

# INTERNATIONAL STANDARD

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**10333-2**

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## **Personal fall-arrest systems —** **Part 2:** **Lanyards and energy absorbers**

*Systèmes individuels d'arrêt de chute —*  
*Partie 2: Longes et absorbeurs d'énergie*

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## Foreword

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

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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

Attention is drawn to the possibility that some of the elements of this part of ISO 10333 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 10333-2 was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 4, *Personal equipment for protection against falls*.

ISO 10333 consists of the following parts, under the general title *Personal fall-arrest systems*:

- *Part 1: Full-body harnesses*
- *Part 2: Lanyards and energy absorbers*
- *Part 3: Self-retracting lifelines*
- *Part 4: Vertical rails and vertical lifelines which incorporate a sliding-type fall arrester*
- *Part 5: Connectors*

The systems performance tests will be the subject of a future part 6 to ISO 10333.

## Introduction

In cases where the hazard of falling from a height exists and where, for technical reasons or for work of very short duration, safe access cannot be otherwise provided, it is necessary to consider the use of personal fall-arrest systems (PFAS). Such use should never be improvised and its adoption should be specifically provided for in the appropriate formal provisions for safety in the work place.

PFAS complying with this part of ISO 10333 should satisfy ergonomic requirements and should only be used if the work allows means of connection to a suitable anchor device of demonstrated strength and if it can be implemented without compromising the safety of the user. Personnel should be trained and instructed in the safe use of the equipment and be observant of such training and instruction.

This part of ISO 10333 is based on current knowledge and practice concerning the use of PFAS that incorporate a full body harness as specified in ISO 10333-1.

This part of ISO 10333 presumes that the manufacturer of the PFAS, subsystems or components will, for the sake of consistency and traceability, operate a quality management system which will comply with national and regional regulations in force at the time. Guidance on the form this quality management system may take can be found in ISO 9000 (all parts), *Quality management and quality assurance standards*.

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# Personal fall-arrest systems

## Part 2: Lanyards and energy absorbers

### 1 Scope

This part of ISO 10333 specifies requirements, test methods, instructions for use and maintenance, marking, labelling and packaging, as appropriate, for lanyards and energy absorbers.

Lanyards and energy absorbers are used together as a connecting subsystem in personal fall-arrest systems (PFAS) which will be specified in a future International Standard (see ISO 10333-6 in the Bibliography).

Two classes of energy absorbers are specified for the purposes of this part of ISO 10333:

- a) Type 1: used in PFAS where, due to installation, the potential free-fall distance can be limited to a maximum of 1,8 m and, if a fall takes place, the arresting force is limited to a maximum of 4,0 kN;
- b) Type 2: used in PFAS where, due to installation, the potential free-fall distance can be limited to a maximum of 4,0 m and, if a fall takes place, the arresting force is limited to a maximum of 6,0 kN.

This part of ISO 10333 is applicable only to lanyards and energy absorbers limited to single-person use of a total mass not exceeding 100 kg.

**NOTE** Users of fall-protection equipment whose total mass (including tools and equipment) exceeds 100 kg are advised to seek advice from the equipment manufacturer regarding the suitability of this equipment, which may need additional testing.

For the purposes of this part of ISO 10333, energy absorbers may be supplied integral to a lanyard, integral to a full body harness (FBH), or may be supplied separately.

The scope of this part of ISO 10333 does not extend to:

- a) PFAS that incorporate lanyards without energy absorbers or without a means of energy dissipation;
- b) special lanyards and energy absorbers which are integral (i.e. can only be separated by mutilation or by special tool) to the PFAS components as specified in ISO 10333-4.

This part of ISO 10333 does not specify those additional requirements that would apply when lanyards and energy absorbers are subjected to special conditions of use (where, for example, there exist unusual limitations concerning access to the place of work and/or particular environmental factors). Thus treatments to ensure the durability of the materials of construction (such as heat treatment, anti-corrosion treatment, protection against physical and chemical hazards) are not specified in this part of ISO 10333, but should comply with appropriate International Standards or, failing that, with national standards and other specifications dealing with relevant physical characteristics and/or the safety of users. In particular, when it is considered necessary to test the corrosion resistance of metallic parts of the equipment, reference should be made to ISO 9227.

