UL 60947-5-5

STANDARD FOR SAFETY

Low-Voltage Switchgear and Controlgear – Part 5-5: Control circuit devices and switching elements – Electrical emergency stop device with mechanical latching function

UL Standard for Safety for Low-Voltage Switchgear and Controlgear – Part 5-5: Control circuit devices and switching elements – Electrical emergency stop device with mechanical latching function, UL 60947-5-5

First Edition, Dated August 11, 2017

Summary of Topics

This revision of UL 60947-5-5 dated September 13, 2019 incorporates Amendment 2 of the First Edition of IEC 60947-5-5.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated May 24, 2019.

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UL 60947-5-5

Standard for Low-Voltage Switchgear and Controlgear – Part 5-5: Control circuit devices and switching elements – Electrical emergency stop device with mechanical latching function

First Edition

August 11, 2017

This ANSI/UL Standard for Safety consists of the First Edition including revisions through September 13, 2019.

The most recent designation of ANSI/UL 60947-5-5 as an American National Standard (ANSI) occurred on September 13, 2019. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or Preface. The National Difference Page and IEC Foreword are also excluded from the ANSI approval of IEC-based standards. Any other portions of this ANSI/UL standard that were not processed in accordance with ANSI/UL requirements are noted at the beginning of the impacted sections.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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Preface (UL)

This UL Standard is based on IEC Publication 60947-5-5: 1.1 edition Low-Voltage Switchgear and Controlgear – Part 5-5: Control circuit devices and switching elements – Electrical emergency stop device with mechanical latching function, as revised by amendment 1 (2005-1) and corrigendum (July 2007), and amendment 2 (2016-02). IEC publication 60947-5-5 is copyrighted by the IEC.

This UL Standard 60947-5-5 Standard for Safety for Low-Voltage Switchgear and Controlgear – Part 5-5: Control circuit devices and switching elements – Electrical emergency stop device with mechanical latching function, is to be used in conjunction with the fifth edition of UL 60947-1 and the third edition of UL 60747-5-1. The requirements for control circuit devices and switching elements – electrical emergency stop device with mechanical latching function are contained in this Part 2 Standard and UL 60747-1 and UL 60747-5-1.

Requirements of this Part 2 Standard, where stated, amend the requirements of UL 60947-1 and UL 60747-5-1.

Where a particular subclause of UL 60947-1 and UL 60947-5-1 is not mentioned in UL 60947-5-5, the UL 60947-1 and/or UL 60947-5-1 subclause applies.

Note – Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

National Differences

National Differences from the text of International Electrotechnical Commission (IEC) Publication 60947-5-5, Low-voltage switchgear and controlgear – Part 5-5: Control circuit devices and switching elements – Electrical emergency stop device with mechanical latching function – Edition 1:1997 consolidated with amendments 1 and 2 are indicated by notations (differences) and are presented in bold text. The national difference type is included in the body.

There are five types of National Differences as noted below. The difference type is noted on the first line of the National Difference in the standard. The standard may not include all types of these National Differences.

D1 – These are National Differences which are based on **basic safety principles and requirements**, elimination of which would compromise safety for consumers and users of products.

D2 – These are National Differences from IEC requirements based on existing **safety practices**. These requirements reflect national safety practices, where empirical substantiation (for the IEC or national requirement) is not available or the text has not been included in the IEC standard.

DC – These are National Differences based on the **component standards** and will not be deleted until a particular component standard is harmonized with the IEC component standard.

DE – These are National Differences based on **editorial comments or corrections**.

DR – These are National Differences based on the **national regulatory requirements**.

Each national difference contains a description of what the national difference entails. Typically one of the following words is used to explain how the text of the national difference is to be applied to the base IEC text:

Addition / Add - An addition entails adding a complete new numbered clause, subclause, table, figure, or annex. Addition is not meant to include adding select words to the base IEC text.

Deletion / Delete - A deletion entails complete deletion of an entire numbered clause, subclause, table, figure, or annex without any replacement text.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR – Part 5-5: Control circuit devices and switching elements – Electrical emergency stop device with mechanical latching function

FOREWORD

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This Consolidated version of IEC 60947-5-5 bears the edition number 1.2. It consists of the first edition (1997-11) [documents 17B/837/FDIS and 17B/856/RVD], its amendment 1 (2005-01) [documents 17B/1389/FDIS and 17B/1399/RVD] and its corrigendum (July 2007), and its amendment 2 (2016-02) [documents 121A/60/FDIS and 121A/72/RVD]. The technical content is identical to the base edition and its amendments.

