# INTERNATIONAL STANDARD

# ISO 10333-6

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2004-01-15

# Personal fall-arrest systems —

## Part 6: System performance tests

*Systèmes individuels d'arrêt de chute —*

*Partie 6: Essais de performance*

Reference number
ISO 10333-6:2004(E)

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# Foreword

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

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

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

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

ISO 10333-6 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 incorporating a sliding-type fall arrester*

— *Part 5: Connectors with self-closing and self-locking gates*

— *Part 6: System performance tests*

# Introduction

Fall arrest equipment has been traditionally manufactured and tested as discrete components, which are then linked together in series to form a personal fall arrest system (PFAS) by the user, before commencing work.

This requires personnel in the supply and use chain who are capable of deciding which combinations of components can be linked together and which of those cannot.

Over the years, a continuous process of fall simulation and strength testing has revealed the dangers of linking incompatible components together, as a result of test failures, near misses and accidents. Examples have included: inadvertent release of connections, localized overloading or overstressing of components, and unexpected decrease in performance levels. These incidents occurred because insufficient analysis and attention had been paid to the particular combination of components in question, and because the interaction between the components in a fall was unknown.

Further investigation showed that the behaviour of a complete system under test could reveal shortcomings which could not be detected when the individual components of the same system were tested separately.

Consequently, in 1979 and 1985, other fall arrest standards with a lineage back to 1947 were revised to ensure that performance tests were conducted on complete systems. This allowed the complete PFAS to be tested in the actual mode of use, and an arrested fall to be simulated as closely as possible under test conditions.

This part of ISO 10333 fully supports the essential requirements of the range of current International Standards written to specify the components that are used to form personal fall arrest systems, i.e. the other parts of ISO 10333, and ISO 14567.

However, in recognizing the importance of complete personal fall arrest system performance tests, this part of ISO 10333 provides test methods for situations where it is both important and desirable to ascertain satisfactory system performance and interactive component compatibility. It goes beyond that required in the above component standards by specifying system performance testing applicable to complete personal fall arrest systems, as opposed to component testing, which only requires tests on individual components.

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 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 ought also to satisfy ergonomic requirements and 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 need to 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.

# Personal fall-arrest systems —

# Part 6:
# System performance tests

## 1 Scope

This part of ISO 10333 specifies tests and requirements for complete personal fall arrest systems (PFAS) made up from specific combinations of components and subsystems selected from those conforming to the other parts of ISO 10333 and to ISO 14567, where it is both important and desirable to ascertain satisfactory system performance and interactive component compatibility. It includes PFAS performance tests using a rigid torso test mass as a surrogate for the faller. Examples of personal fall arrest systems, as well as descriptions of how components or subsystems may be connected together to constitute a system, are also given.

This part of ISO 10333 is applicable to PFAS limited to single-person use of a total mass not exceeding 100 kg and, when activated, will arrest the person and limit the arresting force to a maximum of 6 kN.

It is not applicable to

a) PFAS which use waist belts or chest harnesses as the sole body holding component,

b) PFAS incorporating lanyards without energy absorbers or without a means of energy dissipation,

c) subsystems and components outside the PFAS scopes of the other parts of ISO 10333 and ISO 14567, or

d) equipment used for material lifting purposes.

Where other features are integral with components and subsystems which allow them to be assembled into other types of safety system associated with personal fall arrest systems — for example, work positioning systems (WPS), fall restraint systems (FRS), controlled descent systems (CDS), confined space access systems (CSAS) or rescue systems (RS) — this part of ISO 10333 relates only to the fall arrest function of such components and subsystems.

This part of ISO 10333 does not specify those additional requirements that would apply when personal fall arrest systems 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).

NOTE Personal fall arrest systems outside the scope of this part of ISO 10333 need to be performance tested in the manner in which they are intended to be used, taking into account the workplace geometry. Advice will need to be sought from the equipment manufacturer accordingly.

## 2 Normative references

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

ISO 10333-1:2000, *Personal fall-arrest systems — Part 1: Full-body harnesses*

ISO 10333-2: 2000, *Personal fall arrest systems — Part 2: Lanyards and energy absorbers*

ISO 10333-3: 2000, *Personal fall arrest systems — Part 3: Self-retracting lifelines*

ISO 10333-4: 2002, *Personal fall arrest systems — Part 4: Vertical rails and vertical lifelines incorporating a sliding-type fall arrester*

ISO 10333-5:2001, *Personal fall-arrest systems — Part 5: Connectors with self-closing and self-locking gates*

ISO 14567:1999, *Personal protective equipment for protection against falls from a height — Single-point anchor devices*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10333-1 to ISO 10333-5, ISO 14567 and the following apply.

**3.1**
**personal fall arrest system**
**PFAS**
assembly of interconnected components and subsystems, including a full-body harness worn by the user, that when connected to a suitable anchor device will arrest a fall from a height

NOTE A personal fall arrest system minimizes the fall arrest forces, controls the total fall distance to prevent collision with the ground or other relevant obstruction, and maintains the user in a suitable post-fall arrest attitude for rescue purposes. For examples, see Figure 1.

**3.2**
**subsystem**
constituent part of a personal fall arrest system which may consist of one or more components and which is used to connect the user from the fall arrest attachment element of the full-body harness to the anchor device

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

**3.3**
**component**
constituent part of a personal fall arrest system or subsystem that has completed the manufacturer’s production cycle and is available for purchase

**3.4**
**manufacturer**
business concern that manufactures components or subsystems or both for use in personal fall arrest systems

**3.5**
**assembler**
business concern or person who assembles components or subsystems into systems ready for use

NOTE An assembler could be the manufacturer, a manufacturer’s agent or distributor, supplier, the purchasing company intending to use the components or subsystems, a purchaser, safety officer, supervisor, or the user.

**3.6**
**total mass**
sum of the user’s mass and all attached clothing and equipment

**3.7**
**required free space**
space required beneath a user to avoid collision with the ground or a structure

## 4 Designation

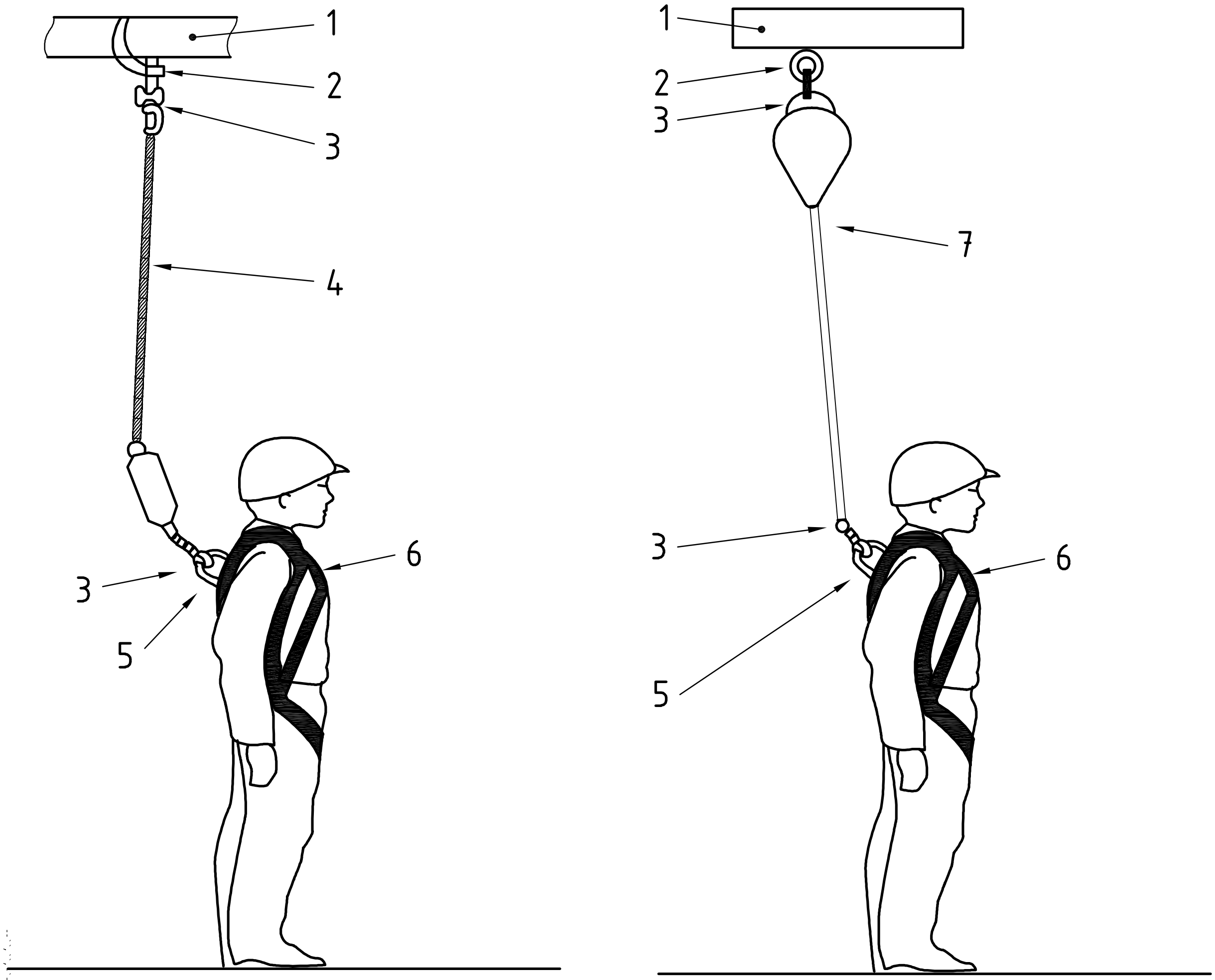
Designation shall be by means of a code that uses abbreviations and symbols to represent the assembled order of components and subsystems in the configuration of a personal fall arrest system, in accordance with Tables 1 and 2.