## 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 10333. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 10333 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

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

ISO 1834:1999, *Short link chain for lifting purposes — General conditions of acceptance.*

ISO 1835:1980, *Short link chain for lifting purposes — Grade M (4), non-calibrated, for chain slings etc.*

ISO 2307:1990, *Ropes — Determination of certain physical and mechanical properties.*

ISO 3108:1974, *Steel wire ropes for general purposes — Determination of actual breaking load.*

ISO 4878:1981, *Textiles — Flat woven webbing slings made of man-made fibre.*

ISO 9227:1990, *Corrosion tests in artificial atmospheres — Salt spray tests.*

ISO 10333-1:—<sup>1)</sup>, *Personal fall-arrest systems — Part 1: Full body harnesses.*

ISO 10333-4, *Personal fall-arrest systems — Part 4: Vertical rails and vertical lifelines which incorporate a sliding-type fall arrester.*

ISO 10333-5, *Personal fall-arrest systems — Part 5: Connectors.*

ISO 14567, *Personal protective equipment for protection against falls from a height — Single-point anchor devices.*

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

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

## 3 Terms and definitions

For the purposes of this part of ISO 10333, the following terms and definitions apply.

### 3.1 Lanyards and energy absorbers

#### 3.1.1

##### **lanyard**

finished length of flexible material, which in conjunction with an energy absorber is used as a connecting subsystem in PFAS

#### 3.1.2

##### **adjustable lanyard**

lanyard which incorporates a mechanism which allows its length to be shortened or lengthened

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1) To be published.

**3.1.3****energy absorber**

component designed to dissipate the kinetic energy generated during a fall, and which limits the arresting forces applied to the PFAS, anchor device and user

**3.1.4****energy-absorbing lanyard**

lanyard with an integral energy absorber

**3.1.5****FBH with energy absorber**

FBH with an integral energy absorber

**3.1.6****permanent extension**

difference in the pin centre lengths of an energy absorber before and after deployment

**3.1.7****pin centre length (PCL)**

straight line distance measured between the bearing point of one energy absorber termination to the other, with the absorber under tension

See Figure 1.

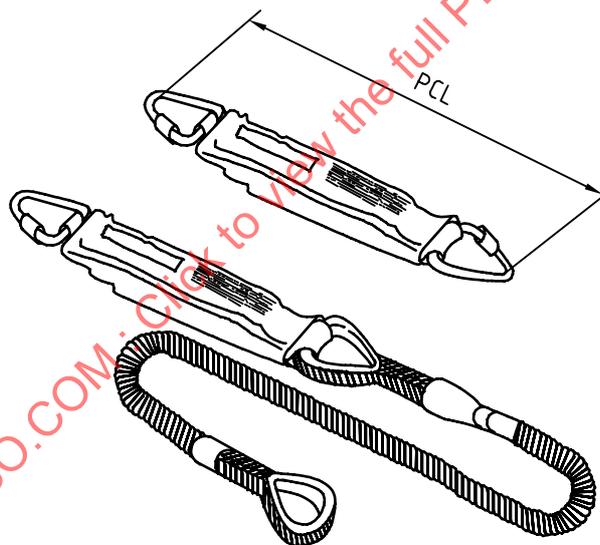


Figure 1 — Example of an energy absorber (upper view) and an energy-absorbing lanyard (lower view)

**3.1.8****deployment**

when the energy absorber begins and continues to permanently extend in order to dissipate the energy applied to it, it is said to have deployed

NOTE In the case of the tear-web/tear-stitch types, tearing produces a permanent extension; in the case of the friction types, dragging of the rope or webbing through the friction device produces a permanent extension.

**3.1.9****free-fall distance**

total vertical distance through which a worker falls under the forces of gravity and air resistance only, from the start of the fall to the onset of the arresting force

**3.1.10**

**total mass**

total sum of the worker's mass plus all attached clothing and equipment

**3.2 General definitions**

**3.2.1**

**component**

constituent part of a PFAS (3.2.3) or subsystem (3.2.2) that has completed the manufacturer's production cycle and is available for purchase

**3.2.2**

**subsystem**

constituent part of a PFAS (3.2.3) which may consist of one or more components, and is used to connect the user from the fall-arrest attachment element of the FBH to the anchor device

NOTE A subsystem performs the two essential functions in PFAS of a) connecting, and b) arresting and energy absorbing.

**3.2.3**

**personal fall-arrest system**

**PFAS**

assembly of interconnected components and subsystems, including a FBH worn by the user, that when connected to a suitable anchor device will arrest a fall from a height

NOTE A PFAS minimizes the fall-arrest forces, controls the total fall distance so as to prevent collision with the ground or other relevant obstruction, and maintains the user in a suitable post-fall arrest attitude for rescue purposes.

**4 Requirements**

**4.1 General**

To ensure that components assembled into a personal fall-arrest system perform correctly, it is recommended that they be tested in accordance with ISO 10333-6 [1].

**4.2 Lanyard**

**4.2.1 Fibre ropes and webbing**

**4.2.1.1** Fibre ropes, webbing and sewing threads for lanyards shall be made from virgin high-tenacity filament or multifilament synthetic fibre or fibres suitable for the intended use.

**4.2.1.2** The number of strands of a laid rope shall be at least three. Three-strand polyamide ropes shall comply with ISO 1140, three-strand polyester ropes with ISO 1141.

