranged so that it is not possible for the user to access zones where the risk of a fall exists. Details of restraint systems are given in Clause 8.

Sometimes users choose to use their restraint system for support, e.g. on a sloping roof where it is possible to move around without support, but where the use of a support would aid carrying out the work. Users should be aware of the consequences of a slip or equipment failure when using this technique. They should consider in their risk assessment the appropriateness of their equipment and whether a safety back-up system should be employed.

7.2.3 Work positioning systems

If the planned method of work is for the user to be in a partly or entirely supported position, then a work positioning system should be used. The work positioning system should include a safety back-up system, in addition to the primary support, so that should there be an operator error or failure of the primary support, a fall will be prevented or arrested. A rope access system can be used for work positioning. Details of work positioning systems are given in Clause 10 and details of rope access systems are given in BS 7985: A1 2009 A1.

In addition to its primary function of providing support and preventing a fall, work positioning equipment is likely to be strong enough to arrest a free fall of limited distance and force, but might not conform to the other essential requirements for a fall arrest system, unless combined with appropriate additional components, e.g. an energy absorber.

7.2.4 Rope access systems

If the planned method of work is to use two separately secured lines, one as the means of support and the other as a safety back-up, for access or egress to and from the workplace, and if both lines are to be attached to the user's harness, a rope access system should be used in accordance with the recommendations given in BS 7985: A1 2009 A1.

NOTE If the system is based on a line which moves with the user e.g. a bosun's chair, this is not a rope access system but a work positioning system.

7.2.5 Fall arrest systems

If the planned method of work is such that if the user loses controlled physical contact with the working surface there will be a free fall, a fall arrest system conforming to BS EN 363 should be used. This comprises a full body harness conforming to BS EN 361, a suitable anchor, and a system or device that has energy absorbing capacity and that provides a means of attachment to that anchor. Details of fall arrest systems are given in Clause 9.

8 Restraint systems

8.1 General

8.1.1 Restraint systems are used to prevent users from reaching zones where the risk of a fall exists. They involve the connection of the user to the structure by means of a lanyard or an anchor line, the position and length of which is such that, irrespective of the user's movements in a broadly horizontal plane, they can never get into a situation from which a fall can occur. Fundamentally, restraint systems prevent the initiation of a fall (see Figure 1).

8.1.2 Restraint systems have a number of constraints. These are as follows:

- they are limited to movement in the broadly horizontal plane;
- they restrict the user's mobility, i.e. they might allow movement to certain parts of a structure, but not to others;
- they are site-specific, i.e. the length of the restraining lanyard or anchor line might only be appropriate to one situation.

8.1.3 There are some notable differences between restraint systems and other personal fall protection systems. These include the following.

- The only fall that can occur using a restraint system is a "fall on the level" i.e. a trip or slip resulting in the user falling onto the surface on which they were standing.
- The force experienced by a user connected to a restraint system and the force at the anchor are likely never to exceed the equivalent of twice the mass of the user.
- No rescue provisions are normally needed with a restraint system.

NOTE Rescue provisions might be necessary, depending on the location of the work, to deal with a situation in which the user of a restraint system becomes incapacitated, for example if they are working at a difficult to reach location on a rooftop.

8.2 Selection of the components of a restraint system

8.2.1 General

A restraint system should comprise the following components:

- a body-holding device, comprising a waist belt (preferably incorporating a sub-pelvic support), a sit harness or a full body harness (see 12.6);
- a fixed anchor point e.g. an eyebolt, or a mobile anchor point, running along a horizontal rigid or flexible anchor line (see Clause 16);
- a lanyard or anchor line, connected between the body holding device and the anchor point (see 8.2.2, 12.7 and 12.9);
- connectors, for joining the lanyard or anchor line to the anchor point and to the body-holding device (see 12.5).

8.2.2 Lanyards and anchor lines for restraint systems

The range of the user's broadly horizontal movement should be restricted by the length of the lanyard or anchor line and by the position of the anchor point (see Figure 1) to ensure that the user is physically prevented from entering an area where there is a risk of a fall from a height. The length of the lanyard or anchor line should be such that when connected to the intended anchor point it is long enough to allow the user to reach the intended work area but short enough to prevent fall arrest conditions being created (see Figure 2b). If it is too short the work area might not be within reach (see Figure 2a). If it is too long it might create free fall and fall arrest conditions, which, if realised, could severely injure the user or cause system failure (see Figure 2c and 2d). The limit of movement should be determined by tracing the locus of the point at which the lanyard or anchor line connects to the body-holding device, as shown in Figure 1.

To extend the range of horizontal movement, so increasing the areas accessible to the user, and permit two or more users to be connected simultaneously, a restraint system employing a horizontal anchor line may be used (see Figure 3). The anchor line may be rigid, e.g. a rail, or flexible, e.g. a wire rope. Horizontal anchor lines for fall arrest applications are suitable for this purpose (see 9.5). Each user should be connected to the anchor line by a separate connector.

A lanyard or anchor line for restraint should not be used for fall arrest purposes.

An energy absorbing lanyard of the correct length may be used for restraint provided that the situation in which it is to be used is such that it will not be subjected to a force that could cause the energy absorber to begin to deploy (i.e. a force in excess of 2 kN).

8.3 Use of restraint systems

A restraint system should not be used in a situation in which it might unexpectedly be relied upon to perform a fall arrest function, for example where there is a risk of a fall over an edge (see Figure 4b) or where there is a risk of a fall through a surface made of fragile material (see Figure 5), as this could lead to serious injury to the user. The Work at Height Regulations 2005 ^{A1} (as amended) ^{A1} specifically require steps to be taken to prevent any person from falling through any fragile material. In such situations other methods of fall protection should be utilized, e.g. platforms and crawling boards.

NOTE 1 Figure 5 shows a restraint system preventing a fall over an edge (see Figure 5a) but putting the user at risk of a fall through a roof light (see Figure 5b).

NOTE 2 A test to determine the fragility of roofing assemblies is given in ^{A1} ACR(M)001 *Test for non fragility of profile sheeted roofing assemblies* published by the Advisory Committee for Roofsafety [7] ^{A1}.

If during the work it becomes apparent that the restraint system would not prevent a fall over an edge, for example because the connecting lanyard is too long, then work should be stopped immediately and action taken to remedy the situation, for example by adjusting or replacing the connecting lanyard or by utilizing a different method of fall protection.

Account should be taken of any elongation of a lanyard or anchor line that could allow, for example, a fall over an edge.

On a flat or shallow pitch roof a lanyard or anchor line should not be used in a position, for example near a gable, in which it might be relied upon to perform a fall arrest function, (see Figure 6a), or might allow the user to fall to the ground (see Figure 6b). In such a situation an alternative method of fall protection should be used.

NOTE 3 In Figure 6a, Positions A, B and C are appropriate applications of restraint systems, as the user is prevented from reaching the gutter. Position D, unless a “stop” is fitted to the horizontal anchor line, would allow a fall at the gable.

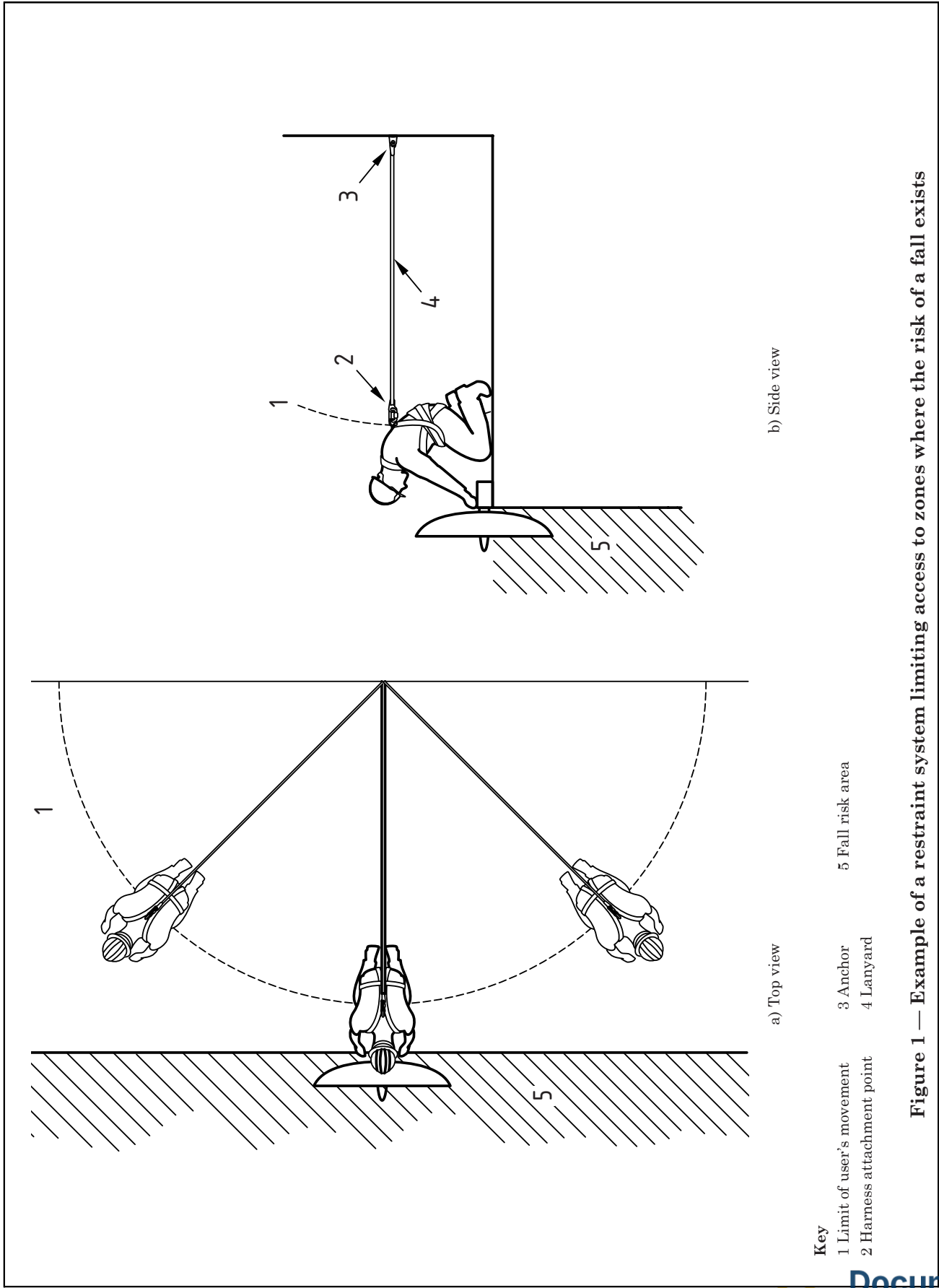
NOTE 4 In Figure 6b, the length of the lanyard would allow a fall to the ground.