**Table 1 — Abbreviations and symbols**

| Abbreviation/symbol | Component/subsystem | Applicable International Standard |
|---|---|---|
| FBH | Full-body harness | ISO 10333-1 |
| EAL | Energy-absorbing lanyard | ISO 10333-2 |
| SRL | Self-retracting lifeline | ISO 10333-3 |
| TVLL | Temporary vertical lifeline | ISO 10333-4 |
| PVLL | Permanent vertical lifeline | ISO 10333-4 |
| VR | Vertical rail | ISO 10333-4 |
| + | Connector | ISO 10333-5 |
| A | Anchor device | ISO 14567 |

**Table 2 — Codes**

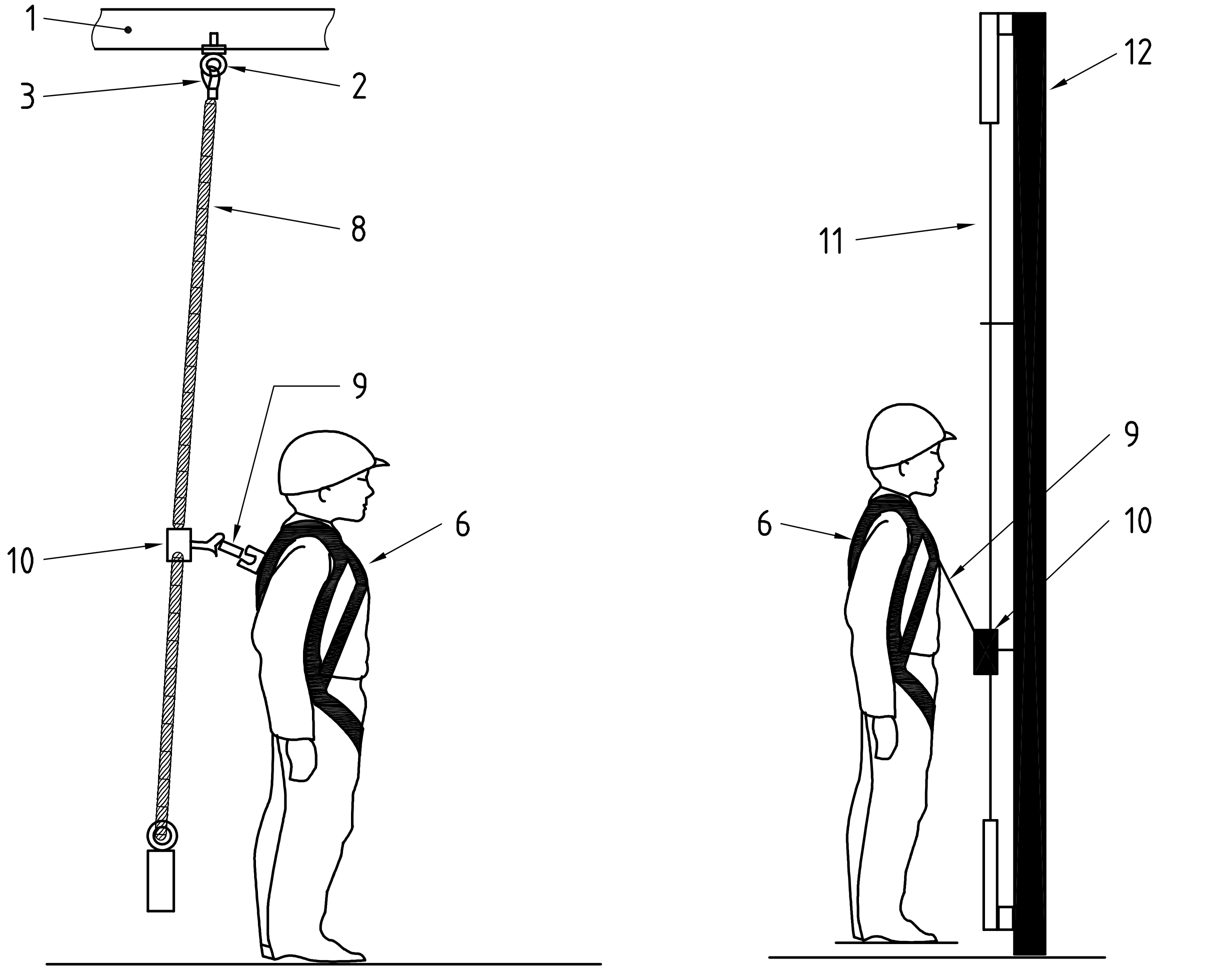
| Code | PFAS type | Figure |
|---|---|---|
| A + EAL + FBH | PFAS based on an energy-absorbing lanyard. | 1 a) |
| A + SRL + FBH | PFAS based on a self-retracting lifeline. | 1 b) |
| A + TVLL + FBH | PFAS based on a temporary vertical lifeline. | 1 c) |
| A + PVLL + FBH | PFAS based on a permanent vertical lifeline. | 1 d) |
| A + VR + FBH | PFAS based on a vertical rail. | 1 e) |




a) PFAS based on energy-absorbing lanyard

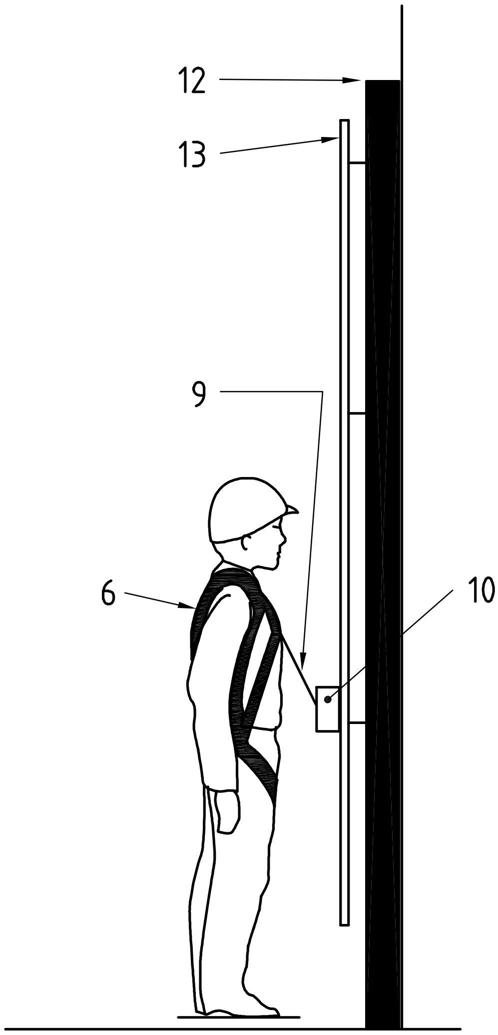
b) PFAS based on self-retracting lifeline

**Figure 1 — Examples of fall arrest systems (PFAS)** *(continued)*




**c) PFAS based on temporary vertical lifeline** **d) PFAS based on permanent vertical lifeline**

**Figure 1 — Examples of fall arrest systems (PFAS)** *(continued)*




**e) PFAS based on vertical rail**

**Key**

1 structure
2 anchor device
3 connector
4 energy-absorbing lanyard
5 fall arrest attachment on full-body harness
6 full-body harness worn by user
7 self-retracting lifeline
8 lifeline
9 connecting line
10 sliding-type fall arrester
11 tensioned lifeline
12 permanently installed ladder
13 vertical rail

**Figure 1 — Examples of fall arrest systems (PFAS)**

# 5 Requirements

NOTE Guidance on design, ergonomics and the issue of free space is given in Annex A.

## 5.1 Components and subsystems

**5.1.1** It is recognized that user organizations have to acquire components and subsystems from the same or different manufacturers for the purposes of assembly into a personal fall arrest system. It can be difficult to determine whether or not the intended combination will produce a satisfactory performance and whether or not the specific components or subsystems are compatible with one another. If the assembler is not confident about the performance of the complete personal fall arrest system, or the compatibility of components or subsystems, especially in cases where there is insufficient information available, the system should be tested in accordance with this part of ISO 10333, the purpose being to indicate obvious design defects associated with dynamic performance.

**5.1.2** A full-body harness and lanyard *without* an energy absorber or a means of energy dissipation shall not be used as a PFAS.

**5.1.3** The assembler shall ensure that the specific combination of components and subsystems intended for assembly into a PFAS has been proved capable of meeting the individual requirements of ISO 10333-1 to ISO 10333-5, and ISO 14567, according to type.

**5.1.4** The manufacturer shall give sufficient information on the compatibility of specific components and subsystems to the purchaser.

**5.1.4** The assembler shall ensure that specific components or subsystems are compatible with any other component or subsystem intended to be assembled into a PFAS.

## 5.2 System performance

**5.2.1** PFAS shall be tested in accordance with Table 3 as appropriate to type. It is a basic requirement of a PFAS that when the specific combination of components/subsystems is assembled together in the manner intended, the operation of the total system be designed to arrest the fall of the person using the PFAS in a manner which is as safe as is reasonably practicable.

**Table 3 — Testing of PFAS**

| PFAS type | See |
|---|---|
| A + EAL + FBH | 6.2 |
| A + SRL + FBH | 6.3 |
| A + TVLL + FBH | 6.4 |
| A + PVLL + FBH | 6.5 |
| A + VR + FBH | 6.6 |

**5.2.2** When systems are performance-tested in accordance with the appropriate subclause,

a) the arrest force shall not exceed 6 kN,

b) the angle formed between the back of the torso tests mass and the vertical plane shall not exceed 45º,

c) for A + TVLL + FBH-configured PFAS, the fall distance, $H_D$, shall not exceed 2,0 m, and shall be recorded in accordance with 6.2 for required free space calculation purposes,

d) for A + PVLL + FBH- and A + VR + FBH-configured PFAS, the fall distance, $H_D$, shall not exceed 1,5 m, and shall be recorded in accordance with 6.2 for required free space calculation purposes, and

e) for A + EAL + FBH- and A + SRL + FBH-configured PFAS, the fall distance, $H_D$, shall be recorded in accordance with 6.2 for required free space calculation purposes.