**4.2.1.3** Lanyards constructed from braided rope shall comply with EN 892 (single rope) or EN 1891, type A. Any equivalent material is acceptable.

**4.2.1.4** Where lanyards are specified for, or when it is known that lanyards will be used in work carried out near welding or oxy-cutting stations or heat sources, lanyards shall be protected by suitable heat-protective means.

**4.2.2 Chains**

Chains shall comply with the requirements for 6,0 mm chains given in ISO 1835. Egg-shaped or similar end links and all connecting links shall be compatible with the chain in all respects. After manufacture, chain lanyards shall be proof tested to the levels given in ISO 1834.

### 4.2.3 Terminations

**4.2.3.1** One end of a lanyard may be permanently spliced or fixed to a FBH in accordance with ISO 10333-1, or to an energy absorber according to this part of ISO 10333, or to a connector which meets the requirements of ISO 10333-5. The free end(s) of the lanyard shall be terminated in such a manner that they can be connected into a PFAS by an appropriate connector which meets the requirements of ISO 10333-5.

**4.2.3.2** Eye splices in laid fibre rope shall consist of four tucks using all the yarns in the strands and two tapered tucks. The length of the splicing tails emerging after the last tuck shall be at least one rope diameter. Tails shall be whipped to the rope and protected with a rubber or plastic sleeve, or otherwise integrally finished to prevent the termination or splice from unravelling. Sealing compounds used shall be compatible with the rope material. Eyes shall be formed around a plastic or metal thimble of size and strength in accordance with the rope manufacturer's recommendations.

**4.2.3.3** Stitched eye terminations on webbing lanyards shall be sewn using lock stitching. Thread shall be compatible with the webbing material and shall be a contrasting colour to facilitate inspection. Reinforcement or another method shall be used to protect terminations from concentrated wear at all webbing-to-metal fitting interfaces. Webbing ends shall be seared or otherwise prevented from unravelling.

**4.2.3.4** Eye terminations of wire rope lanyards shall be manufactured either with:

- a) a spliced eye with one compression swage with thimble; or
- b) a return eye with a minimum of two compression swages with thimble.

**4.2.3.5** Selection of swage fitting, size, material type, compression die size/pressure, position of swage(s) on rope, and thimble size, shall be carried out in accordance with the rope manufacturer's recommendations. In particular, aluminium swages are recommended for steel wire ropes and copper swages for stainless-steel wire ropes.

**4.2.3.6** Wire rope ends shall be brazed, whipped or have an equivalent finish to prevent unravelling. Brazing should be carried out prior to forming the eye.

**4.2.3.7** Knots shall not be used to form lanyard terminations.

### 4.2.4 Fittings

**4.2.4.1** All buckles, adjustment mechanisms, thimbles, and integral connections shall be smoothly finished and free from defects due to faulty material and manufacture. They shall not have sharp or rough edges that may cut, abrade or otherwise damage the lanyard material or cause injury to the user.

**4.2.4.2** Adjustment mechanisms shall self-lock securely onto the lanyard material but shall not present roughened surfaces or sharp edges that may abrade or otherwise damage the material.

**4.2.4.3** When tested in accordance with 5.2.4, all metallic fittings shall be free from red rust, as visible to the unaided eye, or other evidence of corrosion of the base metal. The presence of white scale after the test is acceptable.

### 4.2.5 Adjustment slippage

When tested in accordance with 5.2.1, the adjustment mechanism on adjustable lanyards shall not allow a lanyard slippage of more than 25 mm.

### 4.2.6 Static strength

When tested in accordance with 5.2.2, the lanyard, including its terminations and if applicable its adjustment device, shall sustain a force as specified in Table 1 without tearing or rupture of any element.

**Table 1 — Force requirements for static strength**

Component	Maximum force kN
Webbing-based lanyards	22
Fibre-rope-based lanyards	22
Wire-rope-based lanyards	15
Chain-based lanyards	15
NOTE The higher strength requirement for textile materials is necessary as these materials are more prone to wear and are more vulnerable to damage than their metallic counterparts.	

**4.2.7 Dynamic strength for adjustable lanyards**

When tested in accordance with 5.2.3, adjustable lanyards shall retain the test mass clear of the ground without tearing or rupture of any element.

**4.3 Energy absorber**

**4.3.1 General**

**4.3.1.1** Energy absorber material and mechanisms designed to be utilized in the dissipation of kinetic energy shall have protective coverings incorporated to shield against external contaminants, sharp objects and adverse climate.

**4.3.1.2** Where energy absorbers are specified for, or when it is known that they will be used in work carried out near welding or oxy-cutting stations or heat sources, energy absorbers shall be protected by suitable heat-protective means.