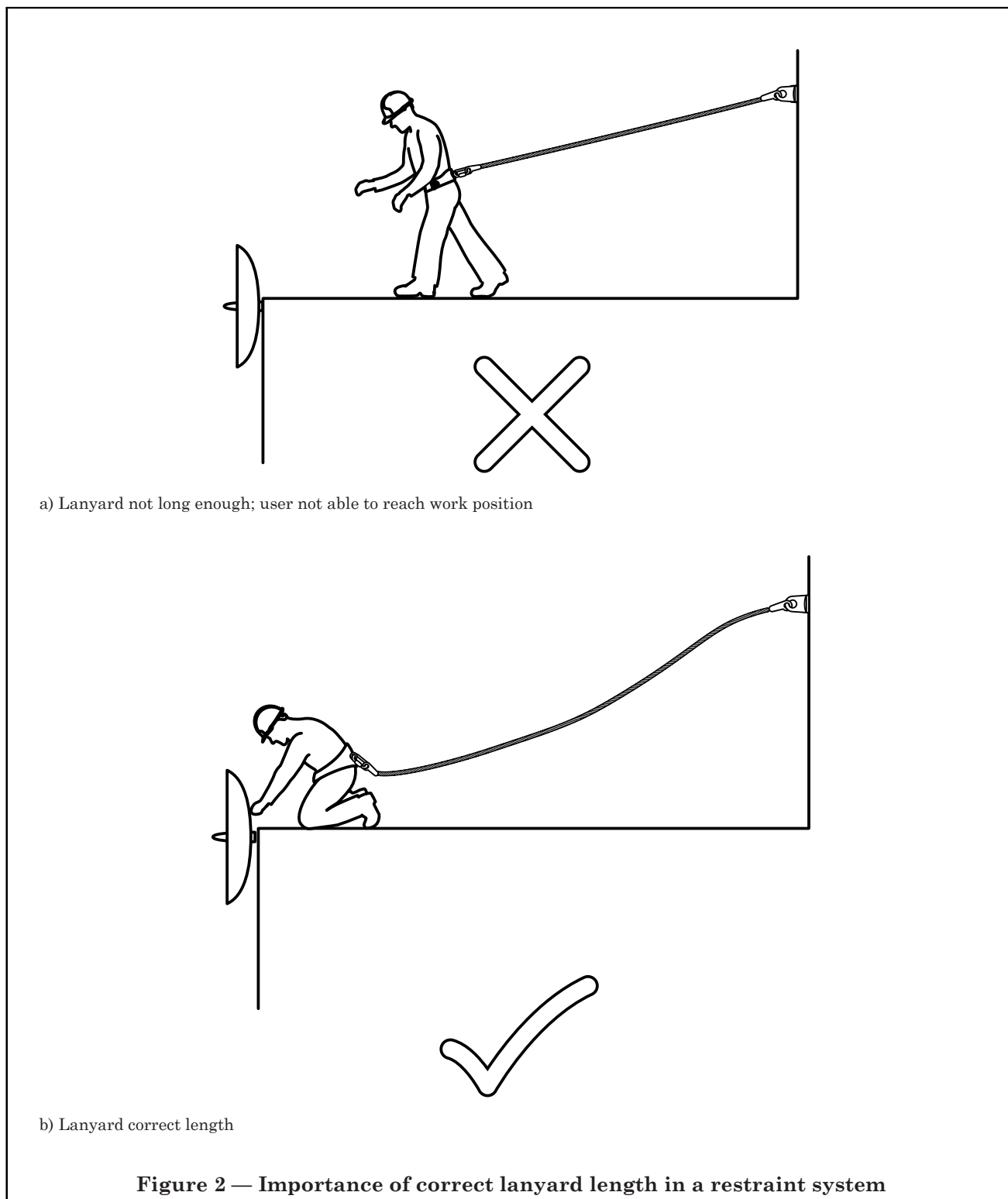
On a roof with a horizontal anchor line along its ridge, safe access to the gable can be arranged by using additional fixed single-point anchors. This requires the user to carry and use an additional fixed length lanyard, which should be connected to the additional anchor before the user disconnects the first lanyard from the horizontal anchor line. Thorough user training (see Clause 15) and a detailed safety method statement (see Clause 6) are essential if such a system is to be used. Advice on other ways of extending the accessible area is given in the new edition of BS 7883¹⁾.

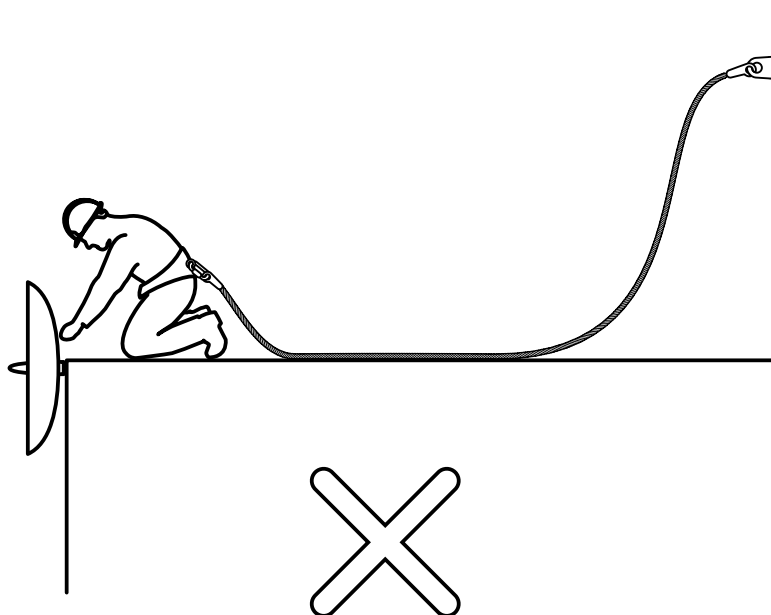
Some restraint systems incorporate a manually adjustable lanyard or anchor line fitted with a lever by which the user can vary the limit of travel. Extreme care should be taken when using such a system to ensure that the user does not adjust the lanyard or anchor line such that he or she could reach a position from which a fall from a height could occur.

^{A1} Where a horizontal anchor line is used, it should be positioned such that any deflection generated by the user(s), e.g. by pulling on it, does not allow a fall from a height to take place (see 16.4.1 and Figure 50). ^{A1}

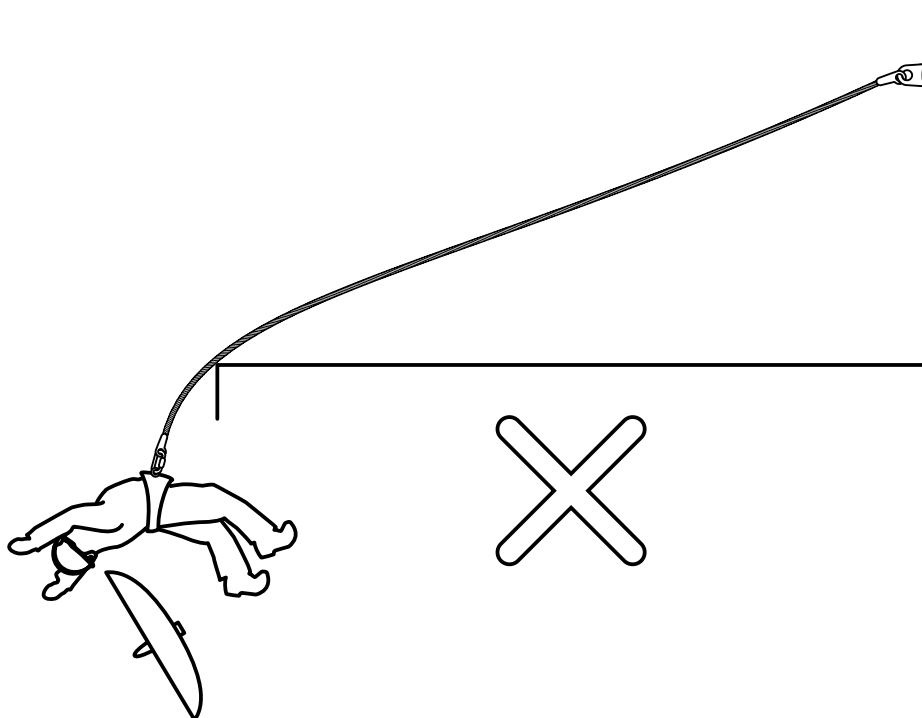
¹⁾ In preparation.





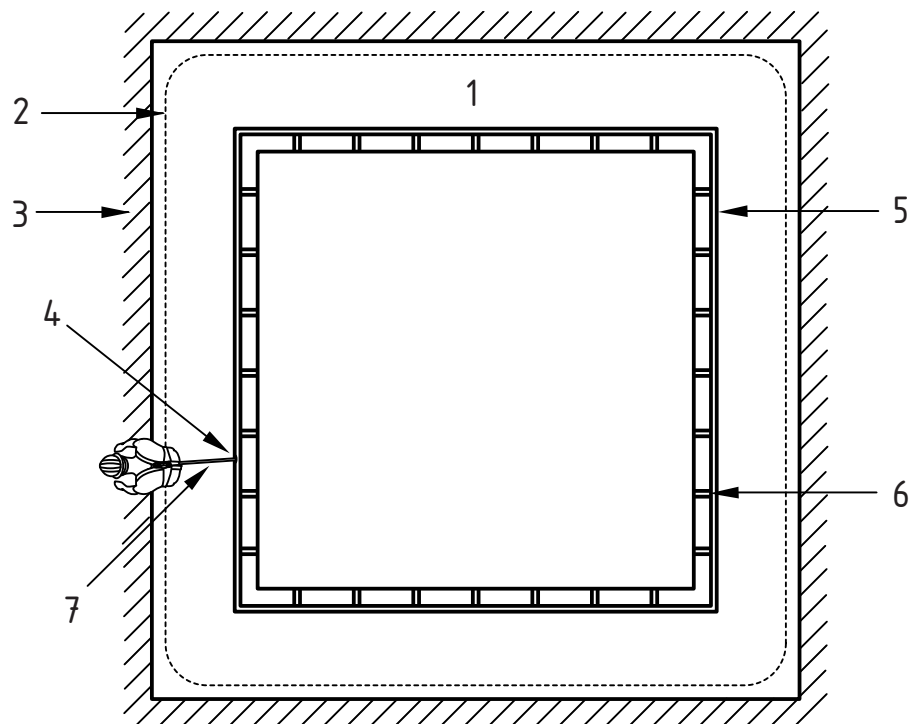


c) Lanyard too long; user at risk of a fall

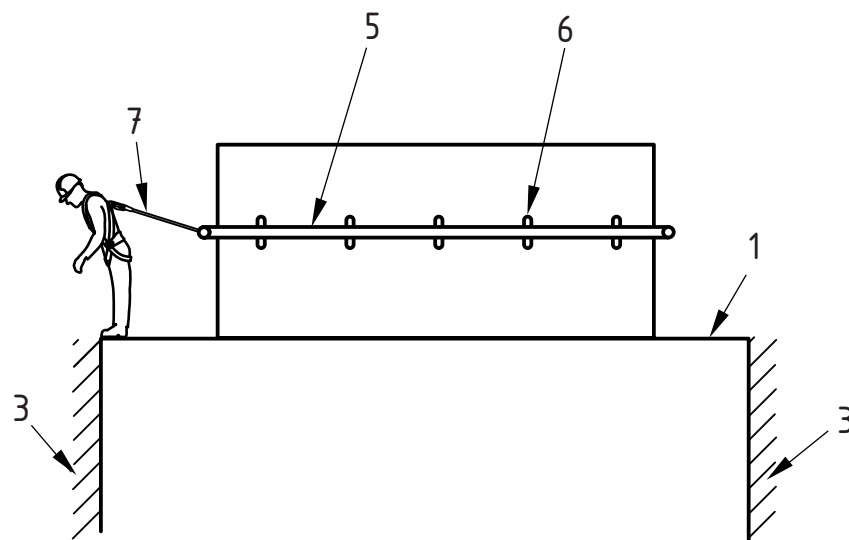


d) Lanyard too long; user falls over the edge

Figure 2 — Importance of correct lanyard length in a restraint system *(continued)*