This Final version does not show where the technical content is modified by amendments 1 and 2. A separate Redline version with all changes highlighted is available in this publication.

International Standard IEC 60947-5-5 has been prepared by subcommittee 17B: Low-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

This standard shall be used in conjunction with IEC 60947-1 and with IEC 60947-5-1.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under ″http://webstore.iec.ch″ in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

The present IEC 60947-5-5 deals specifically with electrical emergency stop devices with mechanical latching function and gives additional electrical and mechanical requirements to those given in the following International Standards:

– ISO 13850 giving requirements for the emergency stop function of a machine, whatever be the energy used;

– IEC 60204-1 giving additional requirements for an emergency stop function realized by the electrical equipment of a machine;

– IEC 60947-5-1 specifying electrical characteristics of electromechanical control circuit devices.

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR – Part 5-5: Control circuit devices and switching elements – Electrical emergency stop device with mechanical latching function

1 Scope

This section of IEC 60947-5 provides detailed specifications relating to the electrical and mechanical construction of emergency stop devices with mechanical latching function and to their testing.

This standard is applicable to electrical control circuit devices and switching elements which are used to initiate an emergency stop signal. Such devices may be either provided with their own enclosure, or installed according to the manufacturer's instructions.

This standard does not apply to:

– emergency stop devices for non-electrical control circuit, for example hydraulic, pneumatic;

– emergency stop devices without mechanical latching function.

An emergency stop device may also be used to provide an emergency switching off function.

This standard does not deal with any specific requirements on noise as the noise emission of electrical emergency stop devices with mechanical latching function is not considered to be a relevant hazard.

NOTE See also 9.2.5.4 of IEC 60204-1:2005.

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.

IEC 60050(441):1984, *International Electrotechnical Vocabulary (IEV) – Chapter 441: Switchgear, controlgear,* Amendment 1 (2000)

IEC 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2:2007, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-6:2007, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-11:1981, *Environmental testing – Part 2: Tests – Test Ka: Salt mist*

IEC 60068-2-27:2008, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-30:2005, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60417-DB:2002[1], *Graphical symbols for use on equipment*

IEC 60204-1:1997, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements* Amendment 1 (1999)

IEC 60721-3-3:1994, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 3: Stationary use at weather protected location* Amendment 1 (1995) Amendment 2 (1996)

IEC 60947-1:2007, *Low-voltage switchgear and controlgear – Part 1: General rules* IEC 60947-1:2007/AMD1:2010 IEC 60947-1:2007/AMD2:2014

IEC 60947-5-1:2016, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*

IEC 61310-1:2007, *Safety of machinery – Indication, marking and actuation – Part 1: Requirements for visual, acoustic and tactile signals*

ISO 13850:2015, *Safety of machinery – Emergency stop function – Principles for design*

[1] "DB" refers to the IEC on-line database, available at: http://www.graphical-symbols.info/equipment.

3 Definitions

For the purpose of this section of IEC 60947-5, the following definitions apply in addition to those given in IEC 60947-1 and in IEC 60947-5-1.

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	A	
Actuated position		3.6
Actuating system (of an emergency stop device)		3.3
Actuator (of an emergency stop device)		3.4
	D	
Direct opening action (of a contact element)		3.9
	E	
Emergency stop (function or signal)		3.1
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	L	
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	P	
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	R	
Resetting (of an emergency stop device)		3.8
Rest position		3.5
	T	
Trip wire switch		3.10

3.1
emergency stop (function or signal)

function or signal which is intended:

– to avert or to reduce hazards to persons, damage to machinery or to work in progress;

– to be initiated by a single human action.

[ISO 13850:2015, definition 3.1, modified– extended to “emergency stop signal”, no use of E-stop]

3.2
emergency stop device

manually operated control circuit device used to initiate an emergency stop function

NOTE An emergency stop device may also provide auxiliary functions, for example for redundancy and/or for signalling through additional contact element(s). Such additional contact(s) may be normally open and/or normally closed.

3.3
actuating system (of an emergency stop device)

mechanical parts which transmit the actuating force to the contact elements

[IEC 60050-441:1984, 441-15-21, modified – restricted to electromechanical emergency stop devices; the note is not relevant anymore]

3.4
actuator (of an emergency stop device)

part of the actuating system which is actuated by a part of the human body

NOTE 1 Examples of an actuator may be a button, a wire, a rope, a bar, a foot pedal.

[IEC 60050-441:1984, 441-15-22, modified – actuation is intented to be achieved by human only]

3.5
rest position

position of an emergency stop device, or of a part of it, which has not been actuated

NOTE In rest position, the machine (or equipment) may work.