**5.2.3** With the torso test mass remaining in post-drop suspension, there shall be none of the following results on a full-body harness:

a) tearing of webbing material;

b) tearing of any primary strap sewn joint;

c) partial or complete fracture of any fastening or adjusting buckle;

d) inadvertent opening of any fastening buckle;

e) straps applying pressure to the neck of the torso test mass.

**5.2.4** With the torso test mass remaining in post-drop suspension, there shall be neither of the following results on other parts of the PFAS:

a) tearing or rupture of any component (except where such tearing was deliberately designed to contribute to energy dissipation);

b) partial fractures or inadvertent opening of connector gates.

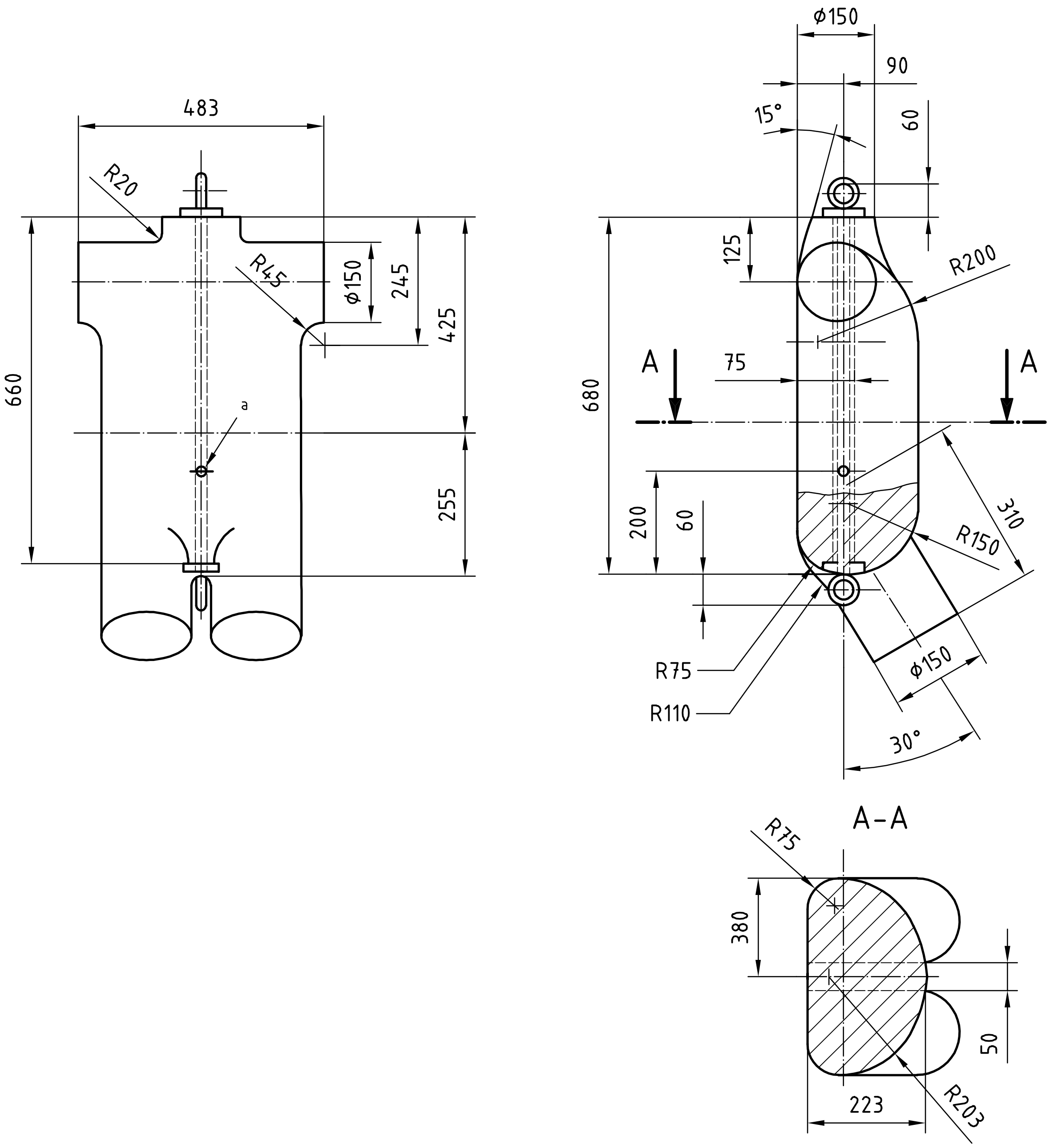
# 6 Test methods

## 6.1 Apparatus

### 6.1.1 Torso test mass for dynamic test

The torso test mass for the dynamic performance test shall be in accordance with Figure 2. The suspension eyebolts shall have an inside diameter of (40 ± 1) mm and a maximum cross-section diameter of (16 ± 1) mm. The surface shall be smooth and, if of timber construction, shall be shellacked or varnished.

Dimensions in millimetres




Minimum radius of curvature = R50.

The mass shall be 100 kg.

Material shall be hardwood or plastic (Shore hardness > 90).

a Centre of gravity.

**Figure 2 — Torso test mass for dynamic testing**

### 6.1.2 Test structure

**6.1.2.1** The test structure shall be of rigid construction, with a natural frequency of vibration in the vertical axis where the anchor device is to be fixed of not less than 200 Hz, and such that the application of a force of 20 kN on that point does not cause a deflection greater than 1 mm.

**6.1.2.2** The test structure shall provide a rigid anchor point consisting of a ring of (20 ± 1) mm bore and (15 ± 1) mm diameter cross-section, or a rod of the same diameter cross-section. As necessary, to accommodate specific anchor devices and subsystems, alternative methods of fixing to the test structure are acceptable.

**6.1.2.3** The test structure shall be at such a height as to prevent the torso test mass from striking the floor during dynamic testing. There should be sufficient space underneath the pre-release position of the torso test mass to allow for factors such as free fall, PFAS length and extension, full-body harness stretch and the height of the torso test mass.

### 6.1.3 Quick release device

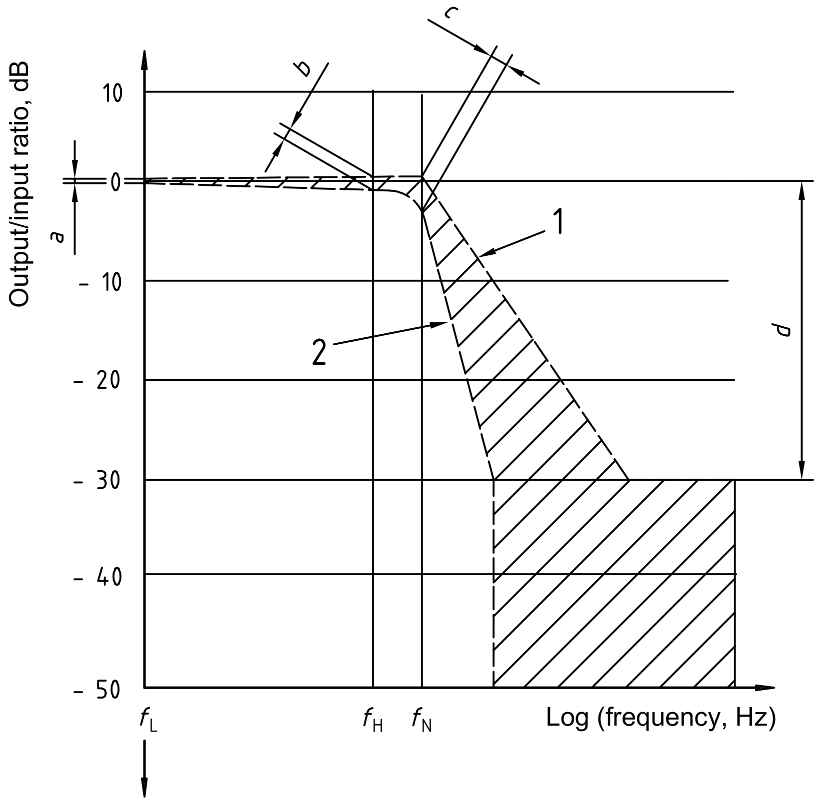
A device shall be provided which is compatible with the rigid torso test mass or connectors and which ensures the release of the torso test mass without initial velocity.

### 6.1.4 Force measuring instrumentation

**6.1.4.1** The instrumentation shall be capable of measuring forces from 1,2 kN to 20 kN with an accuracy of ± 2 % and of withstanding a force of 50 kN without damage. It shall be 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.

**6.1.4.2** 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 3.

**6.1.4.3** A recorder shall be used 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 3 — Frequency response characteristics of the force-measuring instrumentation**

## 6.2 Performance test for A + EAL + FBH type PFAS

### 6.2.1 Preparation

**6.2.1.1** The components/subsystems submitted for testing shall include the specific type of

a) anchor device (A),

b) energy-absorbing lanyard or other lanyard-energy absorber combination (EAL),

c) full-body harness (FBH), and

d) connector (+), and quantity of connectors as necessary.

**6.2.1.2** Secure the anchor device to the test structure, and assemble the components/subsystems into the intended PFAS, in accordance with the manufacturer's instructions.

### 6.2.2 Testing

**6.2.2.1** Fit the supplied full-body harness onto the torso test mass as it would be worn by a human wearer, in accordance with the manufacturer's instructions. Adjust the full-body harness to ensure a snug fit to the torso test mass.

**6.2.2.2** Raise the torso test mass in an upright posture. Attach one end of the energy-absorbing lanyard to one of the full-body harness fall arrest attachment points using one of the supplied connectors and, similarly, the other end to the load cell, which shall be attached to the anchor device installed on the test structure.