a) Top view

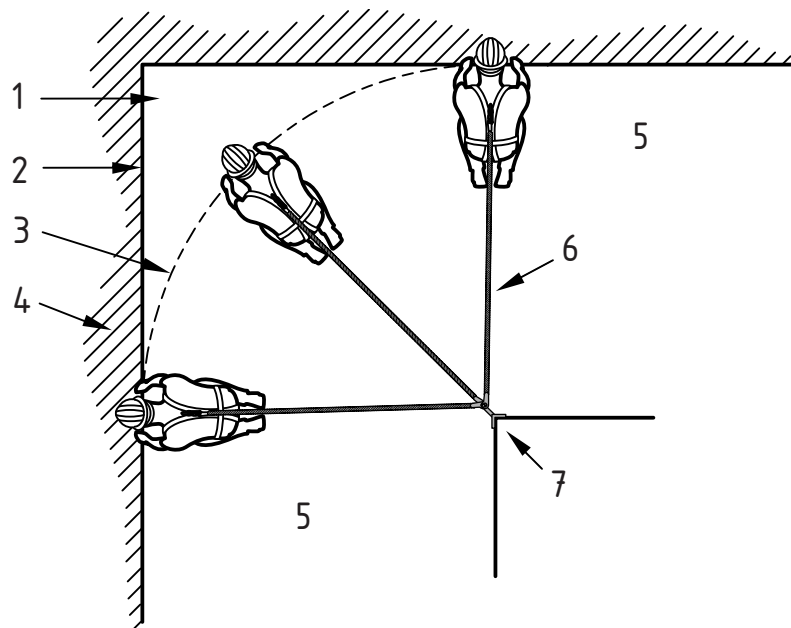


b) Side view

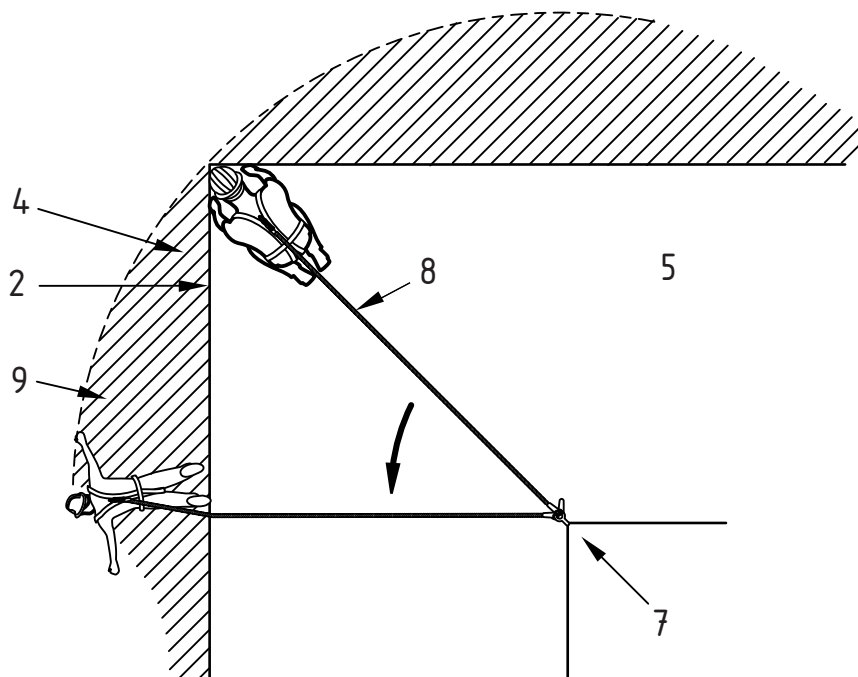
Key

- | | |
|----------------------------|-----------------------|
| 1 Walkway | 5 Anchor line |
| 2 Limit of user's movement | 6 Anchor line support |
| 3 Fall risk area | 7 Lanyard |
| 4 Traveller | |

Figure 3 — Example of a restraint system using a rigid horizontal anchor line



a) Restraint system prevents user from reaching the corner of the roof

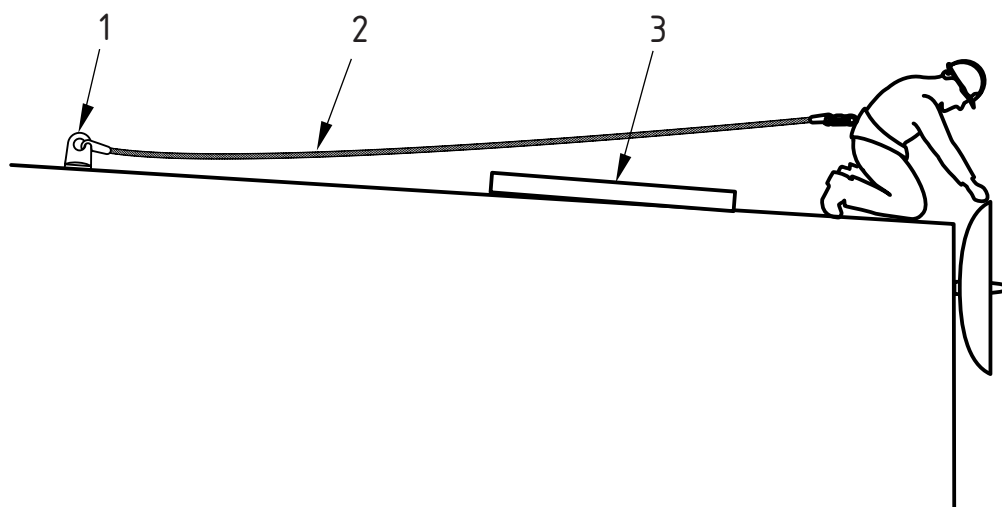


b) Increasing lanyard length permits user to access the corner but puts them at risk of a fall over an edge

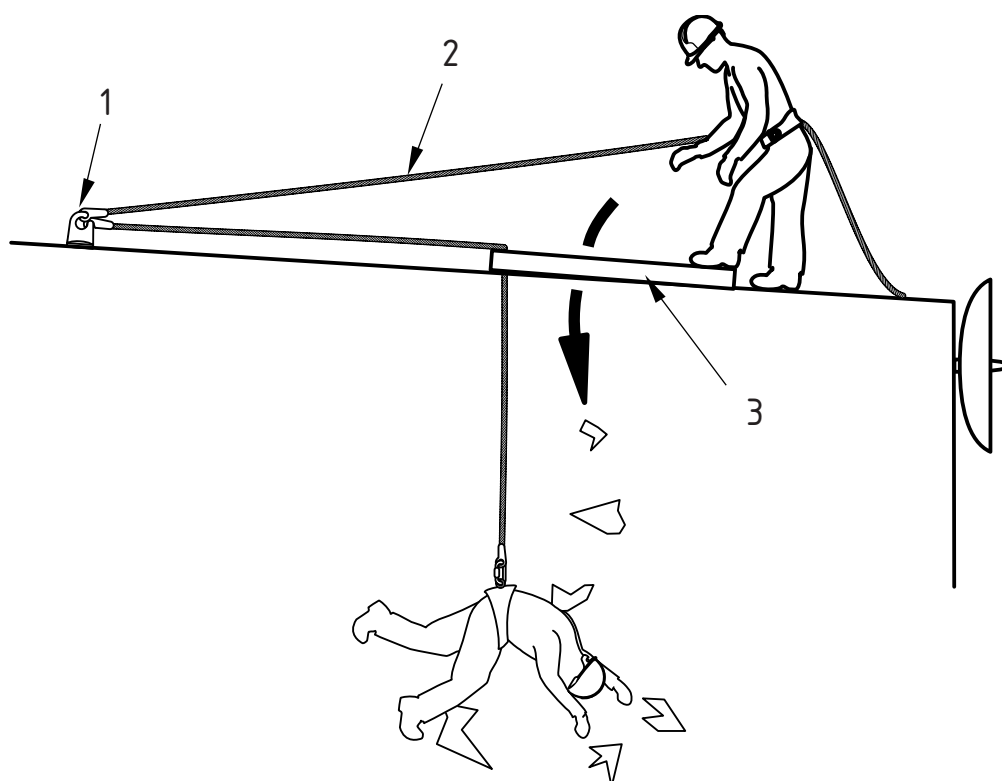
Key

- | | |
|--------------------------------|---|
| 1 Area that user cannot access | 6 Lanyard |
| 2 Edge of walkway | 7 Anchor |
| 3 Limit of user's movement | 8 Lanyard extended to enable user to reach corner |
| 4 Fall risk area | 9 Swing fall over edge possible |
| 5 Walkway | |

Figure 4 — Dangers of using a restraint system to access the corner of a flat roof



a) User prevented from reaching a zone from which there is the risk of a fall over an edge

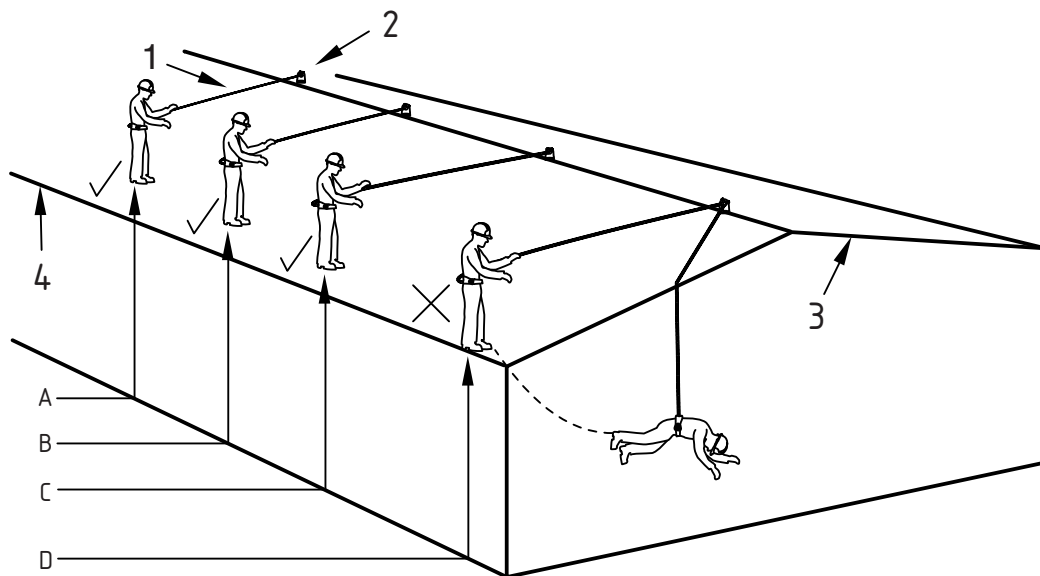


b) User at risk of a fall through an unprotected roof light

Key

- 1 Anchor
- 2 Lanyard
- 3 Roof light

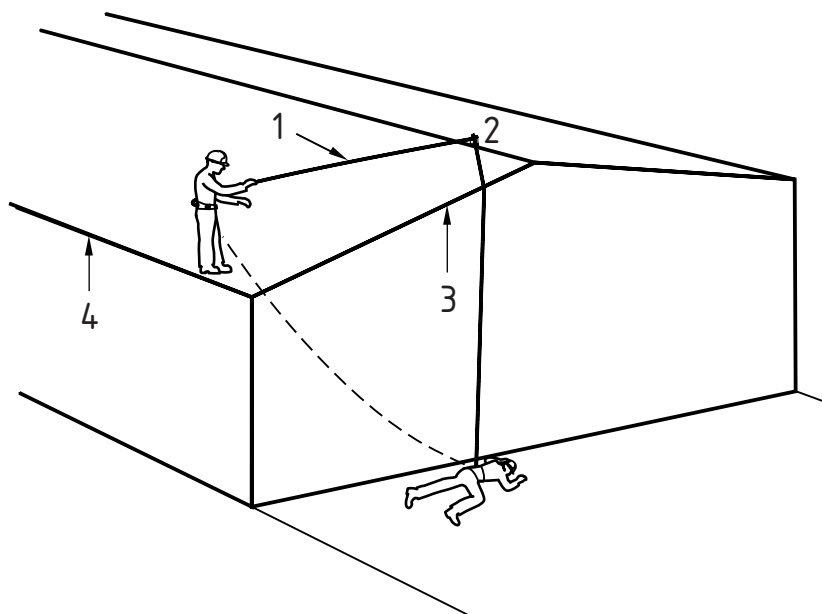
Figure 5 — Situation in which a restraint system should not be used because there is a risk of a fall through a fragile material



A, B, C Safe positions

D Position from which there is the risk of a fall arrest situation

a) Safe positions and position from which there is the risk of a fall arrest situation



b) Situation in which there is a risk of a fall to the ground

Key

- | | |
|-----------|---------------|
| 1 Lanyard | 3 Gable edge |
| 2 Anchor | 4 Gutter edge |

Figure 6 — Limitations and dangers of using a restraint system on a sloping roof

9 Fall arrest systems

9.1 General

9.1.1 *Basic characteristics of a fall arrest system*

A fall arrest system physically links the user to the workplace structure by a series of interconnected components which arrests the free fall of the user, should a fall take place, by applying an arresting force and decelerating the user through a short arrest distance.

When a fall arrest system is used, there are four phases to a fall as follows:

- initiation, i.e. the cause;
- the fall itself;
- fall arrest, i.e. termination of the fall;
- suspension, after the fall.