3.6
actuated position

position of an emergency stop device, or of a part of it, after it has been actuated

NOTE In the actuated position of the emergency stop device the machine (or equipment) remains at rest.

3.7
latching (of an emergency stop device)

function or means which engage and maintain the actuating system in the actuated position until reset by a separate manual action

3.8
resetting (of a emergency stop device)

manual action to retun the actuating system of the emergency stop device from the actuated position to the rest position

NOTE Examples of resetting include the rotation of a key, or of the actuator, pulling the actuator or pushing or rotating a special reset button.

3.9
direct opening action (of a contact element)

DEPRECATED: positive opening action (of a contact element)

achievement of contact separation as a direct result of a specified movement of the switch actuator through non-resilient members (e.g. non dependent upon springs)

[IEC 60947-5-1:2016, K.2.2, modified – addition of a deprecated term]

3.10
trip wire switch

rope pull switch

pull cord operated switch

emergency stop device in which the actuator is a rope, a wire or similar means

4 Marking and product information

4.1 General

Information for installation, operation, maintenance and/or periodic testing shall be provided when necessary on or with the emergency stop device.

The verification of clause 4 shall be conducted according to 7.2.1.

NOTE 1 In certain circumstances, it may be necessary to provide additional information, for example:

– by labels,

– by marker flags attached to wires or ropes to improve their visibility,

by a graphical symbol (see 4.2.2 or Table A.1 of IEC 61310-1:2007).

4.2 Indications on buttons

4.2.1 Buttons used as emergency stop device actuators shall be coloured red. When a background exists behind the actuator, it shall be coloured yellow.

Where a symbol is needed for clarification, the symbol IEC 60417-5638 (DB:2002-10) shall be used (see Figure 2).

Figure 2 – Symbol (5638) for emergency stop

4.2.2 The direction of unlatching shall be identified when resetting is achieved by rotation of the button. This identification shall have the same or nearly the same colour as the actuator in order to avoid misinterpretation.

NOTE See also IEC 60073 and ISO 3864 series.

4.3 Additional requirements for trip wire switches

Information provided by the manufacturer shall include:

– the maximum length of wire or rope;

– the correct tension of wire or rope;

– the distances between supports;

– recommendation to use only straight runs of wire or rope;

– if applicable, guidance on maintenance for pulleys and eyelets, and the measures necessary to ensure that the wire or rope remains in proper position.

4.4 Additional requirements for colour coding

A resetting button, for example where applicable with a trip wire switch, shall be coloured blue.

When coloured indicators are provided to assist setting of a trip wire switch:

– green shall indicate the correct setting of the rest position; and

– yellow shall indicate the correct setting of the actuated position.

5 Electrical requirements

5.1 Depending on the associated devices, the utilization categories shall be one or more categories selected from Table 1 of IEC 60947-5-1:2016.

NOTE For guidance refer to Annex K of IEC 60947-5-1:2016.

5.2 All normally closed contact elements of an emergency stop device shall have a direct opening action, in accordance with Annex K of IEC 60947-5-1:2016.

The tests shall be conducted according to Annex K of IEC 60947-5-1:2016.

5.3 The degree of protection provided by the emergency stop device shall be stated by the manufacturer in accordance with annex C of IEC 60947-1.

5.4 Tests for electrical characteristics shall be conducted according to IEC 60947-5-1.

NOTE Subclause 7.2.7 of IEC 60947-5-1:2016 only applies to control switches suitable for isolation.

5.5 Electrical requirements for functional safety applications: in cases where it is necessary to obtain data, tests shall be made according to A.3.2.3 of this standard.

6 Mechanical requirements

6.1 General requirements

6.1.1 Means shall be provided to enable the emergency stop device to be securely installed in its intended mounting position.

The test shall be conducted according to 7.2.1.

6.1.2 The emergency stop device shall meet the requirements of 7.3, 7.4, 7.5, 7.6 and, where applicable, of 7.7.5.

6.1.3 It shall be possible to operate and reset the emergency stop device under all normal service conditions.

The test shall be conducted according to 7.2 to 7.7.4.

6.1.4 Vibration or shocks shall not cause the opening of the contacts in the closed position or the closing of the contacts in the open position, nor operation of the latching mechanism.

The tests shall be conducted according to 7.5 and 7.6.

6.2 Latching

6.2.1 When the emergency stop signal (including the necessary clearance distance) has been generated during actuation of the emergency stop device, the emergency stop function shall be maintained by latching of the actuating system. The emergency stop signal shall be maintained until the emergency stop device is reset (disengaged). It shall not be possible for the emergency stop device to latch-in without generating the emergency stop signal.