**4.3.2 Terminations**

**4.3.2.1** One end of an energy absorber may be permanently spliced or fixed to an FBH in accordance with ISO 10333-1, or to a lanyard in accordance with this part of ISO 10333, or to a connector which meets the requirements of ISO 10333-5. The free end(s) of the energy absorber shall be terminated in such a manner that they can be connected into a PFAS by an appropriate connector which meets the requirements of ISO 10333-5.

**4.3.2.2** Where the free end(s) of the energy absorber are connected to metal components or will be connected into a PFAS using connectors in accordance with ISO 10333-5, suitable reinforcement or another method shall be used to protect terminations from concentrated wear at all textile-to-metal fitting interfaces.

**4.3.2.3** All buckles, fittings, thimbles and integral connections shall be smoothly finished and free from defects due to faulty material and manufacture. They shall not have sharp or rough edges that may cut, abrade or otherwise damage textile material or cause injury to the user.

**4.3.2.4** When tested in accordance with 5.3.9, all metallic fittings shall be free from red rust, as visible to the unaided eye, or other evidence of corrosion of the base metal. The presence of white scale after the test is acceptable.

### 4.3.3 Energy-absorbing lanyards and FBH with energy absorber

If an energy absorber is integral with a lanyard or harness (i.e. the energy absorber cannot be removed without mutilating the lanyard or harness, or without the use of a special dedicated tool), all the requirements specified in 4.3 apply. Alternative test methods are specified for these types of subsystems.

### 4.3.4 Inadvertent operation

In order to avoid inadvertent deployment, an energy absorber shall not have a permanent extension greater than 40 mm when tested in accordance with 5.3.1 or 5.3.2.

### 4.3.5 Dynamic performance

When tested in accordance with 5.3.3 or 5.3.4 or 5.3.5, an energy absorber shall limit the arrest force to a maximum of 4,0 kN for Type 1 or 6,0 kN for Type 2. Permanent extension of the energy absorber shall not exceed 1,2 m for Type 1 or 1,75 m for Type 2.

### 4.3.6 Static strength

When tested in accordance with 5.3.6 or 5.3.7, a fully deployed energy absorber shall withstand a force of 22 kN for Type 1 or 15 kN for Type 2 without tearing or rupture.

### 4.3.7 Dynamic performance after conditioning

#### 4.3.7.1 General

The requirements in 4.3.7.2 to 4.3.7.5 are optional, but are strongly recommended where it is known that the energy absorber is intended for use in extremes of climate.

#### 4.3.7.2 Elevated temperature

The energy absorber shall be tested in accordance with 5.3.3 or 5.3.4 or 5.3.5 within 5 min after the conditioning described in 5.3.8.2. The energy absorber shall limit the arrest force to a maximum of 4,0 kN for Type 1 or 6,0 kN for Type 2. Permanent extension of the energy absorber shall not exceed 1,2 m for Type 1 or 1,75 m for Type 2.

#### 4.3.7.3 Wet

The energy absorber shall be tested in accordance with 5.3.3 or 5.3.4 or 5.3.5 within 5 min after the conditioning described in 5.3.8.3. The energy absorber shall limit the arrest force to a maximum of 5,0 kN for Type 1 or 6,0 kN for Type 2. Permanent extension of the energy absorber shall not exceed 1,2 m for Type 1 or 1,75 m for Type 2.

#### 4.3.7.4 Cold

The energy absorber shall be tested in accordance with 5.3.3 or 5.3.4 or 5.3.5 within 5 min after the conditioning described in 5.3.8.4. The energy absorber shall limit the arrest force to a maximum of 5,0 kN for Type 1 or 6,0 kN for Type 2. Permanent extension of the energy absorber shall not exceed 1,2 m for Type 1 or 1,75 m for Type 2.

#### 4.3.7.5 Wet and cold

The energy absorber shall be tested in accordance with 5.3.3 or 5.3.4 or 5.3.5 within 5 min after the conditioning described in 5.3.8.5. The energy absorber shall limit the arrest force to a maximum of 6,0 kN for Type 1 and Type 2. Permanent extension of the energy absorber shall not exceed 1,2 m for Type 1 or 1,75 m for Type 2.