Injury can occur in the following phases:

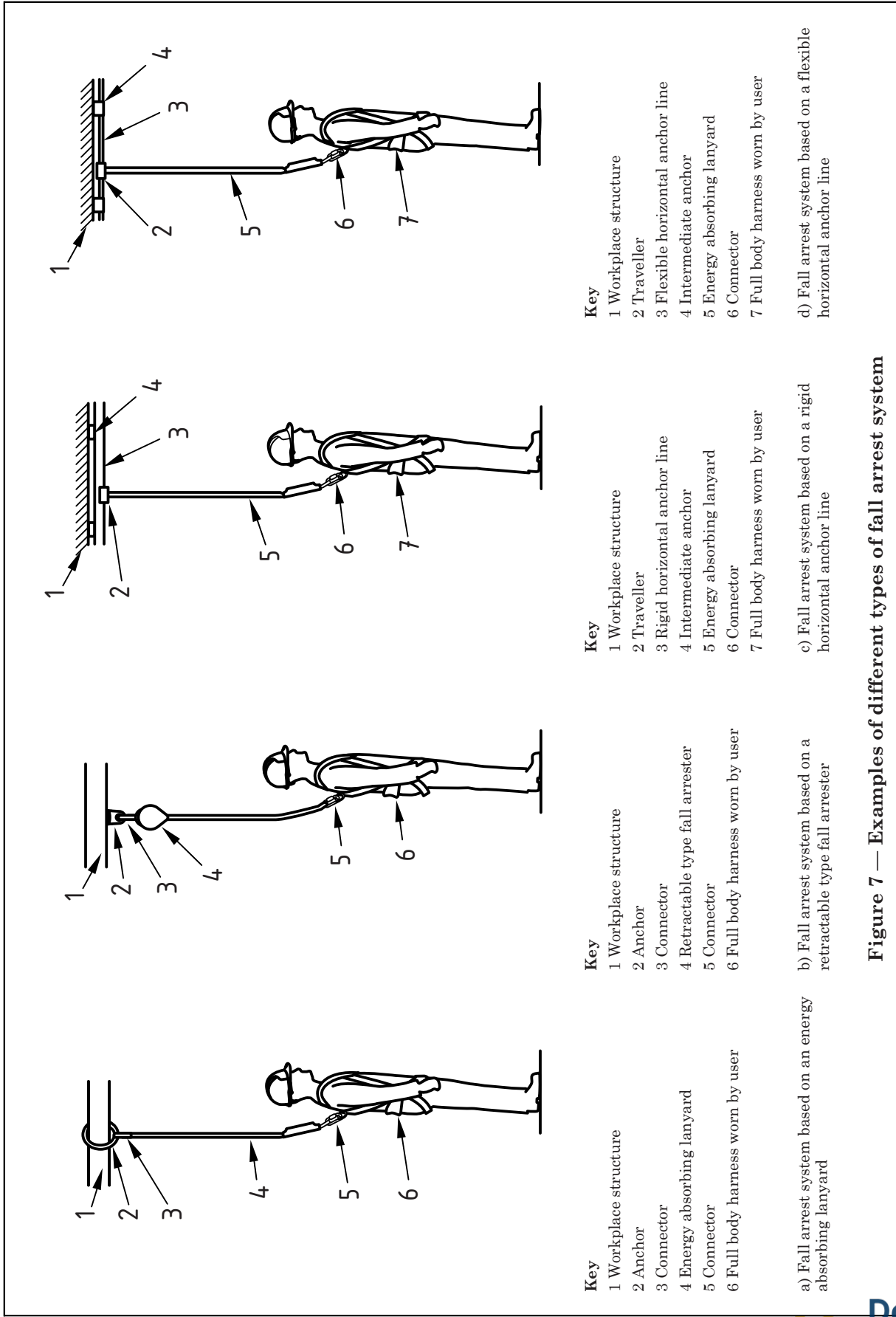
- during the fall itself, e.g. by impact with the structure;
- during fall arrest, e.g. by the violence of the impact as the fall is arrested;
- during the suspension phase, e.g. through suspension $\overline{A_1}$ intolerance $\overline{A_1}$ (see Clause 11 and Annex D).

It is essential to use a fall arrest system that is suitable for the particular work situation in order to minimize the risk of such injuries should a fall occur.

There are four main types of fall arrest systems, as follows (see Figure 7):

- systems based on one or more energy absorbing lanyards (see 9.2);
- systems based on a retractable type fall arrester (see 9.3);
- systems based on vertical anchor line and a guided type fall arrester, which includes systems with a rigid anchor line and systems with a flexible anchor line (see 9.4);
- systems based on a horizontal anchor line with one or more travellers (see 9.5).

NOTE BS EN 363 includes detailed examples of the first three types.



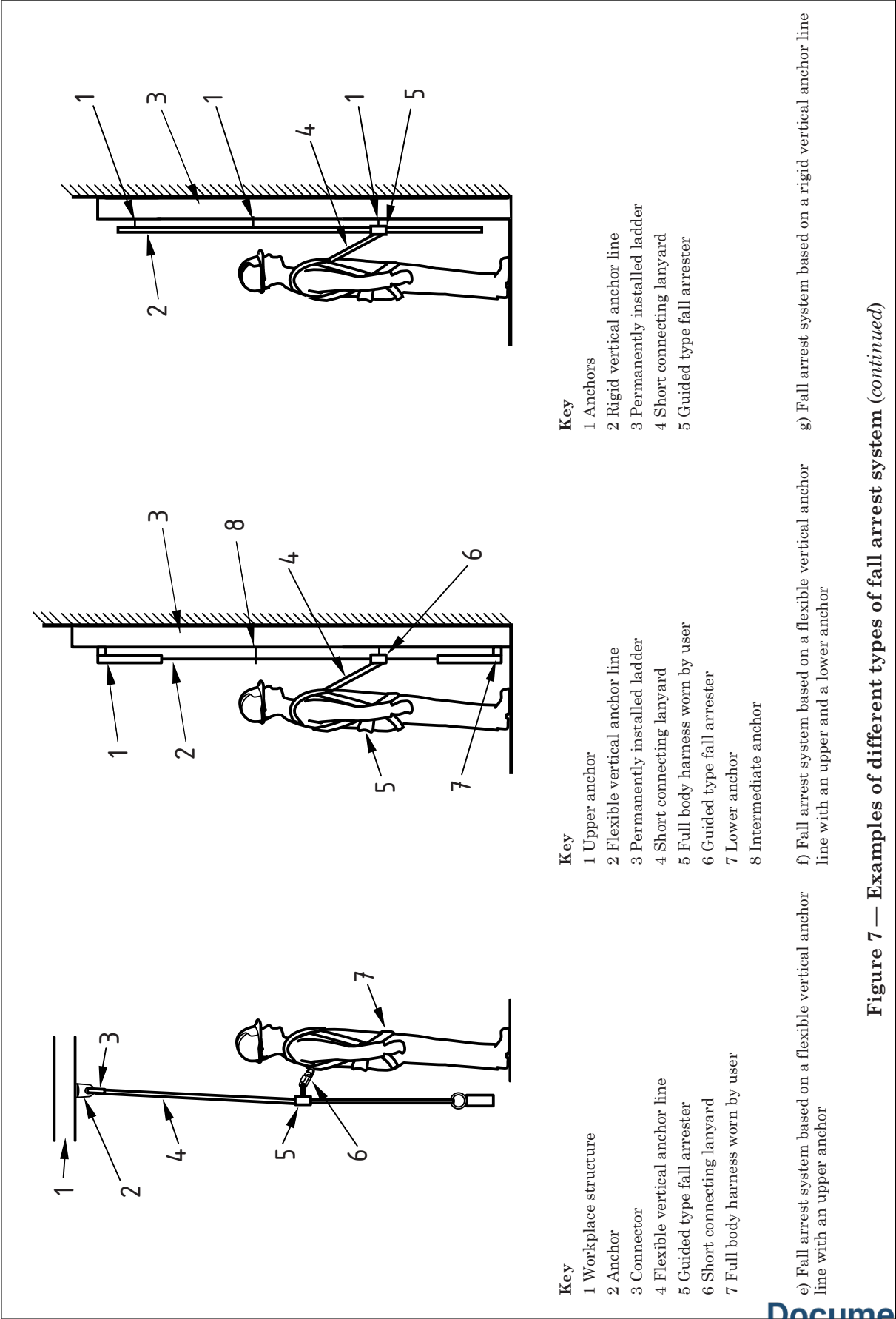


Figure 7 — Examples of different types of fall arrest system (continued)

9.1.2 *Full body harnesses for fall arrest systems*

9.1.2.1 *General*

A full body harness should always be used in a fall arrest system. Under no circumstances should a waist belt or a chest harness be used on its own for fall arrest purposes. A full body harness conforming to BS EN 361 should be used. (See also 12.6.1.)

9.1.2.2 *Use of full body harness attachment points*

Full body harnesses are equipped with one or more designated fall arrest attachment points for connecting the full body harness to the energy absorbing lanyard or retractable type fall arrester. It is essential that only the attachment points designated by the manufacturer for fall arrest purposes are used. Some full body harnesses are also fitted with side waist attachment points for work positioning. These side waist attachment points should not under any circumstances be used as attachment points for fall arrest purposes.

The designated fall arrest attachment points are as follows:

- a rear (dorsal) attachment point, which is arranged to lie centrally between the shoulder blades when the full body harness is worn;
- a front (sternal) attachment point, which is arranged to lie centrally at the bottom of the breastbone when the full body harness is worn.

The advantages and disadvantages of using each of these two attachment points are given in Annex E.

In the case of a full body harness for use with a retractable type fall arrester, where a rear attachment point on the harness is used, a short extension lanyard should be used (see Note). Where this is integral with the harness, the manufacturer can be expected to have tested the strength of this configuration. In the case of a harness without an integral extension lanyard a short detachable lanyard conforming to BS EN 354 should be used (see Figure 8).

NOTE It is difficult to reach behind the back to attach the swivel hook of the retractable type fall arrester to the rear attachment point on the full body harness. By attaching a short extension lanyard to this point before donning the harness, the free end of the lanyard becomes an extended attachment point, to which it is relatively easy to connect.

9.1.2.3 *Donning a full body harness*

A full body harness should be donned and correctly adjusted in accordance with manufacturers' instructions. It is important to check that the connections at the anchor point and at the attachment point on the full body harness have been made correctly. This involves checking that the gate mechanism of the connector is fully closed and locked and the connector is aligned properly within the anchor and attachment point. The purpose of these precautions is to avoid inadvertent disengagement of the connector during work (referred to as "roll-out"). For more details on connectors see 12.5.

9.1.3 *Lanyards for fall arrest systems*

9.1.3.1 *General*

WARNING. A lanyard should never be used on its own for fall arrest purposes without any means of energy absorption in the fall arrest system.