**6.2.2.3** Lower the torso test mass until the test assembly fully supports it in suspension. Measure and record the height $H_\mathrm{Q}$ (the distance from the underside of the torso test mass to the floor). See Figure 4 a).

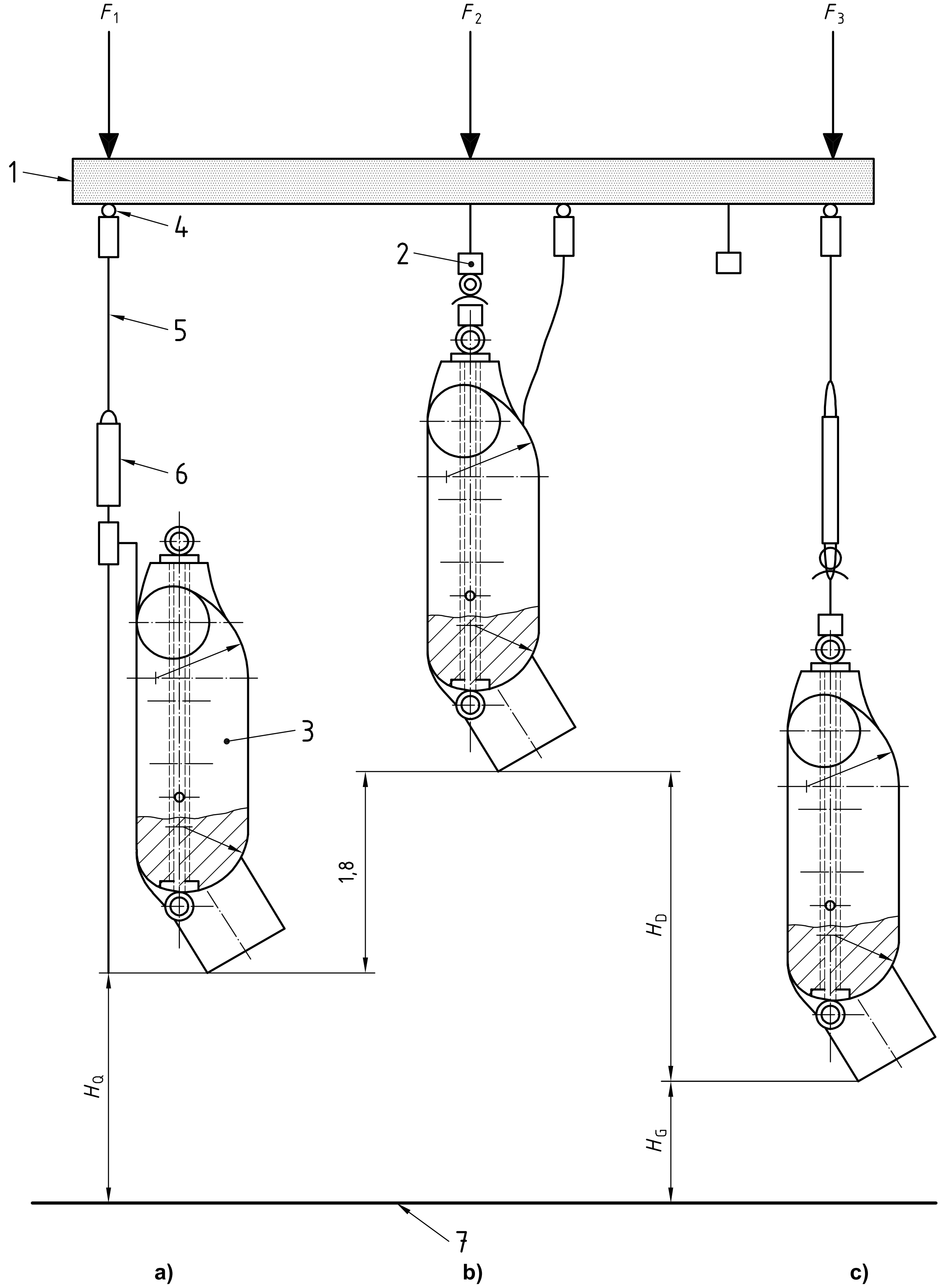
**6.2.2.4** Raise the torso test mass to $H_\mathrm{Q}$ + 1,8 m and secure to the quick release device [Figure 4 b)]. Ensure that the lifting eyebolt on the torso test mass is at a maximum horizontal distance of 300 mm from the vertical axis of the anchor device attachment point before release.

**6.2.2.5** Release the torso test mass. Measure and record the force with respect to time. With the torso test mass at rest [Figure 4 c)], measure and record height $H_\mathrm{G}$ (the distance from the underside of the torso test mass to the floor). Calculate and record the fall distance $H_\mathrm{D}$:

$$H_\mathrm{D} = (H_\mathrm{Q} + 1{,}8) - H_\mathrm{G}$$

**6.2.2.6** With the torso test mass in post-drop suspension, measure and record the angle formed between the back surface of the torso test mass and the energy-absorbing lanyard in the median plane.

Dimensions in metres




**Key**

$F_1$ to $F_3$ load applications

1 test structure

2 quick-release device

3 torso test mass

4 load cell

5 lanyard

6 energy-absorber

7 floor

**Figure 4 — Performance test arrangement for A + EAL + FBH type PFAS**

**6.2.2.7** With the torso test mass remaining in post-drop suspension, observe and record whether, in respect of the full-body harness, there is any

a) tearing of any primary webbing material,

b) tearing of any primary strap sewn joint,

c) partial or complete fracture of any fastening or adjusting buckle,

d) inadvertent opening of any fastening buckle, or

e) straps applying pressure to the neck of the torso test mass,

and, also, whether there is any tearing or rupture of any element of the energy-absorbing lanyard (except where such tearing was deliberately designed to contribute to energy dissipation), and whether any of the above occurs in respect of connectors and anchor devices in addition to any partial fractures or inadvertent opening of gates.

**6.2.2.8** With the test system dismantled and the full-body harness removed from the torso test mass, repeat the examination in accordance with 6.2.2.7, except for d) and e).

**6.2.2.9** Carry out the performance test in accordance with 6.2.2.1 to 6.2.2.8 for each fall arrest attachment point on the specific full-body harness. A new set of components/subsystems shall be submitted in each case.

## 6.3 Performance test for A + SRL + FBH type PFAS

### 6.3.1 Preparation

**6.3.1.1** The components/subsystems submitted for testing shall include the specific type of

a) anchor device (A),

b) self-retracting lifeline (SRL),

c) full-body harness (FBH), and

d) connector (+), and quantity of connectors as necessary.

**6.3.1.2** Secure the anchor device to the test structure and assemble the components/subsystems into the intended PFAS, in accordance with the manufacturer's instructions.

### 6.3.2 Testing

**6.3.2.1** Fit the full-body harness onto the torso test mass as it would be worn by a human wearer, in accordance with the manufacturer's instructions. Adjust the full-body harness to ensure a snug fit to the torso test mass.

**6.3.2.2** Raise the torso test mass in an upright posture. Attach the lifeline end of the SRL to one of the full-body harness fall arrest attachment points using the lifeline connector, and attach the housing of the self-retracting lifeline by its connection method to the load cell, which shall be attached to the anchor device installed on the test structure.

**6.3.2.3** Raise the torso test mass until 300 mm of lifeline is visible, as measured from the lifeline exit point of the self-retracting lifeline to the fall arrest attachment point on the full-body harness, then secure to the quick release device [see Figure 5 a)]. Measure and record height $H_Q$ (the distance from the underside of the torso test mass to the floor). Ensure that the lifting eyebolt on the torso test mass is at a maximum horizontal distance of 300 mm from the vertical axis of the anchor device attachment point before release.

**6.3.2.4** Release the torso test mass. Measure and record the force with respect to time. With the torso test mass at rest [Figure 5 b)], measure and record height $H_G$ (the distance from the underside of the torso test mass to the floor). Calculate and record the fall distance $H_D$:

$$H_D = H_Q - H_G$$

**6.3.2.5** With the torso test mass in post-drop suspension, measure and record the angle formed between the back surface of the torso test mass and the lifeline in the median plane.

**6.3.2.6** With the torso test mass remaining in post-drop suspension, observe and record whether, in respect of the full-body harness, there is any