Table 2 — Summary of test requirements for energy absorbers

Clauses		Type 1	Type 2
4.3.4	Inadvertent operation (kN)	2	2
4.3.5	Dynamic performance (kN, max.) / permanent extension (m, max.)	4 / 1,2	6 / 1,75
4.3.7	Dynamic performance after conditioning (kN, max.) / permanent extension (m, max.) (optional)		
4.3.7.2	Elevated temperature (optional)	4 / 1,2	6 / 1,75
4.3.7.3	Wet (optional)	5 / 1,2	6 / 1,75
4.3.7.4	Cold (optional)	5 / 1,2	6 / 1,75
4.3.7.5	Wet and cold (optional)	6 / 1,2	6 / 1,75
4.3.6	Static strength (kN)	22	15

## 5 Test methods

### 5.1 Apparatus

#### 5.1.1 Test lanyard

##### 5.1.1.1 Test lanyard for Type 1 energy absorber

Use a wire rope lanyard terminated with snap hooks such that the combined length of wire and hooks is  $(2\,400 \pm 25)$  mm, measured from snap hook to snap hook bearing points under a tension of 44 N. The lanyard shall be fabricated from Type 302 stainless steel of 9,5 mm diameter, 7 × 19 aircraft cable construction. The lanyard terminations shall be formed by a method which prevents cable slippage.

##### 5.1.1.2 Test lanyard for Type 2 energy absorber

Use a chain lanyard of length  $(2\,000 \pm 25)$  mm, measured from end link to end link bearing points with the test chain in a taut condition. The chain shall comply at least with the requirements for 6 mm chains given in ISO 1835. Egg-shaped or similar end links and all connecting links shall be compatible with the chain in all respects.

**5.1.2 Test structure**, comprising a rigid anchor structure so constructed that its natural frequency of vibration in the vertical axis at the anchor point is not less than 100 Hz and so that the application of a force of 20 kN on the anchor point does not cause a deflection greater than 1 mm.

The rigid anchor point should be a ring of  $(20 \pm 1)$  mm bore and  $(15 \pm 1)$  mm diameter cross-section, or a rod of the same diameter cross-section.

The rigid anchor point shall be at such a height as to prevent the test mass from striking the floor during dynamic testing.

**5.1.3 Static strength test apparatus**, comprising a test frame, winch or hydraulic puller and indicator, with sufficient traverse to load the components for test.

**5.1.4 Quick-release device**, compatible with the eyebolt of the test mass or connectors, which ensures the release of the test mass without initial velocity.

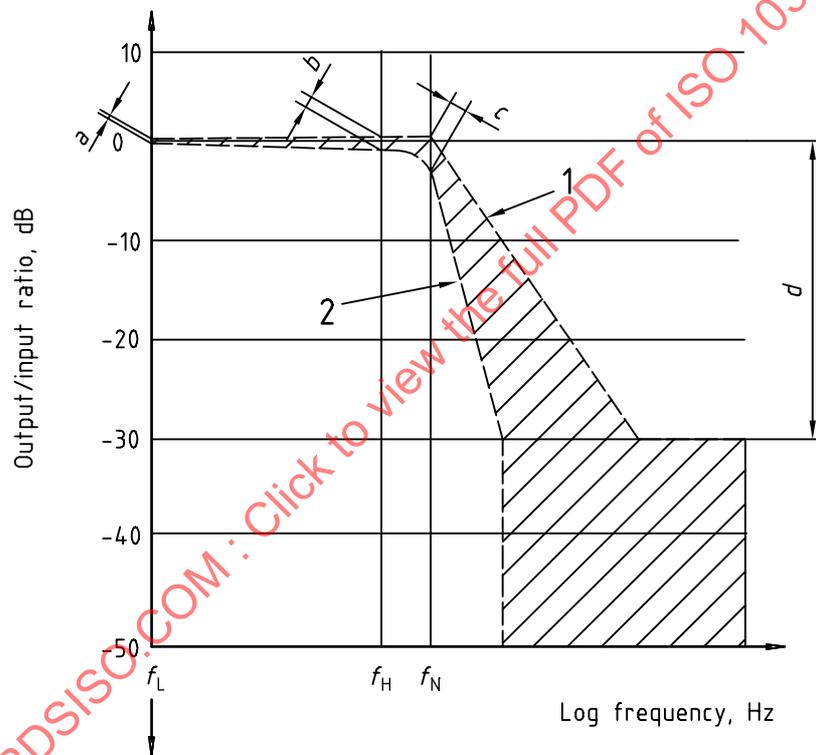
**5.1.5 Test mass**, of steel,  $(100 \pm 1)$  kg, rigidly connected to an eyebolt which provides a secure connection.

The test mass shall have a nominal diameter of 200 mm. The eyebolt shall be central at one end, but an offset additional eyebolt position is also permissible to accommodate horizontal dimensional constraints of relevant testing procedures and equipment.

**5.1.6 Force-measuring instrumentation**, capable of measuring forces from 1,2 kN to 20 kN with an accuracy of  $\pm 2\%$  and of withstanding a force of 50 kN without damage, and arranged so that measurements are carried out with a continuously active band up to 100 Hz but with a minimum sampling rate of 1 000 Hz.

The arrest-force measurement system shall have a corner frequency of 100 Hz with frequency response characteristics which fall within the shaded area illustrated in Figure 2.