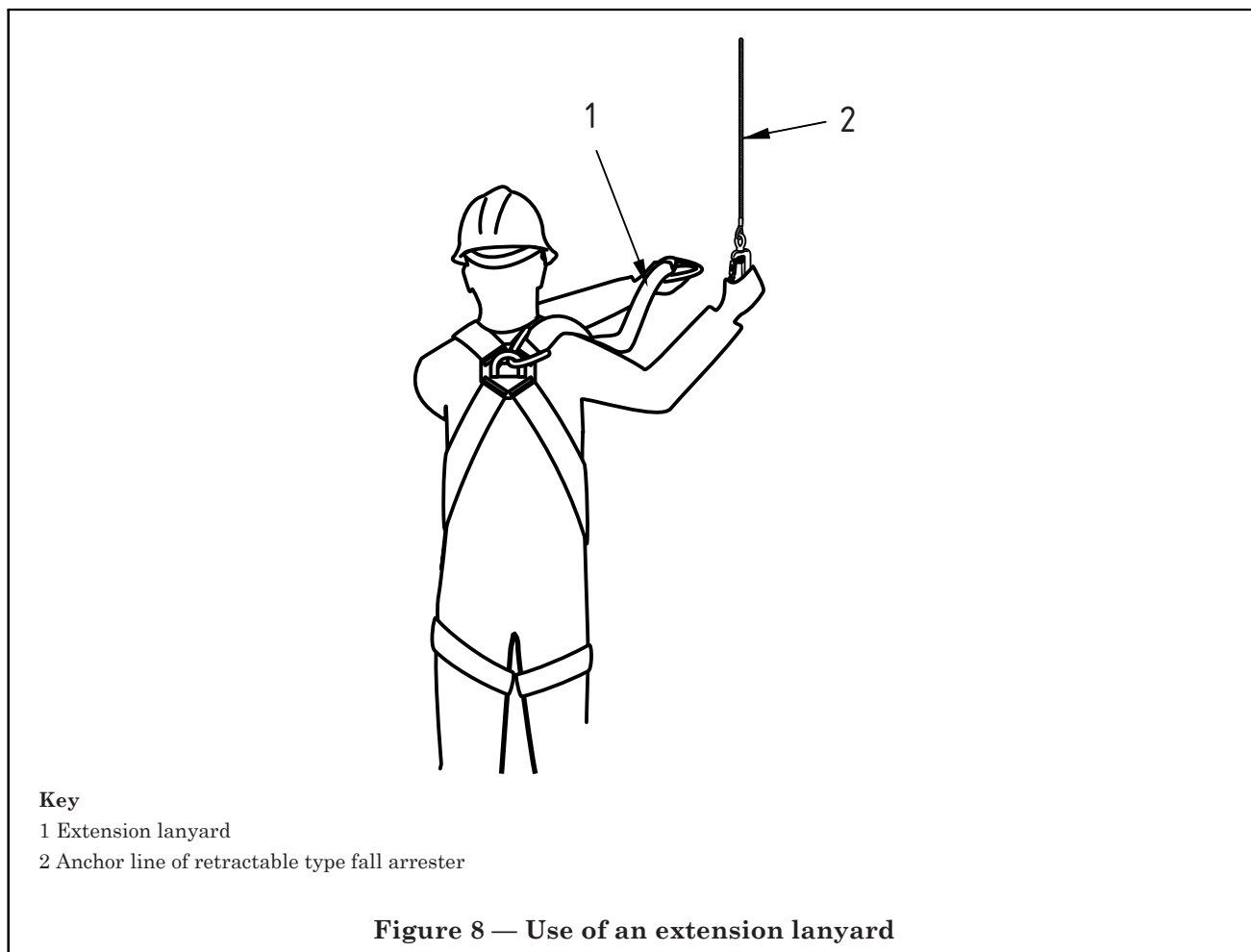
BS EN 363 specifies that a full body harness and a lanyard without an energy absorber shall not be used as a fall arrest system.

BS EN 354, which specifies requirements for lanyards for use in fall arrest systems specified in BS EN 363, requires that lanyards do not exceed 2 m in length, including the energy absorber, if applicable, and the connectors. Shorter lanyards should be used where possible, to minimize the free fall distance (see 9.7) and swing fall problems (see 9.5.7.2).

NOTE 1 BS EN 363 indicates that a retractable lanyard, which comprises the connecting element in a retractable type fall arrester, may be more than 2 m long.

NOTE 2 The free fall distance is that distance through which the user would fall before the fall arrest system begins to arrest the fall, measured from the user's position prior to the fall.

NOTE 3 A swing (or "pendulum") fall is a fall in which at the point of fall arrest the vertical trajectory of the user is diverted into a swing or pendular trajectory with significant horizontal velocity.



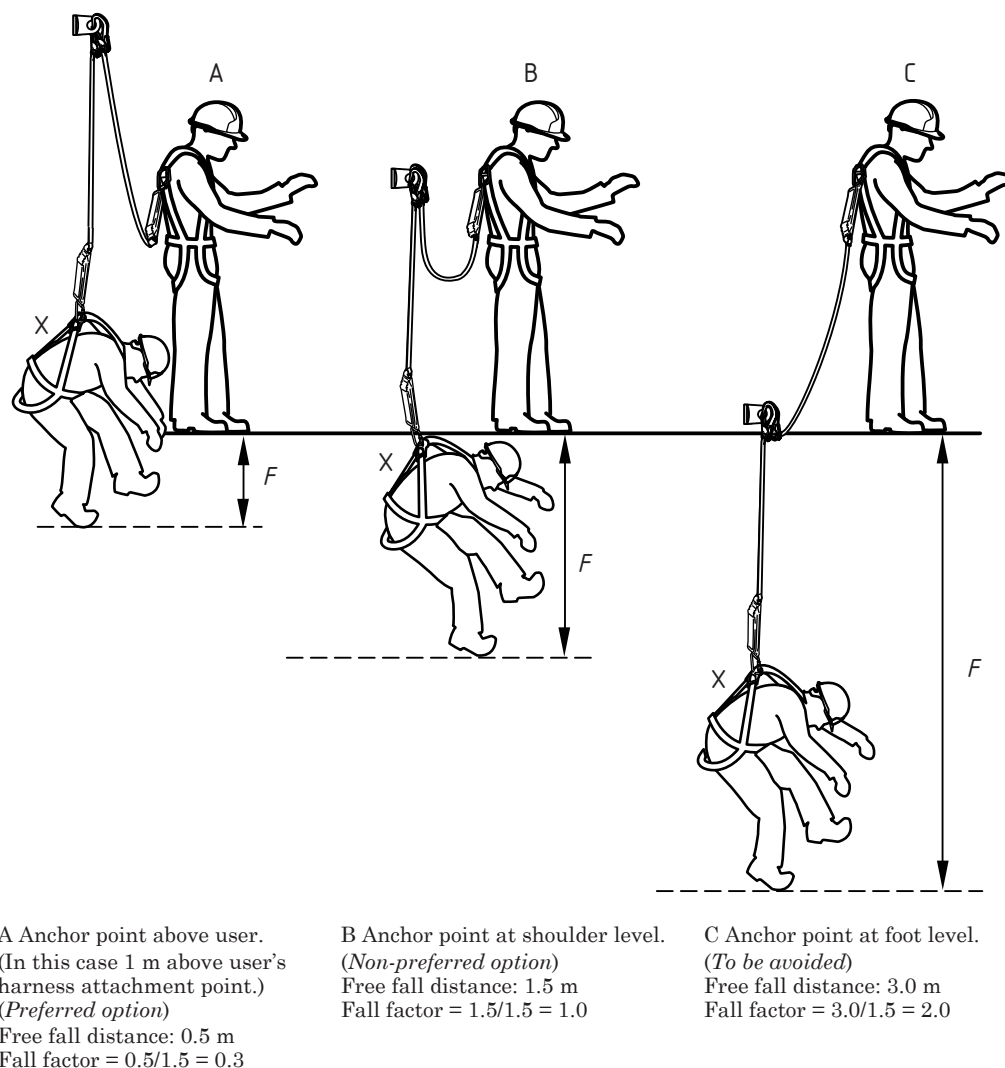
The position of the user's attachment point to the personal fall protection system in relation to the anchor point is of particular importance. This determines the "fall factor", which provides an indication of the length and severity of a potential fall.

This is illustrated in Figure 9, which shows three fall arrest situations. In each case the fall arrest system is based on a 1.5 m long energy absorbing lanyard and a distance between the attachment point on the user's harness and the user's feet of 1.5 m. The free fall distance is the vertical distance between the position of the user's feet immediately prior to the fall and the position of the user's feet at the point at which the lanyard has become taut and started to arrest the fall (distance F in Figure 9).

The fall factor is calculated by taking the free fall distance and dividing it by the length of lanyard available to arrest it (in this case the length of the energy absorbing lanyard prior to deployment of the energy absorber). In a normal work situation the maximum fall factor is 2. The fall factor should be kept as small as possible, i.e. the length of any potential fall should be minimized, for example by choosing an anchor point above the user, and the length of the lanyard should be kept as short as possible. As illustrated in Figure 9, an anchor point above the user gives the smallest fall factor, so is the safest, and is the preferred option; an anchor point at shoulder level gives a larger fall factor and should only be used as a second choice; an anchor point at foot level gives the maximum fall factor and should be avoided if possible (see also 16.6.1).

In situations where the user is likely to need to turn round repeatedly under the anchor point, a lanyard incorporating a swivel fitting should be used to avoid the lanyard twisting, untwisting, hockling or birdcaging.

Knots should not be used to make a termination in a lanyard that is already supplied with terminations, or to shorten its length.



NOTE 1 The lower human figure in each drawing indicates the position of the user at the end of the free fall, i.e. the point at which the energy absorber begins to deploy. This should not be confused with the position the user would be in at the end of the arrest of the fall.

NOTE 2 The drawings are not strictly to scale.

Key

F Free fall distance

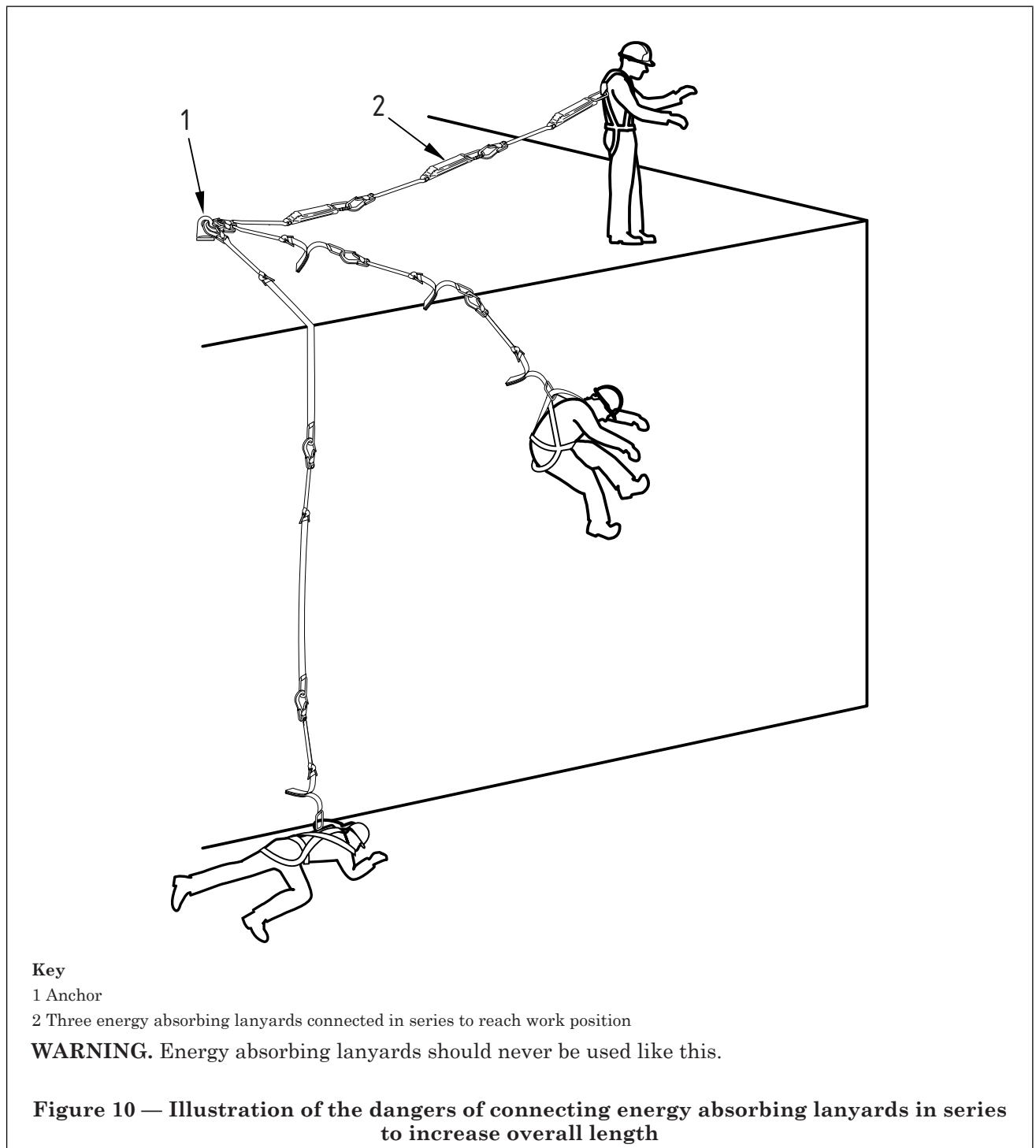
Figure 9 — Illustration of free fall distances and the calculation of fall factors

9.1.3.2 Energy absorbing lanyards

It is essential that an energy absorbing lanyard provides efficient energy absorption, i.e. the lanyard selected should be one that provides the lowest possible arrest force over the smallest possible arrest distance. Lanyards with tear-web type energy absorbers tend to have a smooth arrest force characteristic but since the energy is absorbed over a longitudinal tear in a strip of material the arrest distance is equal to twice the length of the tear. Lanyards with other types of energy absorbers tend to give smaller arrest distances but might not have such a smooth arrest force characteristic as those with the tear-web types. (See 12.8.)