a) tearing of any primary webbing material,

b) tearing of any primary strap sewn joint,

c) partial or complete fracture of any fastening or adjusting buckle,

d) inadvertent opening of any fastening buckle, or

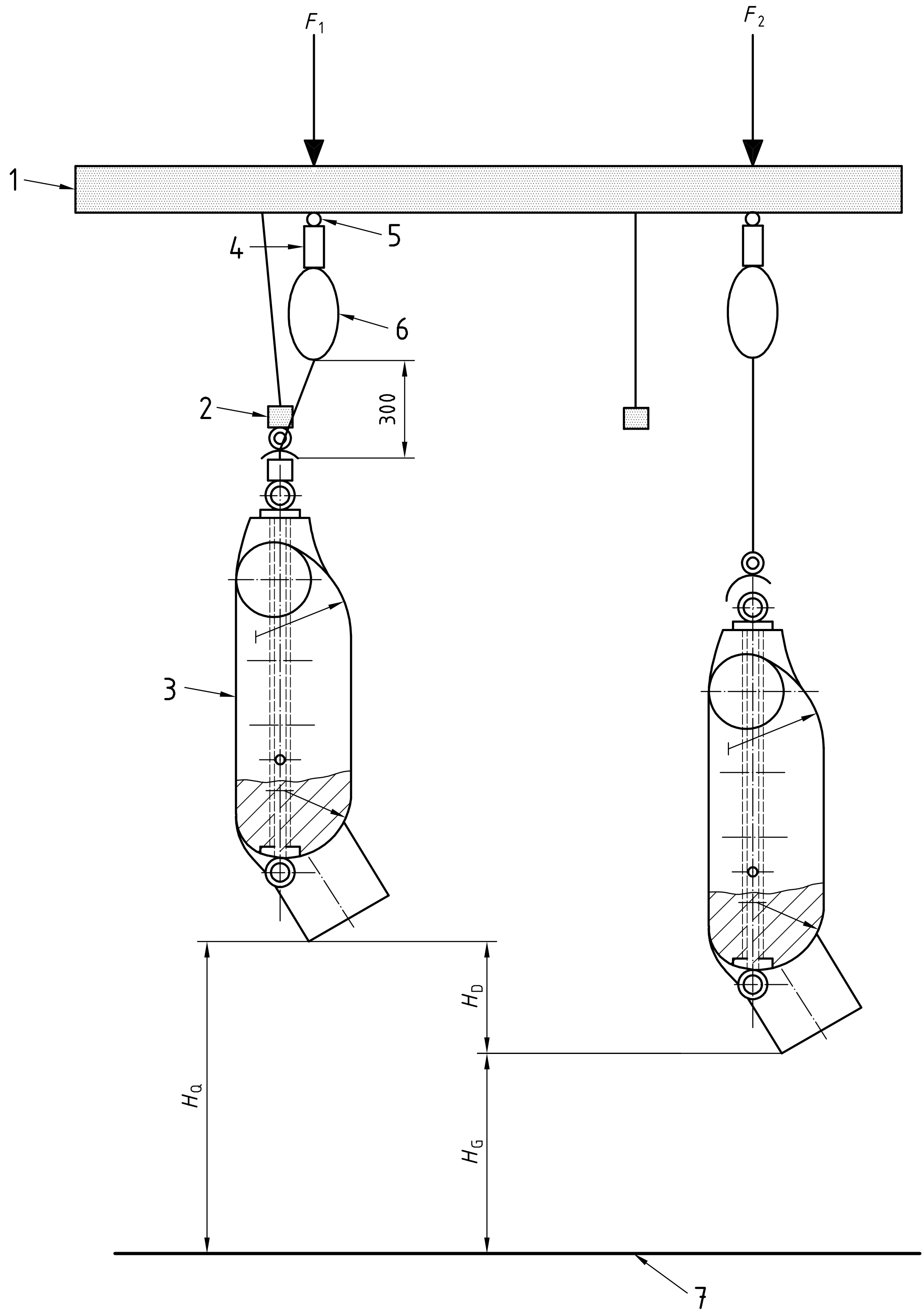
e) straps applying pressure to the neck of the torso test mass,

and, also, whether there is any tearing or rupture of any element of the self-retracting lifeline (except where such tearing was deliberately designed to contribute to energy dissipation), and whether any of the above has occurred in respect of connectors and anchor devices in addition to any partial fractures or inadvertent opening of gates.

**6.3.2.7** With the test system dismantled and the full-body harness removed from the rigid torso test mass, repeat the examination in accordance with 6.3.2.6, except for d) and e).

**6.3.2.8** Carry out the performance test in accordance with 6.3.2.1 to 6.3.2.7 for each fall arrest attachment point on the specific full-body harness. A new set of components/subsystems shall be submitted in each case.

Dimensions in millimetres




**Key**

| | | | | | |
|---|---|---|---|---|---|
| $F_1$, $F_2$ | load applications | 3 | torso test mass | 6 | SRL |
| 1 | test structure | 4 | load cell | 7 | floor |
| 2 | quick-release device | 5 | load cell | | |

**Figure 5 — Performance test arrangement for A + SRL + FBH type PFAS**

## 6.4 Performance test for A + TVLL + FBH type PFAS

### 6.4.1 Preparation

**6.4.1.1** The components/subsystems submitted for testing shall include the specific type of

a) anchor device (A), and quantity of anchor devices as necessary,

b) temporary vertical lifeline (TVLL) and sliding-type fall arrester,

c) full-body harness (FBH), and

d) connector (+), and quantity of connectors as necessary.

**6.4.1.2** Secure the anchor device to the test structure, and assemble the components/subsystems into the intended PFAS, in accordance with the manufacturer's instructions.

### 6.4.2 Testing

**6.4.2.1** Fit the supplied full-body harness onto the torso test mass as it would be worn by a human wearer, in accordance with the manufacturer's instructions. Adjust the full-body harness to ensure a snug fit of the full-body harness to the torso test mass.

**6.4.2.2** Raise the torso test mass in an upright posture. Attach the sliding-type fall arrester to the temporary vertical lifeline in accordance with the manufacturer's instructions. Attach the connecting line of the sliding-type fall arrester to the full-body harness fall arrest attachment point using the connector, and attach the upper end of the temporary vertical lifeline to the load cell, which shall be attached to the anchor device installed on the test structure.

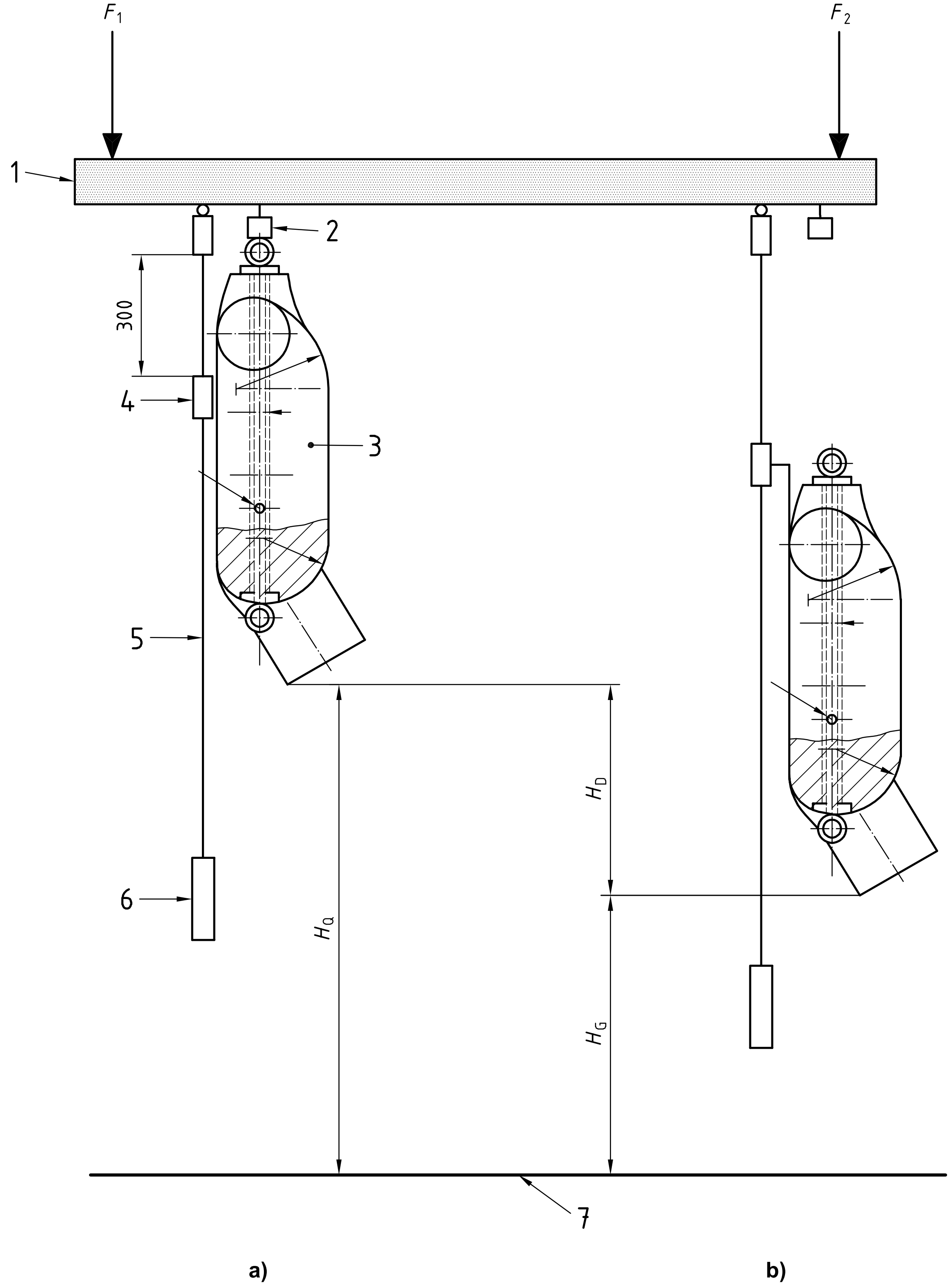
**6.4.2.3** Raise the torso test mass to the maximum height permitted by the length of the sliding-type fall arrester's connecting line, and secure to the quick release device [see Figure 6 a)], so that the sliding-type fall arrester is a maximum of 300 mm from where the temporary vertical lifeline connects to the load cell. Measure and record height $H_Q$ (the distance from the underside of the torso test mass to the floor). Ensure that the lifting eyebolt on the torso test mass is at a maximum horizontal distance of 300 mm from the vertical axis of the anchor device attachment point before release.

**6.4.2.4** Release the torso test mass. Measure and record the force with respect to time. With the torso test mass at rest [(see Figure 6 b)], measure and record height $H_G$ (the distance between the underside of the torso test mass and the test structure floor). Calculate and record the fall distance $H_D$:

$$H_D = H_Q - H_G$$

**6.4.2.5** With the torso test mass in post-drop suspension, measure and record the angle formed between the back surface of the torso test mass and the lifeline in the median plane.

Dimensions in millimetres




**Key**

| | | | | | |
|---|---|---|---|---|---|
| $F_1$, $F_2$ | load applications | 3 | torso test mass | 6 | tensioning mass |
| 1 | test structure | 4 | sliding-type fall arrester | 7 | floor |
| 2 | quick-release device | 5 | TVLL | | |

**Figure 6 — Performance test arrangement for A + TVLL + FBH type PFAS**

**6.4.2.6** With the torso test mass remaining in post-drop suspension, observe and record whether, in respect of the full-body harness, there is any

a) tearing of any primary webbing material,

b) tearing of any primary strap sewn joint,

c) partial or complete fracture of any fastening or adjusting buckle,

d) inadvertent opening of any fastening buckle, or

e) straps applying pressure to the neck of the torso test mass,

and, also, whether there is any tearing or rupture of any element of the temporary vertical lifeline and sliding-type fall arrester (except where such tearing was deliberately designed to contribute to energy dissipation), and whether any of the above has occurred in respect of connectors and anchor devices in addition to any partial fractures or inadvertent opening of gates.