**5.1.7 Recorder**, to obtain the time trace of the force, either at the actual time (when recording with the auxiliary measuring device) or at a later time, after storage of the information.



Frequency response values:

$a = \pm 1/4$ dB	$f_L = 0,1$ Hz
$b = + 1/2$ dB, $-1$ dB	$f_H = 60$ Hz
$c = + 1/2$ dB, $-3$ dB	$f_N = 100$ Hz
$d = -30$ dB	

**Key**

- 1 Slope =  $-9$  dB per octave
- 2 Slope =  $-24$  dB per octave

**Figure 2 — Frequency response characteristics for the force-measuring instrumentation**

## 5.2 Lanyard tests

### 5.2.1 Slippage test (adjustable lanyard)

**5.2.1.1** Adjust the lanyard to its mid-length position. Mark the lanyard and the adjusting mechanism so that the marks align and so that slippage can be assessed.

**5.2.1.2** Install the adjustable lanyard in the test apparatus (5.1.3) and apply a static tensile force of 6,0 kN between its two end points, (supplied terminations), for a period of at least 3 min. Remove the force and measure any slippage observed.

### 5.2.2 Static tensile test (all lanyards)

**5.2.2.1** Install the lanyard in the test apparatus (5.1.3) and apply the tensile force as specified in Table 1. The rate of stressing shall be in accordance with Table 3. Maintain the force for a period of 3 min and observe that there is no tearing or rupture of any element.

**Table 3 — Rate of stressing in static tensile test**

Component	Specified in
Webbing-based lanyards	ISO 4878
Fibre-rope-based lanyards	ISO 2307
Wire-rope-based lanyards	ISO 3108

**5.2.2.2** Where lanyards have integral energy absorbers, test the lanyard element in accordance with 5.2.2.1, and the energy absorber element in accordance with 5.3.6.

### 5.2.3 Dynamic strength test (for adjustable lanyards only)

**5.2.3.1** Operate the adjustment device until the length between the bearing points of the lanyard terminations is  $(2\ 000 \pm 25)$  mm, or where the length of the lanyard prevents this, to the maximum length possible.

**5.2.3.2** Using connectors conforming to ISO 10333-5, attach the test mass (5.1.5) to one termination and attach the other to the rigid structural anchor point (5.1.2).

**5.2.3.3** Raise the test mass so that:

- the lifting eyebolt is at a maximum horizontal distance of 300 mm from the vertical axis of the test rig anchor before release; and
- when the quick-release device ((5.1.4) is operated, the test mass is allowed to fall freely over a distance of  $(4\ 000 \pm 100)$  mm, or where the length of the lanyard prevents this, over the maximum distance possible.

**5.2.3.4** Hold the test mass in position by the quick-release device.

**5.2.3.5** Release the test mass and, when at rest, observe that there is no tearing or rupture of any part of the adjustable lanyard.

## 5.2.4 Corrosion test

Where applicable, a sample of each metallic fitting from the lanyard under test shall be salt spray tested in accordance with ISO 9227, with an initial exposure of 24 h, followed by 1 h drying, followed by a second exposure of 24 h. Assess for corrosion.

## 5.3 Energy absorber tests

### 5.3.1 Initial static resistance test when energy absorber is supplied as a component

Measure or mark the energy absorber so that any deployment can be determined after the test. Install the energy absorber in the tensile test apparatus (5.1.3) and subject it to a tensile force of 2,0 kN across its two terminations. The force shall be applied over 30 s to reduce any dynamic effect, and the 2 kN load shall be maintained for 2 min. Release the load and remove the energy absorber from the machine. After a period of 5 min check whether or not the energy absorber has deployed and measure any permanent extension observed.

### 5.3.2 Initial static resistance test of energy absorbing lanyards or FBH with energy absorber

**5.3.2.1** Where lanyards have integral energy absorbers, test the energy absorber element as detailed in 5.3.1.

**5.3.2.2** Where energy absorbers are integral to harnesses, attempt to fit a connector at the joint between the energy absorber and harness. Then test the energy absorber as detailed in 5.3.1. If it is not possible to insert a connector at this point, fit the harness to the torso test mass as specified in ISO 10333-1:—, subclause 5.1.1. Connect the free end of the absorber in one jaw of the test apparatus, and the lower eyebolt of the torso in the other. Submit the subsystem to the test procedure as detailed in 5.3.1.

### 5.3.3 Dynamic test of energy absorber when supplied as a component

**5.3.3.1** Attach one end of the energy absorber by a connector in accordance with ISO 10333-5 to the test lanyard as detailed in 5.1.1.1 for Type 1 energy absorbers, or to the test lanyard as detailed in 5.1.1.2 for Type 2 energy absorbers.

**5.3.3.2** Connect the free end of the energy absorber by a connector in accordance with ISO 10333-5 to the force-measuring instrument (5.1.6) which is attached to the test structure (5.1.2).