In case of failure in the emergency stop device (including the latching means), the generation of the emergency stop signal shall have priority over the latching function.

The tests shall be conducted according to 7.2, 7.7.2 and 7.7.3.

6.2.2 The latching shall operate correctly when the emergency stop device is used under conditions, specified either in 7.4 or by the manufacturer, whichever is more severe.

The test shall be conducted according to 7.3, 7.4, 7.5, 7.6 and 7.7.

6.3 Additional requirements for button type emergency stop device

6.3.1 The resetting of the latching means shall be by turning a key, by rotation in the designated direction, or by a pulling motion.

The test shall be conducted according to 7.2.1 and 7.2.2.1.

6.3.2 The emergency stop device shall be so designed that:

– the emergency stop actuator can be operated in a direction perpendicular to its mounting surface;

– removal of the actuator is from the inside of the enclosure, or from the outside of the enclosure by use of a tool intended for that purpose;

– it can be actuated by a one-handed continuous motion.

This shall be verified by inspection (see 7.2.1).

6.4 Additional requirements for trip wire switches

6.4.1 The construction of the emergency stop device shall be such that:

– the setting of the wire or rope, and subsequent adjustment, can be carried out without causing malfunction; and

– the installation of the emergency stop device can fulfil the requirements of 4.4.1 and 4.42 of ISO 13850:2015.

The tests shall be conducted according to 7.2 and 7.3.

6.4.2 When the actuator is installed according to the manufacturer's instructions:

– the perpendicular pulling force applied at the mid-length of the wire or rope, necessary for generating the emergency stop signal (opening of the contacts), shall be less than 200 N;

– the perpendicular deflection of the wire or rope (at mid-length), necessary for generating the emergency stop signal, shall be less than 400 mm;

– the breaking or disengagement of the wire or rope shall generate the emergency stop signal;

– the wire or rope shall resist a tension force 10 times higher than the perpendicular pulling force necessary for generating the emergency stop signal.

The tests shall be conducted according to 7.8.1.

6.4.3 Changes in the length of the rope (for example temperature, age etc.) shall be taken into account.

The tests shall be conducted according to 7.2.1.

6.5 Additional requirement for footswitches

A pedal (footswitch) type emergency stop device shall have no cover.

The test shall be conducted according to 7.2.1.

6.6 Mechanical requirements for functional safety applications

In cases where it is necessary to obtain data needed for functional safety applications, tests shall be made according to A.3.2.2 of this standard.

7 Testing of the mechanical design

7.1 General

In accordance with 8.1.1 and 8.1.2 of IEC 60947-1, type tests shall be made to prove compliance with the requirements of clauses 4, 5 and 6.

An emergency stop device may have combinations of both main and auxiliary contacts. The tests given in 7.5 and 7.6 are to verify that all these contacts are not adversely affected by mechanical shocks.

Some tests, for example based on visual inspection, or by checking the literature provided with the emergency stop device, require only one sample.

For the tests described in 7.3.3, 7.4, 7.5, 7.6 and 7.7, three identical samples of emergency stop device shall be selected, and each sample shall be subjected successfully to the sequence of tests, in the order given in this clause.

When more than one type of emergency stop device is manufactured to the same basic design, less than three identical samples may be tested, providing that more than three products of the same family are tested. Such an acceptance shall be fully documented.

7.2 General design inspection

7.2.1 The requirements of 4.1, 6.1.1, 6.4.1 and, where applicable, of 6.3, 6.4.3 and 6.5 are verified by inspection of the mechanical structure of the emergency stop device.

7.2.2 Button type emergency stop device:

7.2.2.1 The requirement of 6.3.1 is checked by latching and resetting the actuator manually.

7.2.2.2 The requirement of 6.3.2 is verified by inspection of the fastening parts, and by pulling and turning the button and other parts of the device by hand.

7.3 Operating tests

7.3.1 General

The purpose of the operating tests is to verify the durability of the latching parts (springs, balls, pins etc.) in normal use.

The test verifies the requirements of 6.1.2, 6.2.2 and 6.3.

The operating tests described in this subclause may be carried out in conjunction with the electrical tests (see clause 5).

7.3.2 Robustness of a button actuator

A button actuator shall withstand:

– a force as specified in Table 1, applied in the three mutually perpendicular axes; and

– a torque as specified in Table 1, in both directions of rotation, in each of the latched and unlatched positions, where the resetting action requires rotation of the push-button.