**6.4.2.7** With the test system dismantled and the full-body harness removed from the torso test mass, repeat the examination in accordance with 6.4.2.6, except for d) and e).

**6.4.2.8** Carry out the performance test in accordance with 6.4.2.1 to 6.4.2.7 for each type or size of lifeline specified for use with the sliding-type fall arrester. A new set of components/subsystems shall be submitted in each case.

**6.4.2.9** Carry out the performance test in accordance with 6.4.2.1 to 6.4.2.7 for each fall arrest attachment point on the specific full-body harness. A new set of components/subsystems shall be submitted in each case.

## 6.5 Performance test for A + PVLL + FBH type PFAS

### 6.5.1 Preparation

**6.5.1.1** The components/subsystems submitted for testing shall include the specific type of

a) anchor device (A), and quantity of anchor devices as necessary,

b) permanent vertical lifeline (PVLL) and sliding-type fall arrester,

c) full-body harness (FBH), and

d) connector (+), and quantity of connectors as necessary.

**6.5.1.2** Secure the permanent vertical lifeline and any intermediate brackets to the test structure and assemble the components/subsystems into the intended PFAS, in accordance with the manufacturer's instructions.

### 6.5.2 Testing

**6.5.2.1** Fit the supplied full-body harness onto the torso test mass as it would be worn by a human wearer, in accordance with the manufacturer's instructions. Adjust the full-body harness to ensure a snug fit to the torso test mass.

**6.5.2.2** Raise the torso test mass in an upright posture. Attach the sliding-type fall arrester to the permanent vertical lifeline in accordance with the manufacturer's instructions. Connect one end of the load cell to the connecting line of the sliding-type fall arrester and the other to the full-body harness sternal fall arrest attachment point using the supplied connectors.

**6.5.2.3** With the sliding-type fall arrester positioned mid-way between the top and next intermediate permanent vertical lifeline fastening point, raise the torso test mass to the maximum height permitted by the length of the sliding-type fall arrester's connecting line, with the load cell hanging downwards [see Figures 7 a) and 8], and secure to the quick release device. The load cell shall be maintained in the pre-release position — otherwise its physical length could significantly contribute to the free fall of the torso test mass during the performance test.

NOTE The load cell can be maintained in this position prior to release of the torso test mass using a small cord, being tied to the top of the load cell and to the connector or other equipment that holds the torso test mass to the quick release device and is released at the same time as the torso test mass.

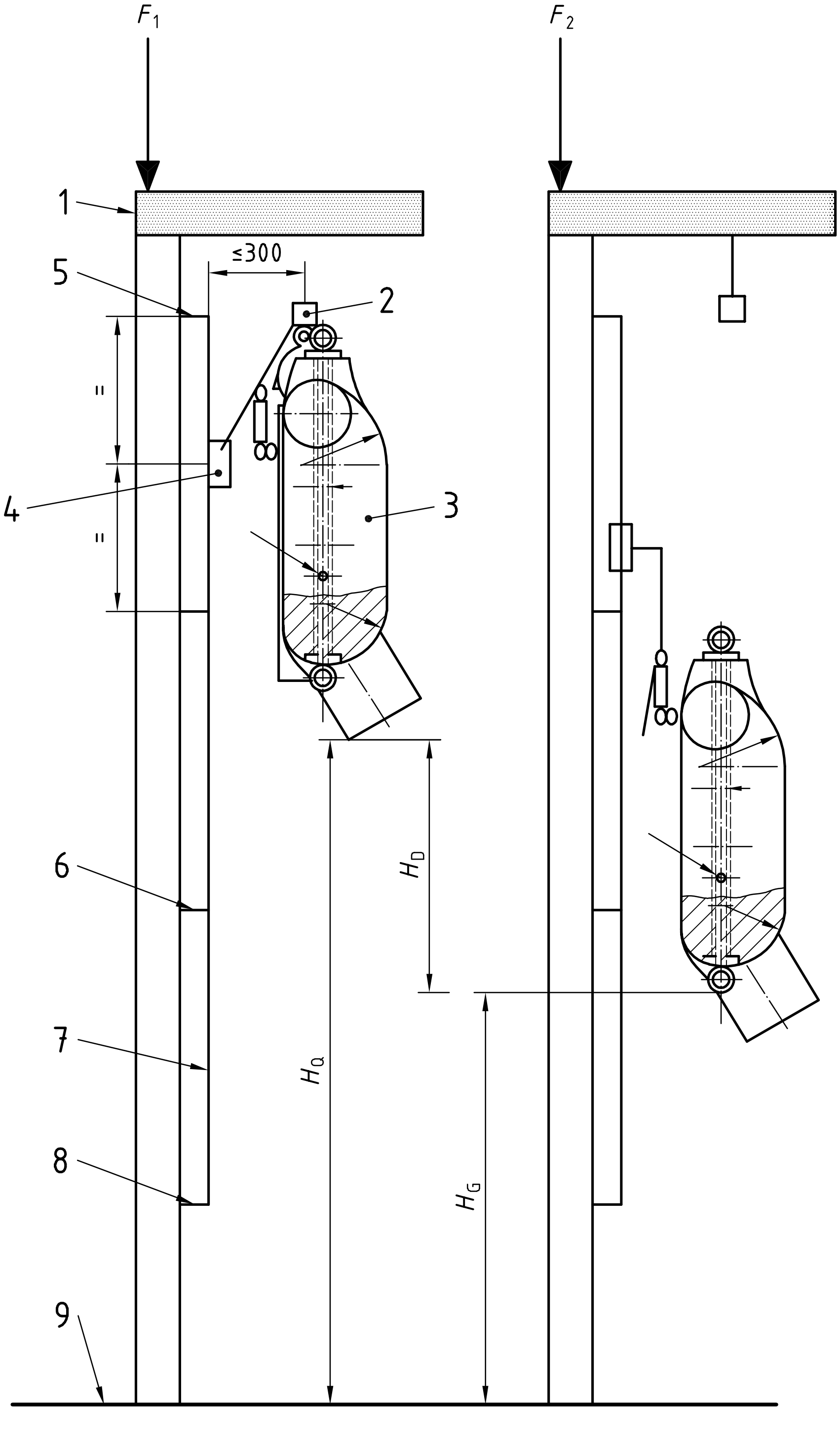
**6.5.2.4** Measure and record height $H_Q$ (the distance from the underside of the torso test mass to the floor). Ensure that the lifting eyebolt on the torso test mass is at a maximum horizontal distance of 300 mm from the permanent vertical lifeline before release.

**6.5.2.5** Release the torso test mass. Measure and record the force with respect to time. With the torso test mass at rest [(Figure 7 b)], measure and record height $H_G$ (the distance from the underside of the torso test mass to the floor). Calculate and record the fall distance $H_D$:

$$H_D = H_Q - H_G$$

**6.5.2.6** With the torso test mass in post-drop suspension, measure and record the angle formed between the back surface of the torso test mass and the lifeline in the median plane.

Dimensions in millimetres




a) b)