**5.3.3.3** Connect the free end of the test lanyard by a connector in accordance with ISO 10333-5 to the test mass (5.1.5).

**5.3.3.4** Lower the test mass until the test assembly fully supports the mass in suspension. Measure and record height  $H_S$  in Figure 3a), i.e. the distance between the underside of the test mass and the test house floor.

**5.3.3.5** Raise the test mass to a height ( $H_S + H_F$ ) where  $H_F$  is equal to 1,8 m for Type 1 energy absorbers, or 4,0 m for Type 2 energy absorbers, and secure to the quick-release device [Figure 3b)]. Ensure that the lifting eyebolt on the test mass is at a maximum horizontal distance of 300 mm from the vertical axis of the test rig anchor.

**5.3.3.6** Release the test mass. Measure and record the force with respect to time. With the test mass at rest, measure and record height  $H_D$  [Figure 3c)]. Calculate ( $H_S - H_D$ ), the permanent extension of the energy absorber.

### 5.3.4 Dynamic test of energy absorbing lanyard

**5.3.4.1** Where energy absorbers are incorporated into lanyards, attach the energy absorber by using a connector in accordance with ISO 10333-5 to the force-measuring instrument (5.1.6) which is attached to the test structure (5.1.2), and attach the end of the lanyard by using a connector in accordance with ISO 10333-5 to the test mass (5.1.5).

**5.3.4.2** Lower the test mass until the test assembly fully supports the mass in suspension. Measure and record height  $H_S$  in Figure 3a), i.e. the distance between the underside of the test mass and the test house floor.

**5.3.4.3** For energy-absorbing lanyards incorporating Type 1 energy absorbers, raise the test mass to a height ( $H_S + H_F$ ) where  $H_F$  is equal to 1,8 m or, where the length of the energy absorbing lanyard prevents this, to the maximum height possible.

**5.3.4.4** For energy-absorbing lanyards incorporating Type 2 energy absorbers, raise the test mass to a height ( $H_S + H_F$ ) where  $H_F$  is equal to 4,0 m or, where the length of the energy-absorbing lanyard prevents this, to the maximum height possible.

**5.3.4.5** Secure the test mass to the quick-release device [Figure 3b)]. Ensure that the lifting eyebolt on the test mass is at a maximum horizontal distance of 300 mm from the vertical axis of the test rig anchor.

**5.3.4.6** Release the test mass. Measure and record the force with respect to time. With the test mass at rest, measure and record height  $H_D$  [Figure 3c)]. Calculate ( $H_S - H_D$ ), the permanent extension of the energy absorber.

### **5.3.5 Dynamic test of FBH with integral energy absorber**

**5.3.5.1** Where energy absorbers are incorporated into FBHs, attempt to fit a connector at the joint between the energy absorber and harness. Then test the energy absorber as detailed in 5.3.3. If it is not possible to insert a connector at this point, fit the harness to the torso test mass as specified in ISO 10333-1:—, subclause 5.1.1.

**5.3.5.2** By using a connector in accordance with ISO 10333-5, attach the free end of the energy absorber to the test lanyard as detailed in 5.1.1.1 for Type 1 energy absorbers, or to the test lanyard as detailed in 5.1.1.2 for Type 2 energy absorbers.

**5.3.5.3** By using a connector in accordance with ISO 10333-5, attach the free end of the test lanyard to the force-measuring instrument (5.1.6) which is attached to the test structure (5.1.2).

**5.3.5.4** Lower the torso test mass until the test assembly fully supports the mass in suspension. Measure and record height  $H_S$  in Figure 3a), i.e. the distance between the underside of the torso leg stump and the test house floor.

**5.3.5.5** Carry out the procedures in accordance with 5.3.3.5 and 5.3.3.6.

### **5.3.6 Residual static strength test for energy absorber supplied as a component**

**5.3.6.1** Install the energy absorber in the test apparatus (5.1.3) and apply a tensile force and ensure that the energy absorber is fully deployed, i.e. there is no energy-dissipating capacity remaining.

**5.3.6.2** If necessary, remount the energy absorber in the test apparatus and apply a tensile force of 22 kN for Type 1 or 15 kN for Type 2 between the two terminations. The time to reach the force shall be 3 min to avoid any dynamic effect. Maintain the force for a period of 3 min and observe that there is no tearing or rupture of any element.

NOTE Once the respective tensile forces have been sustained for the 3 min period, it is permissible, in order to determine the failure load and mode, to progress the test to destruction.