Energy absorbing lanyards should not be connected together in series to increase overall length, because on arrest of a fall the increased free fall distance could lead to the user being subjected to excessive arrest forces or could allow them to hit the ground (see Figure 10). If the work position cannot be reached when a single energy absorbing lanyard is connected to the anchor point, then an anchor point nearer the work position should be utilized.

An energy absorbing lanyard should not be connected in series with another fall arrest device, e.g. a retractable type fall arrester, because on arrest of a fall the increased free fall distance could produce excessive forces on the device and cause failure, or could allow the user to hit the ground.



9.2 Fall arrest systems based on one or more energy absorbing lanyards

9.2.1 Systems based on a single energy absorbing lanyard

Fall arrest systems based on a single energy absorbing lanyard, as illustrated in Figure 11, are the most basic type. They can be used alone or as part of a more complex system, for example a system based on a vertical or a horizontal anchor line (see 9.4 and 9.5).

A fall arrest system based on a single energy absorbing lanyard is temporary and mobile and is suitable as a back-up fall protection system for use with a work positioning system (see 10.2). These systems can also be connected directly to the structure, eliminating the need for anchor points, which is useful in tower work (see 10.2.2.1).

An energy absorbing lanyard comprises a lanyard terminated at one end with a connector for attachment either to an anchor point or directly to a structure. At the other end is an energy absorber, either integral with the lanyard or attached to it by means of a connector. The energy absorber is fitted with a connector for attachment to the user's harness. An example of an energy absorbing lanyard is shown in Figure 12a.

The energy absorbing lanyard remains unloaded during normal work at height. In the event of a fall, the sharp downward pull on the lanyard operates the energy absorber, which absorbs the energy generated by the fall, thus decelerating the user and bringing them to a stop within a short distance (see Figure 13). The user then remains suspended by the lanyard to await rescue.

For details of energy absorbers, see 12.8.

When using a single energy absorbing lanyard, the user's range of movement is limited by the length of the lanyard, i.e. the limit of the range of movement is the point at which the lanyard becomes taut (see Figure 14a). To move beyond this point the user would need to disconnect the lanyard (see Figure 14b), move to the new position and then reconnect the lanyard (see Figure 14c). No fall protection would be provided during the period between disconnection and reconnection of the lanyard. Working in this way is not recommended.

9.2.2 Systems based on two energy absorbing lanyards

In situations where the user requires a range of movement greater than the lanyard length, for example when ascending, descending or traversing a structure, use of a fall arrest system based on two energy absorbing lanyards is necessary to enable the user to move safely, as shown in Figure 15.

The two lanyards are used in relay, being disconnected and reconnected in turn as the user proceeds so that at all times during the movement there is a connection between the user and the structure. The user is initially connected to the structure by the first lanyard. When the user reaches the point at which this lanyard is fully extended (see Figure 15, view A), the second lanyard is connected to the next anchor point on the user's route (see Figure 15, view B). The first lanyard is then disconnected to allow the user to move on (see Figure 15, view C). This procedure is repeated until the route has been safely negotiated (see Figure 15, view D).

These systems have the disadvantage that they can be slow and laborious to use. Also, carrying out repeated connection and disconnection can result in the user suffering musculo-skeletal problems.

Systems based on a vertical or a horizontal anchor line are more efficient (see 9.4 and 9.5).

9.2.3 Systems based on a twin-tailed energy absorbing lanyard

 NOTE 1 Twin-tailed energy absorbing lanyards are specified in BS 8513. 

NOTE 2 This type of lanyard is sometimes referred to as a "Y-shaped" energy absorbing lanyard.

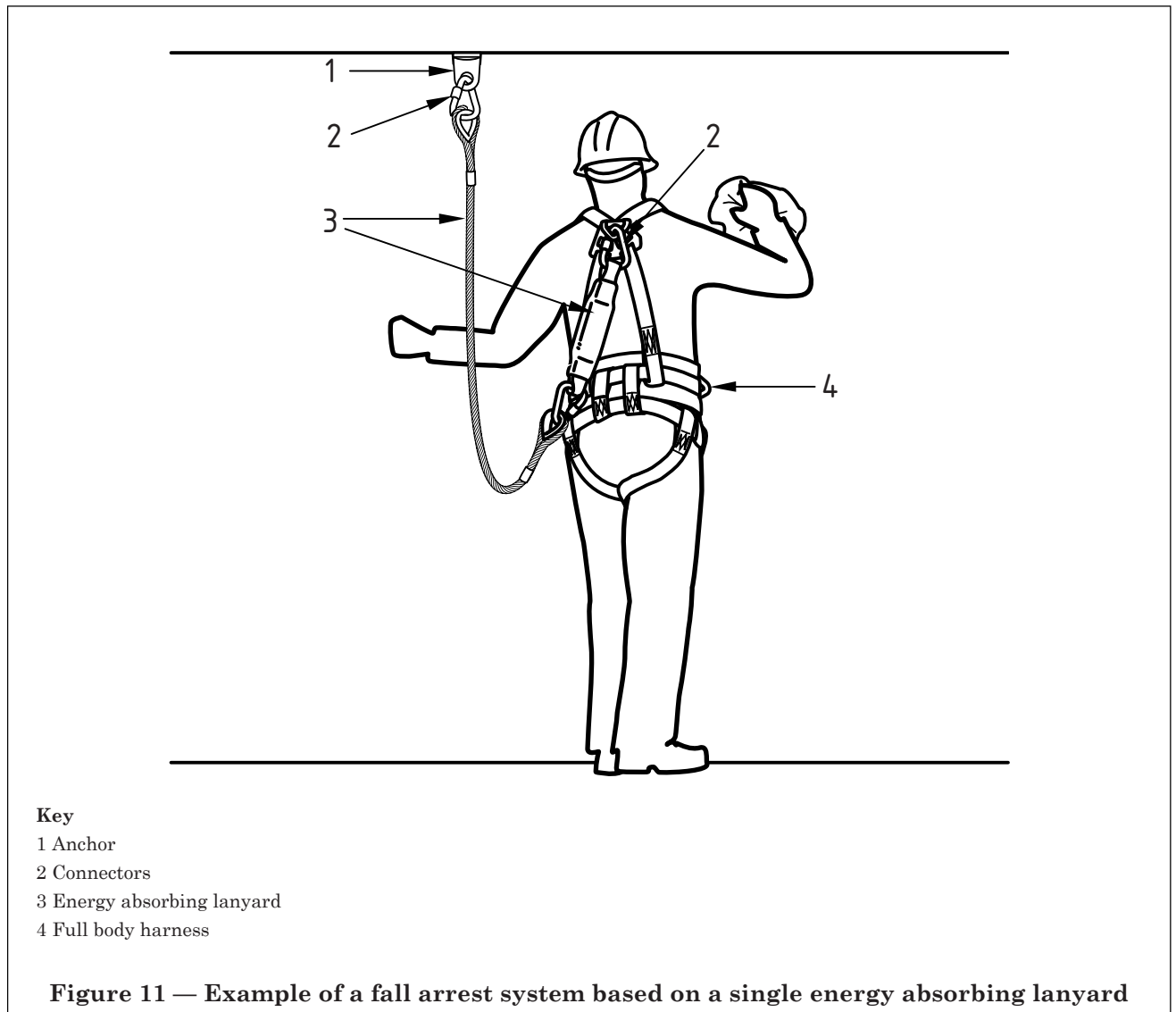
To make climbing with two lanyards more efficient, a system can be used which incorporates two lanyards combined with a single energy absorber, to save weight and thus improve climbing ergonomics (see Figure 16).

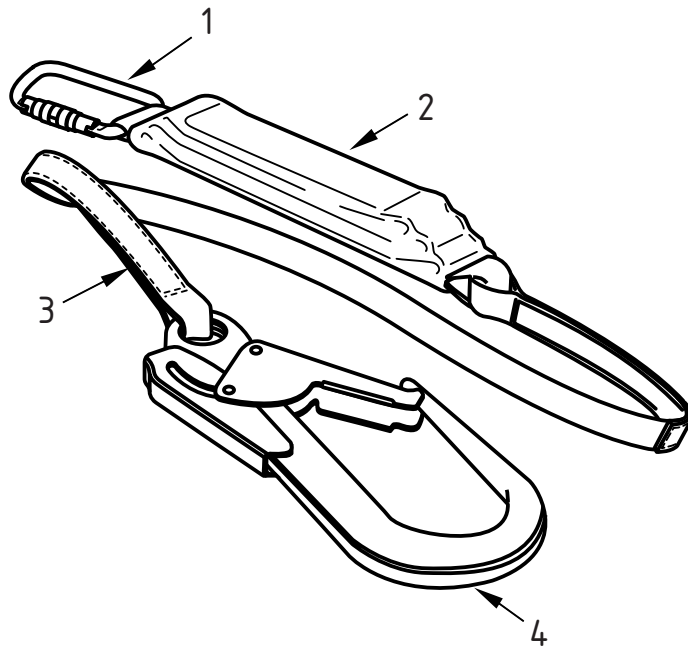
A twin-tailed energy absorbing lanyard comprises two lanyards each terminated at one end with a connector for attachment either to an anchor point or directly to a structure. The other end of each lanyard is attached to a single energy absorber in such a way that either lanyard can transmit a load to the energy absorber. The energy absorber is fitted with a connector for attachment to the user's harness. An example of a twin-tailed energy absorbing lanyard is shown in Figure 12b).

The two lanyards are used in relay as described in 9.2.2.