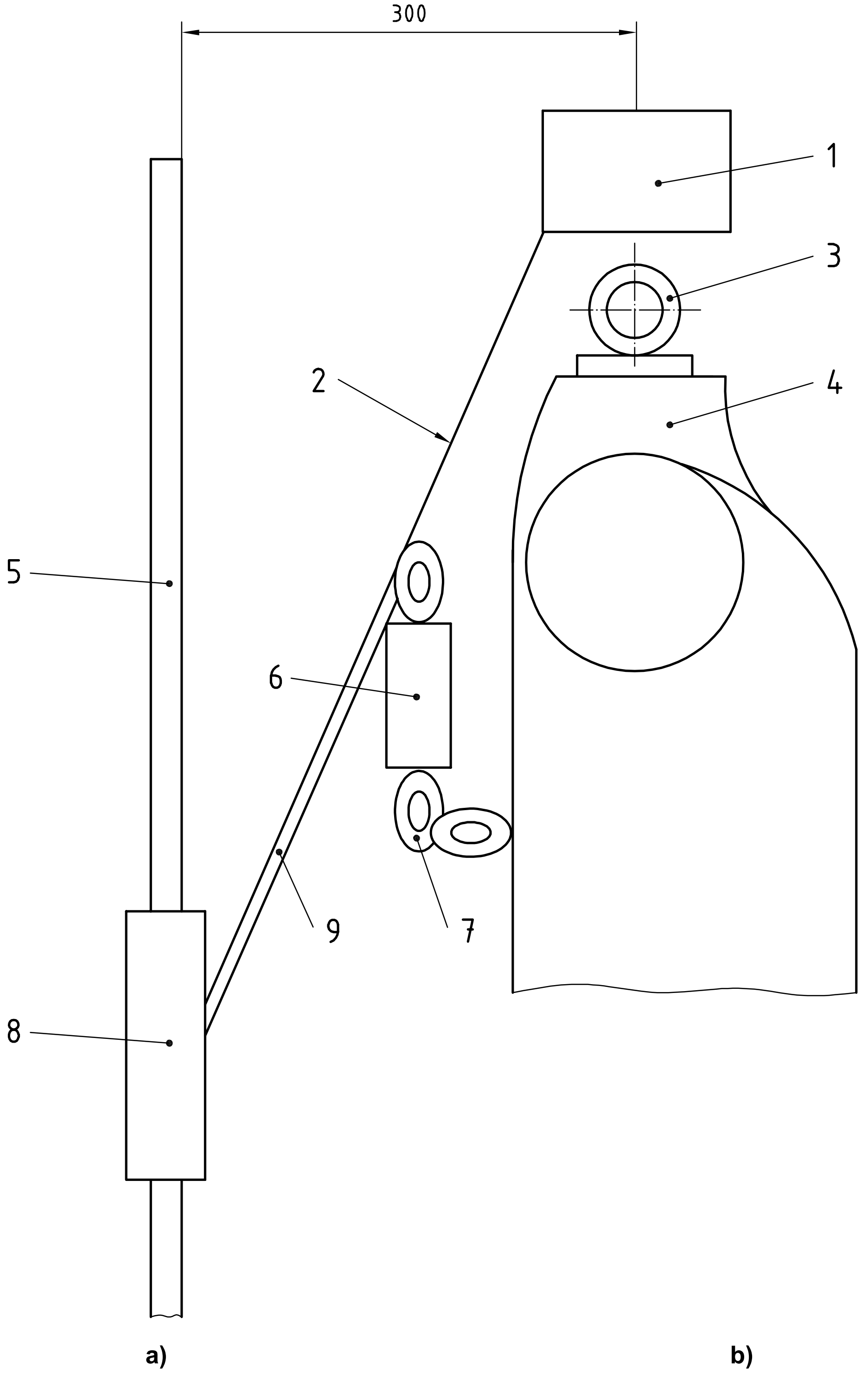
**Key**

$F_1$, $F_2$ load applications

| | | | | | |
|---|---|---|---|---|---|
| 1 | test structure | 4 | sliding-type fall arrester | 7 | PVLL |
| 2 | quick-release device | 5 | upper PVLL fastening point | 8 | lower PVLL fastening |
| 3 | torso test mass | 6 | intermediate PVLL fastening point | 9 | floor |

**Figure 7 — Performance test arrangement for A + PVLL + FBH type PFAS**

Dimensions in millimetres




**Key**

| | | | | | |
|---|---|---|---|---|---|
| 1 | quick-release device | 4 | neck of torso test mass | 7 | load cell connection |
| 2 | small cord | 5 | PVLL | 8 | sliding-type fall arrester |
| 3 | torso test mass eyebolt | 6 | load cell (vertical) | 9 | connecting line |

**Figure 8 — Detail of load cell arrangement in the pre-release position** [see Figure 7 a)]

**6.5.2.7** With the torso test mass remaining in post-drop suspension, observe and record whether, in respect of the full-body harness, there is any

a) tearing of any primary webbing material,

b) tearing of any primary strap sewn joint,

c) partial or complete fracture of any fastening or adjusting buckle,

d) inadvertent opening of any fastening buckle, or

e) straps applying pressure to the neck of the torso test mass,

and, also, whether there is any tearing or rupture of any element of the permanent vertical lifeline and sliding-type fall arrester (except where such tearing was deliberately designed to contribute to energy dissipation), and whether any of the above has occurred in respect of connectors, fixing attachments and anchor devices in addition to any partial fractures or inadvertent opening of gates.

**6.5.2.8** With the test system dismantled and the full-body harness removed from the torso test mass, repeat the examination in accordance with 6.5.2.7, except for d) and e).

**6.5.2.9** Carry out the performance test in accordance with 6.5.2.1 to 6.5.2.8 for each type or size of lifeline specified for use with the sliding-type fall arrester. A new set of components/subsystems shall be submitted in each case.

## 6.6 Performance test for A + VR + FBH type PFAS

### 6.6.1 Preparation

**6.6.1.1** The components/subsystems submitted for testing shall include the specific type of

a) anchor device (A), and quantity of anchor devices as necessary,

b) vertical rail (VR) and sliding-type fall arrester,

c) full-body harness (FBH), and

d) connector (+), and quantity of connectors as necessary.

**6.6.1.2** Secure the vertical rail and intermediate brackets to the test structure and assemble the components/subsystems into the intended PFAS, in accordance with the manufacturer's instructions.

### 6.6.2 Testing

**6.6.2.1** Fit the supplied full-body harness onto the torso test mass as it would be worn by a human wearer, in accordance with the manufacturer's instructions. Adjust the full-body harness to ensure a snug fit to the torso test mass.

**6.6.2.2** Raise the torso test mass in an upright posture. Attach the sliding-type fall arrester to the vertical rail in accordance with the manufacturer's instructions. Connect one end of the load cell to the connecting line of the sliding-type fall arrester, and the other to the full-body harness sternal fall arrest attachment point using the supplied connectors.

**6.6.2.3** With the sliding-type fall arrester positioned mid-way between the top and next intermediate vertical rail fastening point, raise the torso test mass to the maximum height permitted by the length of the sliding-type fall arrester's connecting line, with the load cell hanging downwards [see Figures 9 a) and 10], and secure to the quick release device. The load cell shall be maintained in the pre-release position, otherwise its physical length could significantly contribute to the free fall of the torso test mass during the performance test.

NOTE The load cell can be maintained in this position prior to release of the torso test mass by using a small cord. This is tied to the top of the load cell and to the connector or other equipment that holds the torso test mass to the quick release device, and is released at the same time as the torso test mass.

**6.6.2.4** Measure and record height $H_Q$ (the distance from the underside of the torso test mass to the floor). Ensure that the lifting eyebolt on the torso test mass is at a maximum horizontal distance of 300 mm from the vertical rail before release.

**6.6.2.5** Release the torso test mass. Measure and record the force with respect to time. With the torso test mass at rest, [see Figure 9 b)], measure and record height $H_G$ (the distance from the underside of the torso test mass to the floor). Calculate and record the fall distance $H_D$:

$$H_D = H_Q - H_G$$

**6.6.2.6** With the torso test mass in post-drop suspension, measure and record the angle formed between the back surface of the torso test mass and the lifeline in the median plane.

**6.6.2.7** With the torso test mass remaining in post-drop suspension, observe and record whether, in respect of the full-body harness, there is any

a) tearing of any primary webbing material,

b) tearing of any primary strap sewn joint,

c) partial or complete fracture of any fastening or adjusting buckle,

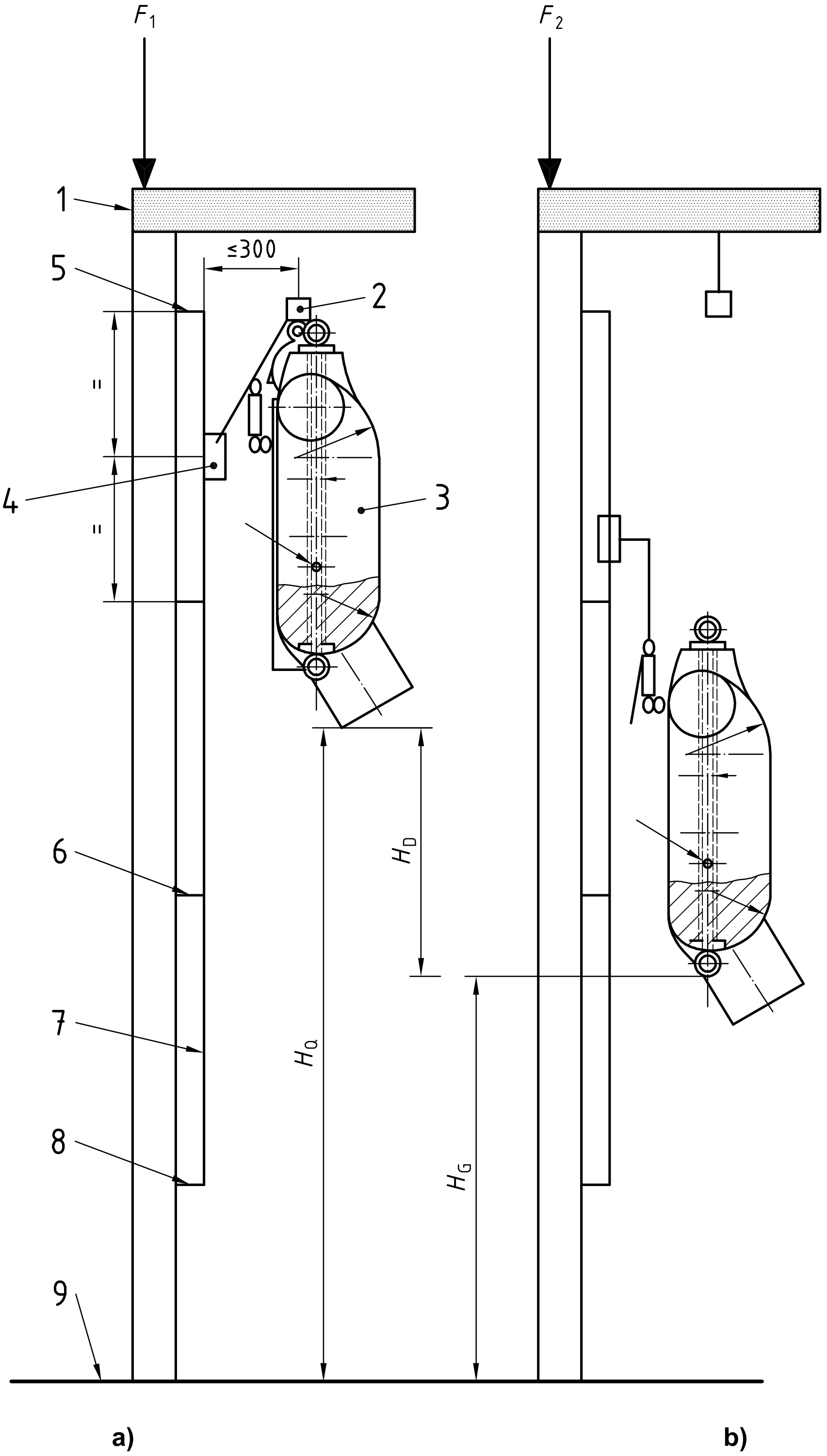
d) inadvertent opening of any fastening buckle, or

e) straps applying pressure to the neck of the torso test mass,

and, also, whether there is any tearing or rupture of any element of the vertical rail fall arrester (except where such tearing was deliberately designed to contribute to energy dissipation), and whether any of the above has occurred in respect of connectors, fixing attachments and anchor devices in addition to any partial fractures or inadvertent opening of gates.