### **5.3.7 Residual static strength test of energy-absorbing lanyards or FBH with energy absorber**

**5.3.7.1** Where lanyards have integral energy absorbers, test the energy absorber element as detailed in 5.3.6.

**5.3.7.2** Where energy absorbers are integral to harnesses, attempt to fit a connector at the joint between the energy absorber and harness. Then test the energy absorber as detailed in 5.3.6. If it is not possible to insert a connector at this point, fit the harness to the torso test mass as specified in ISO 10333-1:—, subclause 5.1.1. Connect the free end of the absorber in one jaw of the test apparatus, and the lower eyebolt of the torso in the other. Submit the subsystem to the test procedure as detailed in 5.3.6.

a) Test mass in suspension      b) Raised to pre-release position      c) Post-drop suspension

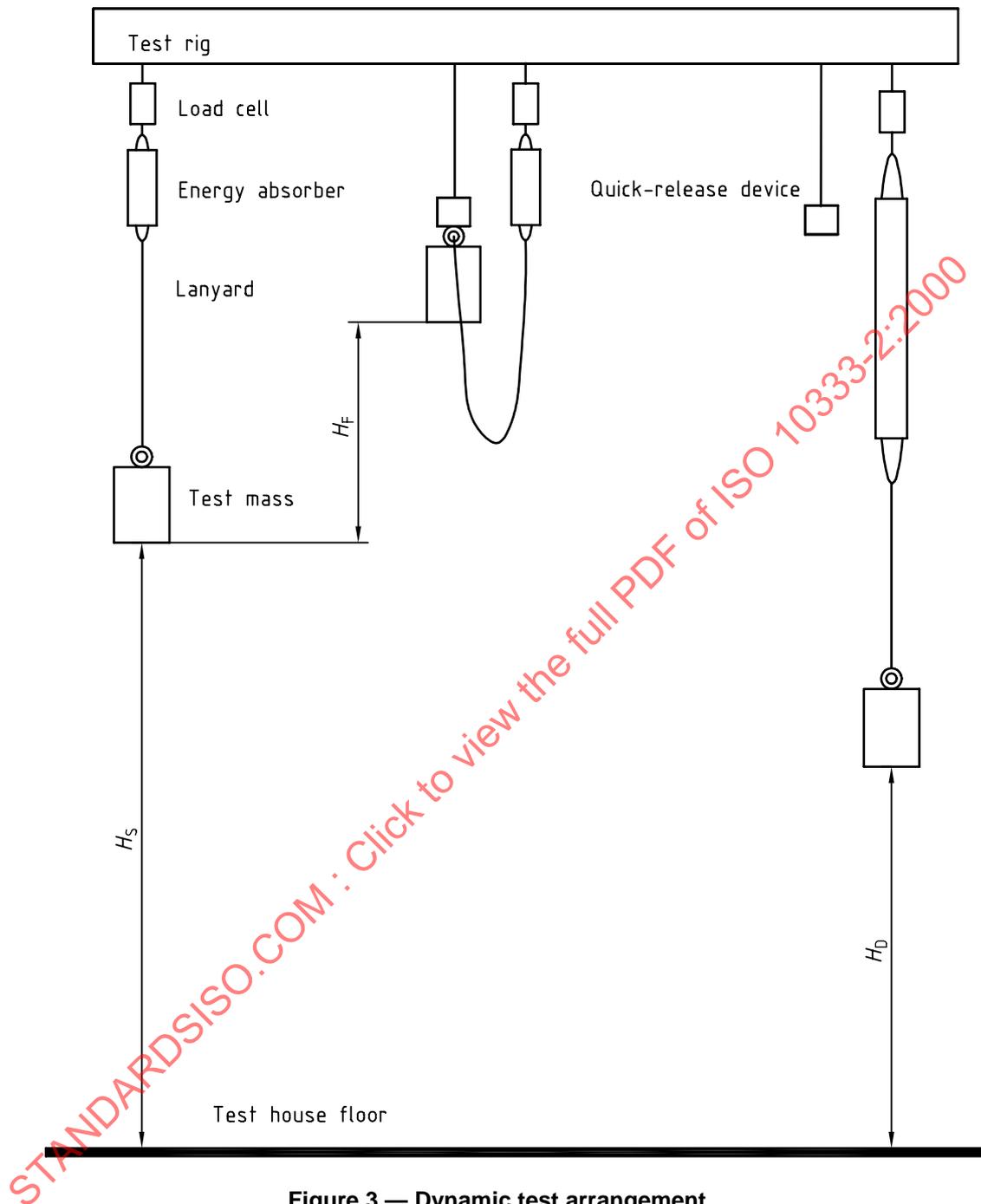


Figure 3 — Dynamic test arrangement

### 5.3.8 Conditioning

#### 5.3.8.1 General

A new energy absorber shall be used for each condition as described in the following subclauses.

#### 5.3.8.2 Elevated temperature conditioning

Place the sample in a heated chamber for a minimum of 8 h at a temperature of  $(45 \pm 2) ^\circ\text{C}$ .