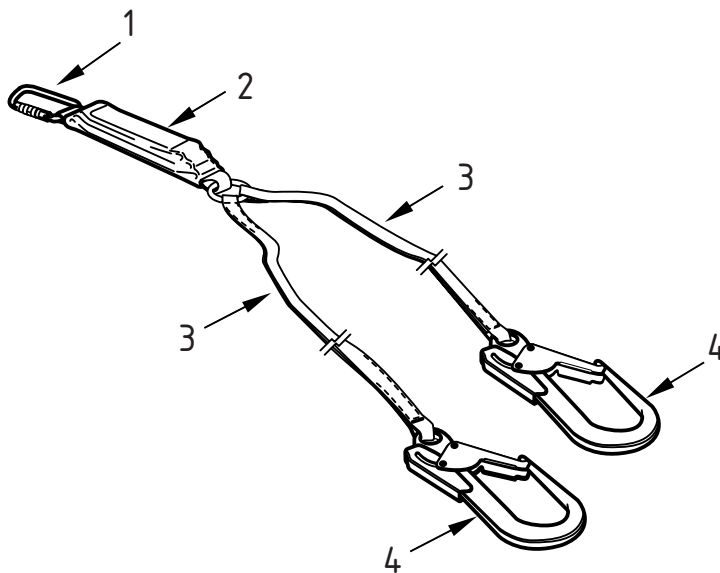
When only one of the lanyards is connected to the anchor point, the second lanyard should be left to hang free, or should also be connected to the anchor point. The second lanyard should not be attached to the user's harness or to their belt or clothing ^{A1} unless there is a specially designed parking point for this purpose, designed to separate from the harness, belt or clothing, ^{A1} as this could limit the extension of the energy absorber in the event of a fall, which would cause excessive arrest forces to be applied to the user and to the fall arrest system. This is particularly important when the lanyards used are relatively

These systems have similar disadvantages to those described in 9.2.2.





a) Single energy absorbing lanyard



b) Twin tailed energy absorbing lanyard

Key

- 1 Connector for attachment to user's harness
- 2 Energy absorber
- 3 Lanyard
- 4 Connector for attachment to anchor

Figure 12 — Examples of energy absorbing lanyards

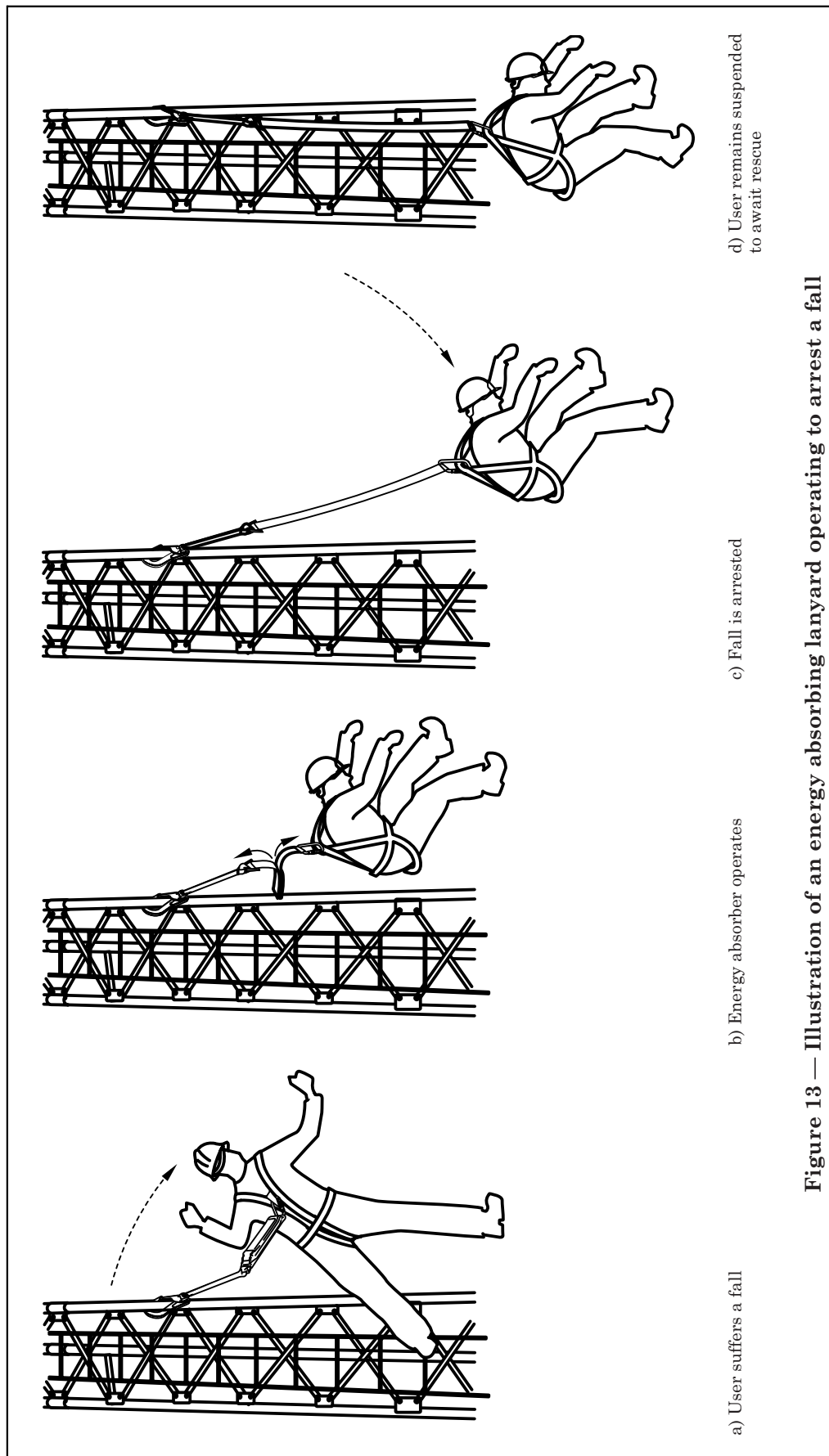
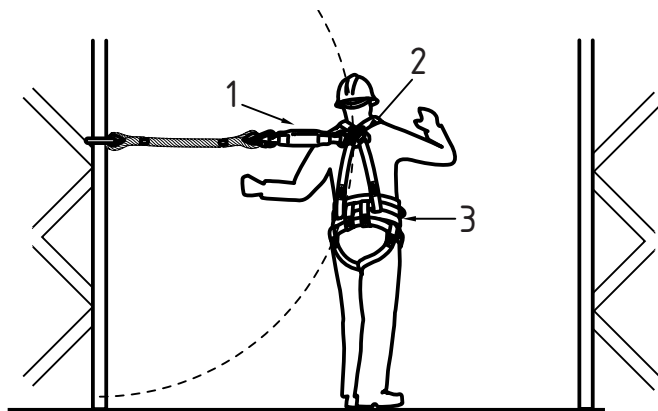
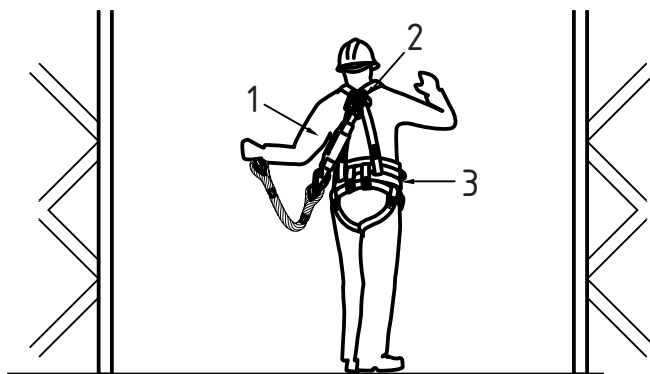


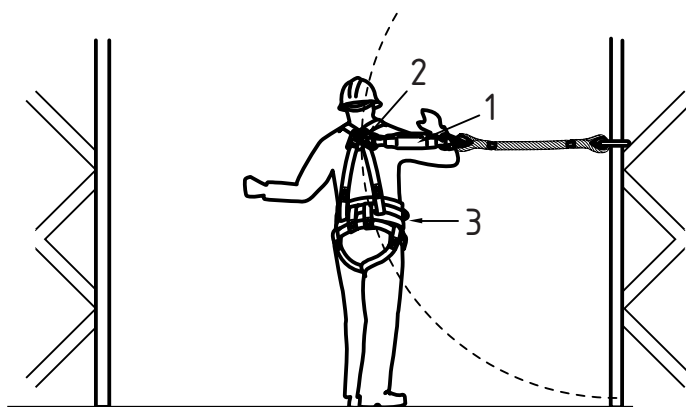
Figure 13 — Illustration of an energy absorbing lanyard operating to arrest a fall



a) User reaches position at full extent of lanyard



b) User disconnects lanyard and moves to new work position. During this period the user is without fall protection

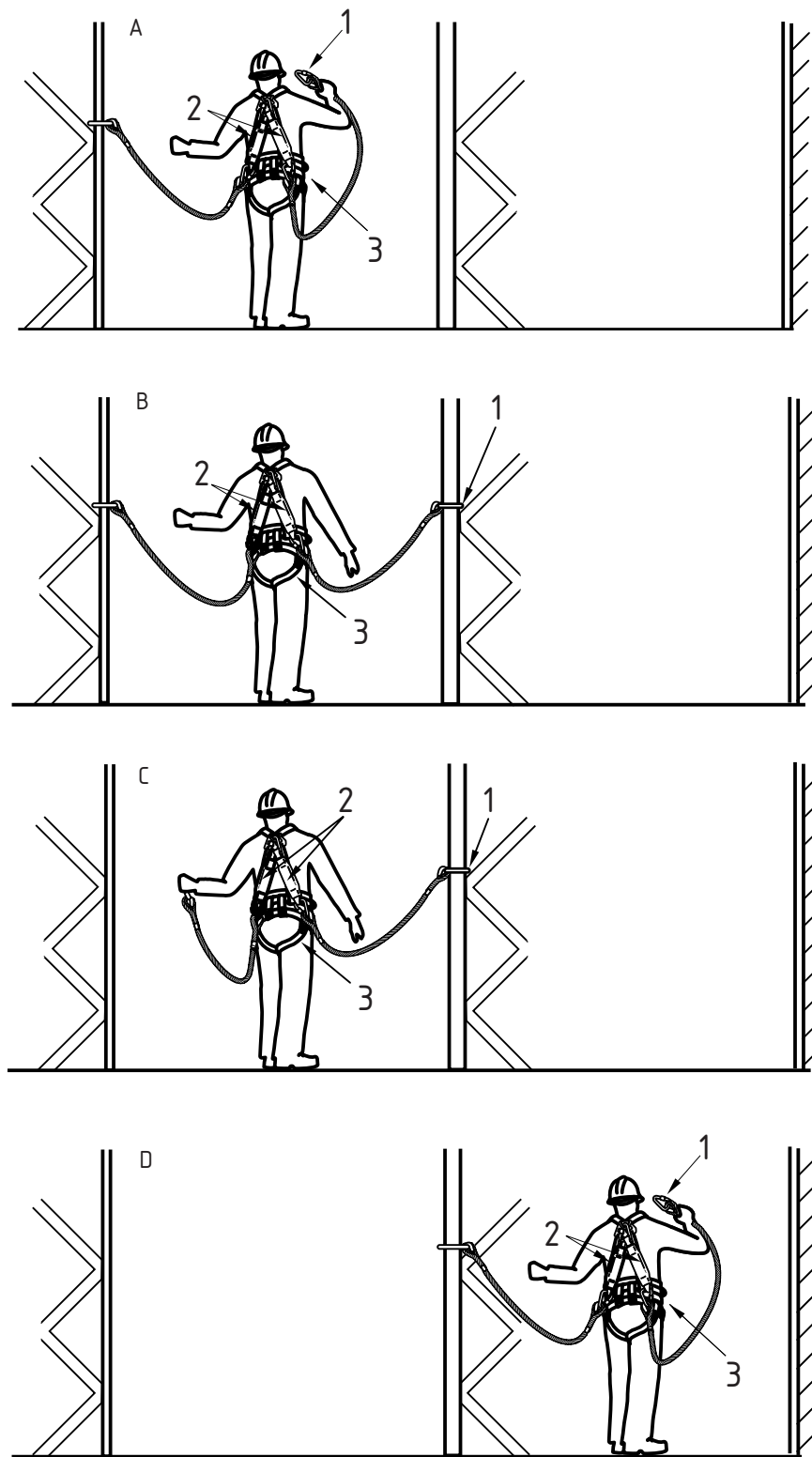


c) User reconnects lanyard in new position.