**6.6.2.8** With the test system dismantled and the full-body harness removed from the torso test mass, repeat the examination in accordance with 6.6.2.7, excepting d) and e).

Dimensions in millimetres




**Key**

$F_1$, $F_2$ load applications

1 test structure

2 quick-release device

3 torso test mass

4 sliding-type fall arrester

5 upper VR fastening point

6 intermediate VR fastening point

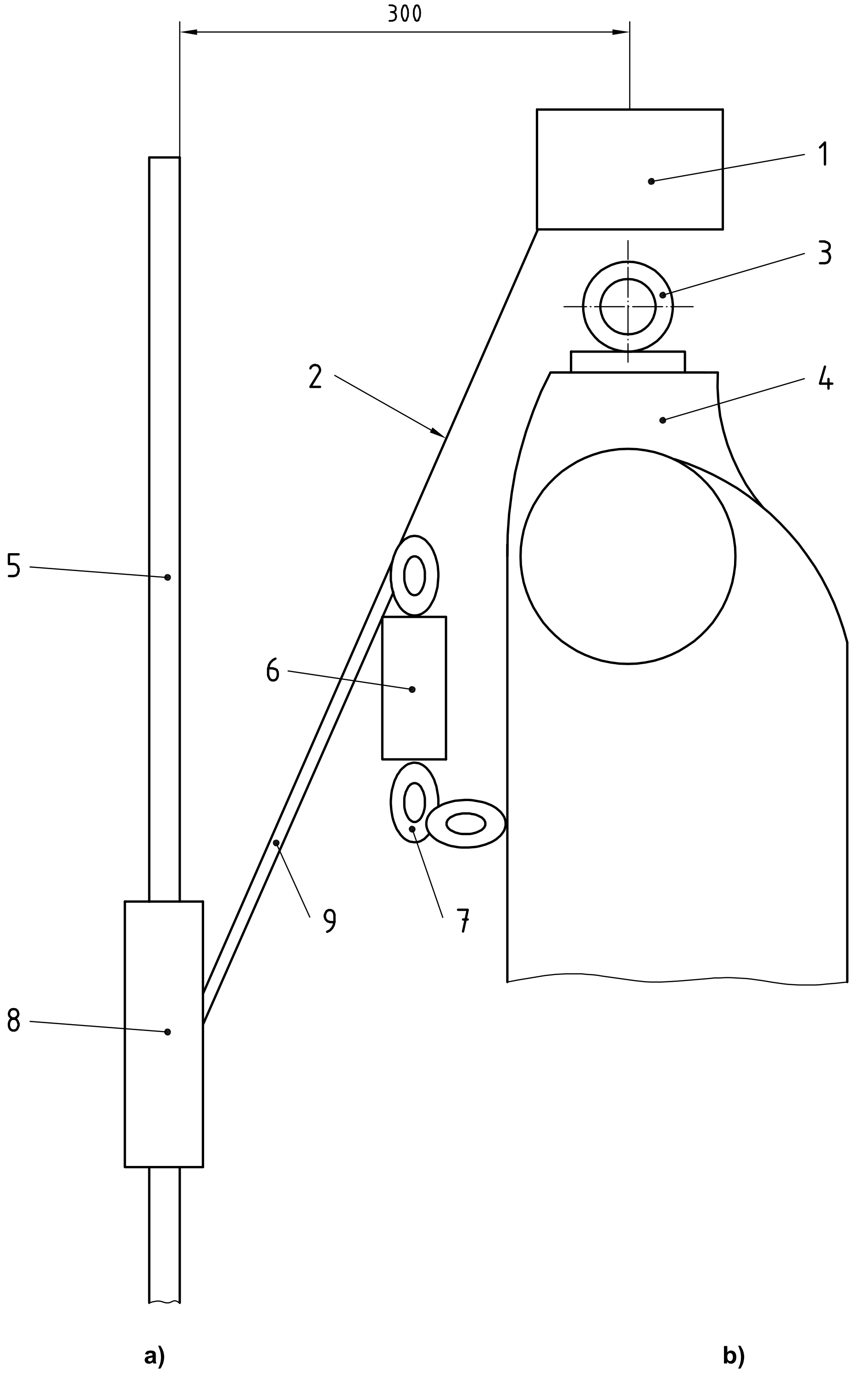
7 VR

8 lower VR fastening

9 floor

**Figure 9 — Performance test arrangement for A + VR + FBH type PFAS**

Dimensions in millimetres




**Key**

| | | | | | |
|---|---|---|---|---|---|
| 1 | quick-release device | 4 | neck of torso test mass | 7 | load cell connection |
| 2 | small cord | 5 | rail | 8 | sliding-type fall arrester |
| 3 | torso test mass eyebolt | 6 | load cell (vertical) | 9 | connecting line |

**Figure 10 — Detail of load cell arrangement in the pre-release position** [see Figure 9 a)]

**6.6.2.9** Carry out the performance test in accordance with 6.6.2.1 to 6.6.2.8 for each type or size of rail specified for use with the sliding-type fall arrester. A new set of components/subsystems shall be submitted in each case.

## 7 Supplied information

**7.1** Instructions for use shall be supplied as specified in the individual component/subsystem standards, i.e. ISO 10333-1 to ISO 10333-5 and ISO 14567, according to type.

**7.2** A record of system performance shall be included with the instructions for use, which shall include

a) a list of the specific PFAS components/subsystems by model/type/identification mark subjected to the performance test,

b) the subclause numbers of this part of ISO 10333 in accordance with which the specific PFAS was tested, and

c) performance details as specified in the example of a record of system performance as shown in Figure 11.

| | |
|---|---|
| PFAS Description:<br><br>Subsystems included:<br><br>Components included:<br><br>ISO 10333-6 test subclauses:<br><br>Date of test:: Tested by: | Serial No./Batch No.: |
| Maximum arrest force: | kN |
| Fall distance $H_D$: | m |
| Angle of rigid torso test mass: | ° |

**Figure 11 — Example of system performance chart**

Required free space (see A.2) may be calculated by adding fall distance with other dimensions as recorded during PFAS performance tests under the specific test conditions, and by including a safety clearance between the torso test mass and the test structure with the torso test mass in post fall arrest suspension. The value of required free space will be different for each configuration of PFAS and each combination of components/subsystems, and will also vary according to test conditions and the amount of safety clearance allowed. An example is shown in ISO 14567.

# Annex A
(informative)

# Design, ergonomics and free space

## A.1 Design and ergonomics

A PFAS shall be designed, manufactured and assembled

a) such that, in the foreseeable conditions of use for which it is intended, the user can perform the risk related activity in a normal manner while enjoying appropriate protection,

b) so as to preclude risks and nuisance factors in the foreseeable conditions of use,

c) so as to allow correct positioning on the user and to remain in place for the foreseeable period of use, bearing in mind ambient factors, movements to be made and postures to be adopted, and such that it is possible to optimize the adaptation of a full-body harness to user morphology by all appropriate means, (e.g. using adequate adjustment elements or the provision of an adequate size range),

d) so that it is as light as possible without prejudicing design strength and efficiency,

e) so that it will remain correctly adjusted under the foreseeable conditions of use, and not become undone or loose without the wearer's knowledge,

f) so that, should a user fall, the vertical drop of the user will be minimized, the vertical drop of the user will be clear of obstacles and the arresting force will remain below a value of 6 kN,

g) such that, after a fall arrest has occurred, the user may be supported as comfortably as possible and maintained in the correct position until help and rescue is available.

## A.2 Free space

**IMPORTANT — Use of a fall arrest system should not be contemplated in situations where there is insufficient free space available. If a fall occurs in such circumstances, the worker could strike the ground or other level.**

Fall arrest systems should be designed to provide adequate distance for any fall to be arrested. The arrest should be achieved by gradually reducing the speed of the fall while bringing it to a halt. If a fall is arrested too abruptly, the worker may suffer serious, and possibly fatal, injuries. The system should allow sufficient height for this to take place without the worker hitting the ground or other substantial object in the fall path (e.g. part of a building).

This allowance is known as required *free space* (clearance distance).

Whichever fall arrest system is used, it is essential to ensure that adequate free space be provided. The following factors should be considered.

a) **Free fall:**

— with energy-absorbing lanyards, the greater the free fall the more the energy absorber has to extend to absorb the energy and hence the greater the free space required;

— with retractable type fall arresters, free fall is much reduced (check manufacturer's specification).

b) **Arest distance:**

— how much the energy-absorbing lanyard extends under test conditions; or

— how much retractable type fall arrester is pulled out during the operation of the brake under test conditions.

c) **Full-body harness stretch:** the attachment point of a full-body harness tends to rise as the arrest force is applied.

d) **Weight of worker in single use systems:** the greater the weight that has to be arrested, the more the energy absorber has to extend or the anchor line has to pull out.

e) **Weight and number of workers in multi-use systems:** the greater the weight and number of workers that have to be arrested, the more the anchor line will be deflected.

f) **Height of worker:** the distance between the attachment point and the worker's feet.

g) **Safety clearance** of at least 1 m to allow for the need for some clearance between the worker's feet and the ground or other impact hazard at the point of maximum extension of the fall arrest system in order to avoid injury (including bounce).

# Bibliography

[1] ISO 1459, *Metallic coatings — Protection against corrosion by hot dip galvanizing — Guiding principles*

[2] ISO 1460, *Metallic coatings — Hot dip galvanized coatings on ferrous materials — Gravimetric determination of the mass per unit area*

[3] ISO 9000, *Quality management systems — Fundamentals and vocabulary*

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