Key

- 1 Energy absorbing lanyard
- 2 Connector
- 3 Full body harness

Figure 14 — Limitations and dangers of using a single energy absorbing lanyard where a range of movement greater than lanyard length is required

**Key**

1 Connector 2 Energy absorbing lanyards 3 Full body harness

A, B, C and D Sequence of actions

Figure 15 — Ensuring continuous connection to the structure by using two energy absorbing lanyards in relay

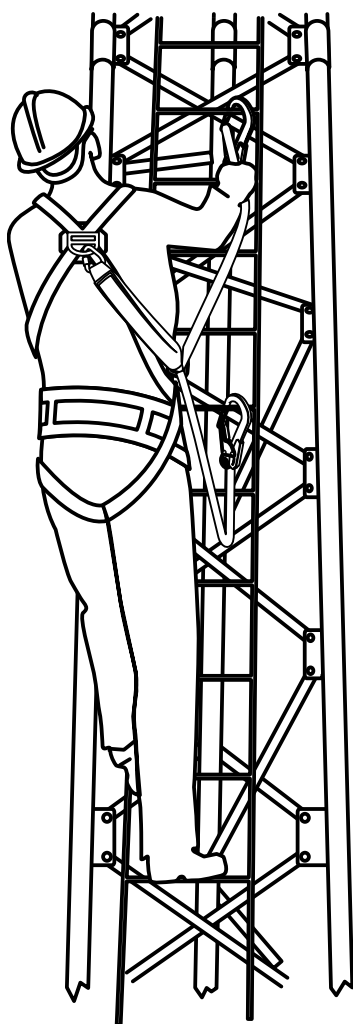


Figure 16 — Example of the use of a fall arrest system based on a twin-tailed energy absorbing lanyard while climbing

9.3 Fall arrest systems based on a retractable type fall arrester

9.3.1 General

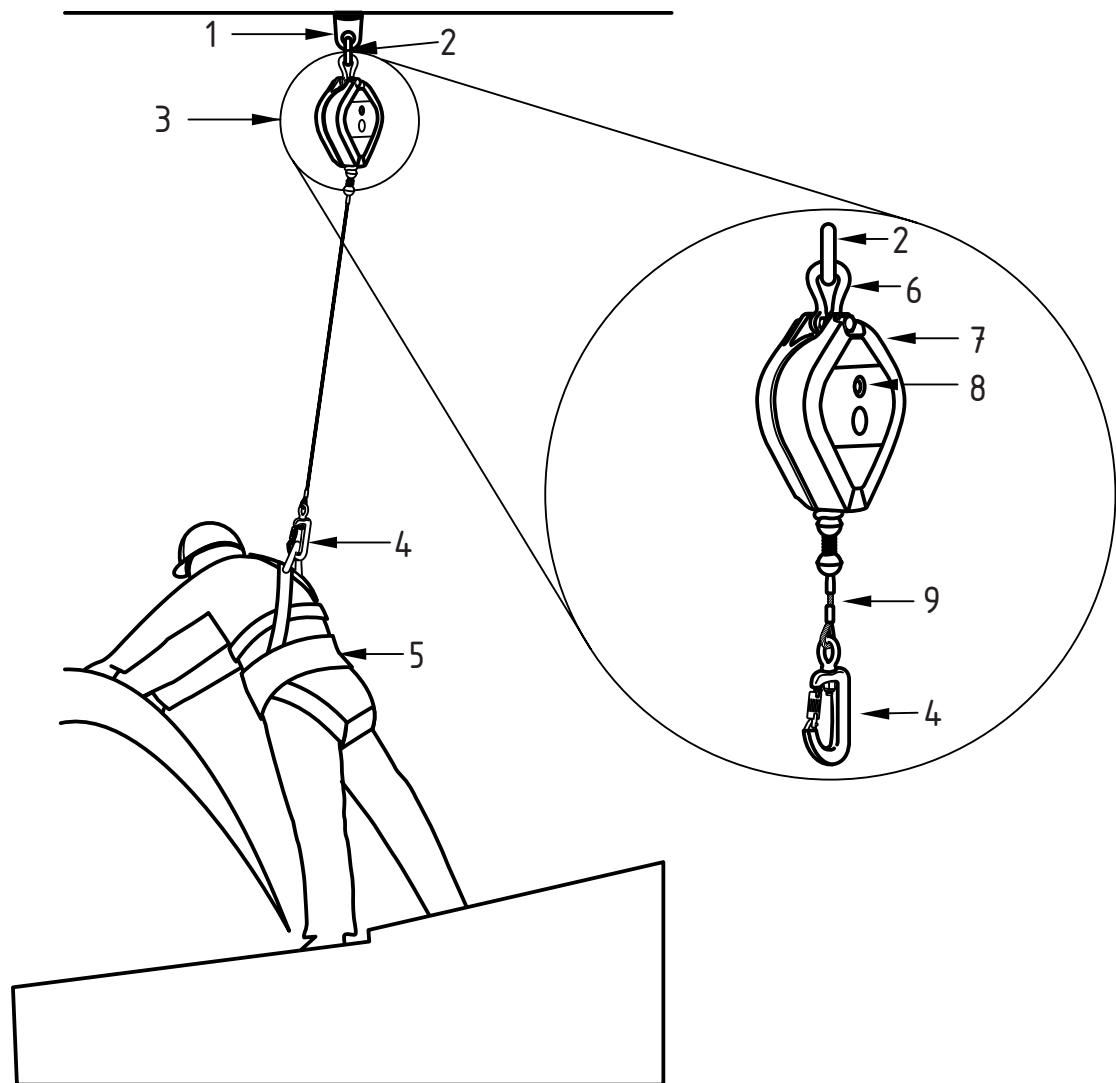
A fall arrest system based on a retractable type fall arrester (see Figure 17), provides a temporary and mobile means of fall arrest where no permanently installed fall arrest system is available.

NOTE Retractable type fall arresters are also known in the industry as “retractable lifelines”, “self-retracting lifelines”, “retractable lanyards”, “retractable arresters”, “inertia reels” and “fall arrest blocks”.

Most retractable type fall arresters are designed for use only where the anchor point is directly above the user (see 9.3.7.3).

Fall arrest systems based on a retractable type fall arrester have the following advantages over those based on energy absorbing lanyards (see 9.2).

- They have a retractable lanyard which is kept under a light tension thus preventing slack from occurring in use. This minimizes the potential free fall distance, and consequently reduces the fall arrest distance. Thus the free space requirement is smaller.
- They provide a greater range of movement in the vertical plane which is useful when the user is climbing up or down a structure.



Key

- | | |
|----------------------------------|-------------------------|
| 1 Anchor point | 6 Shackle |
| 2 Connector | 7 Housing |
| 3 Retractable type fall arrester | 8 Fall arrest indicator |
| 4 Swivel hook | 9 Retractable lanyard |
| 5 Full body harness | |

Figure 17 — Fall arrest system based on a retractable type fall arrester

They have the following disadvantages and limitations.

- Their use is limited by the maximum working length of the retractable lanyard. As the length is increased, the devices become heavier and more unwieldy. The alternative is to continually relocate the device as climbing proceeds.
- They can only be used in a broadly vertical plane, although the range of horizontal movement can be extended by utilizing a horizontal rail system (see 9.5).
- They are not usually suitable for use with flexible horizontal anchor lines.
- Their use is limited to situations where the anchor point is overhead.

Also, retractable type fall arresters have to be installed overhead before work commences. This may necessitate:

- climbing to the intended anchor point with the device whilst utilizing another form of fall protection (permanent or temporary);
- installing the device by a remote means and using a tag lead to extract the lanyard;
- using a mobile elevating work platform or a protected walkway.

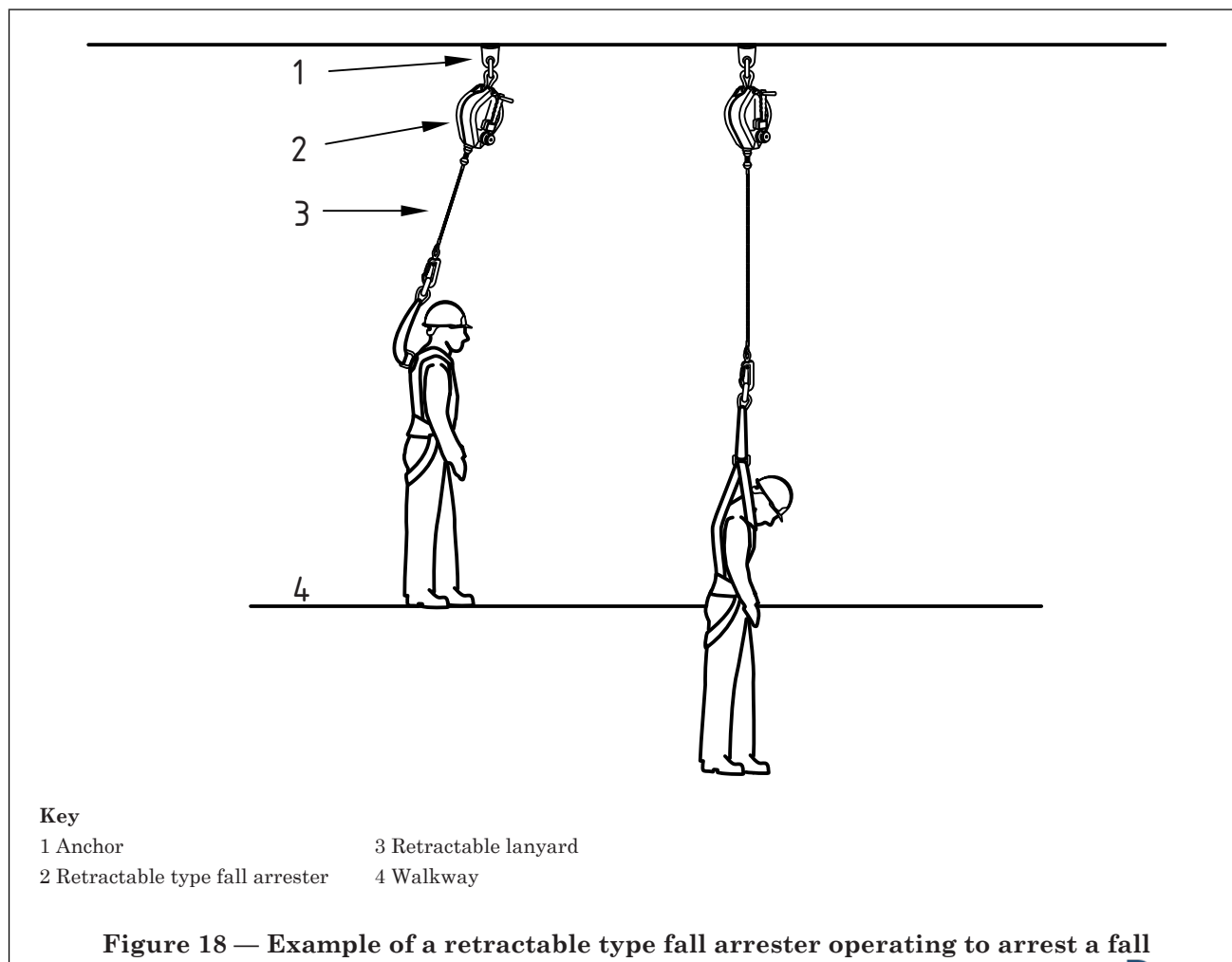
9.3.2 Components of a retractable type fall arrester

9.3.2.1 General

A retractable type fall arrester comprises a retractable lanyard made of wire rope, webbing or synthetic fibre rope which is stored on a reel within a protective housing. The reel is spring-biased so as to wind the retractable lanyard in, which ensures that it is always under a light restraining tension and there is the shortest possible length between the housing and the user. The reel incorporates an inertial clutch mechanism. This allows the lanyard to be slowly extracted and automatically retracted to accommodate the user's body movements while carrying out the work. In the event of a fall, the lanyard is rapidly extracted until it reaches a critical velocity (termed the "lock-on speed") at which point the clutch locks, simultaneously activating a braking mechanism that decelerates the user over a short distance, prevents further extraction of the lanyard and brings the user to a complete stop. The user then remains suspended by the retractable type fall arrester to await rescue (see Figure 18).

NOTE This mechanism is similar to that used in inertia reel seat belts fitted for occupant restraint in motor vehicles.

The end of the lanyard external to the housing is terminated with a connector which has a swivel joint. Such connectors are known as swivel hooks.



The swivel hook is used to connect the retractable lanyard to the user's harness, and has a stop to prevent the lanyard from being fully retracted into the housing. The swivel joint prevents twisting and untwisting of the lanyard as a result of the user turning repeatedly during the work.

The maximum working length of a retractable type fall arrester is the distance from the bearing point of the housing connector to the bearing point of the swivel hook measured with the retractable lanyard fully extracted (see Figure 19).

The maximum working length determines the size and mass of the retractable type fall arrester and the distance the user is able to move away from point at which the housing is connected. The maximum working length is usually in the range 2.0 m to 50.0 m.

The retractable type fall arrester selected should be such that when it is connected to an overhead anchor point, the maximum working length is sufficient to allow the user to reach the whole of the intended work area without continually having to relocate the device.

Retractable type fall arresters conforming to BS EN 360 should be used.