Table 1 – Robustness of a button type actuator

Mounting hole diameter mm	Force N	Torque N m
D16: $16{,}2^{+0{,}2}_{0}$	80	1,6
D22: $22{,}3^{+0{,}4}_{0}$	110	2,2
D30: $30{,}5^{+0{,}5}_{0}$	150	3,0

For mounting holes having dimension other than in Table 1:

– force (in newton) shall be five times the largest dimension of the mounting hole (i.e., for a square or rectangular hole, the diagonal measurement) in mm;

– torque (in newton meter) shall be equal to 0,1 time the largest dimension of the mounting hole (i.e., for a square or rectangular hole, the diagonal measurement) in mm.

For an emergency stop button not mounted in a single hole:

– if the actuator diameter (or largest dimension) is less than 30 mm, use the values for D22 mm;

– if the actuator diameter (or largest dimension) is equal to or greater than 30 mm, use the values for D30 mm.

7.3.3 Durability test

The three samples (see 7.1) shall be subjected to the following test:

The actuator of an emergency stop device shall be moved through its full travel, then it shall be reset in a manner to imitate human operation as closely as possible. For pushbuttons, the requirements of IEC 60947-5-1:2016, 8.3.2.1 a) applies.

The test shall consist of 6 050 cycles in which latching and resetting of the actuator occurs during each cycle. The movement and actuating forces shall be consistent throughout the test. Monitoring of these parameters shall be carried out to ensure consistency. For the actuating forces, verification at the beginning and at the end is required.

The durability test is passed if each emergency stop device completes the 6 050 cycles without failure.

7.4 Conditioning procedures

The purpose of the following procedures is to expose the emergency stop devices to various environmental conditions in order to verify their functioning after such exposure.

Devices intended for mounting on enclosures shall be mounted for the purposes of this conditioning in such a manner as to permit the entire emergency stop device to be exposed to the conditioning media except for the exposure to salt mist in accordance with IEC 60068-2-11. Devices subjected to salt mist may be either provided with their own enclosure, or installed in an enclosure according to the manufacturer's instructions. The device is exposed to the salt mist only outside the enclosure.

The device shall be rinsed clean before further tests are performed.

The three emergency stop devices successfully tested in 7.3.3 shall be subjected to the following exposures:

- 96 h at +70 °C in dry atmosphere (see test Bb of IEC 60068-2-2 and IEC 60721-3-3 class 3K7)
- 96 h at changing moist and warm atmosphere (see IEC 60068-2-30 and IEC 60721-3-3 class 3K7):

  +25 °C/+55 °C 97 % / 93 % RH

- 96 h at –40 °C (see IEC 60068-2-1: test Ab and IEC 60721-3-3 class 3K7)
- 96 h at +35 °C in a solution of 5 % NaCl (see IEC 60068-2-11 and IEC 60721-3-3 class 3C3).

Following the environmental exposures and after the devices have been restored to room temperature, the sequence of tests in 7.5, 7.6 and 7.7 shall be conducted.

7.5 Shock test

7.5.1 The three emergency stop devices which have been conditioned in accordance with 7.4 shall be tested each on one of the three mutually perpendicular axes.

7.5.2 Each emergency stop device is tested in the rest position and shall withstand 15 *g* shock in both directions of the corresponding axis (see IEC 60068-2-27:11 ms: 15 *g*).

During the test, the closed contacts shall not open, the open contacts, if applicable, shall not close and the latching mechanism shall not latch.

The checking means shall be able to detect any opening or closing of contacts longer than 0,2 ms.

7.5.3 The procedure is repeated in the actuated position (actuator latched).

During the test, the open contacts shall not close; the closed contacts, if applicable, shall not open; and the latching mechanism shall not unlatch.

7.6 Vibration tests

7.6.1 The three samples used for 7.5 shall be tested, one for each of the three mutually perpendicular axes.

7.6.2 Each emergency stop device is tested in the rest position as per the following specifications (see IEC 60068-2-6):

– frequency range: 10 Hz to 500 Hz, logarithmic ramp and return;

– duration 2 h: 10 sweep cycles, 1 oct/min;

– maximum peak amplitude: 0,35 mm (0,7 mm from peak to peak);

– maximum acceleration: 50 m/s^2;

– crossover frequency between 58 Hz and 62 Hz.

During the test, the closed contacts shall not open, the open contacts, if applicable, shall not close, and the latching mechanism shall not latch.

The checking means shall be able to detect any opening or closing of contacts longer than 0,2 ms.

7.6.3 The procedure is repeated in the actuated position (actuator latched).

During the test, the open contacts shall not close, the closed contacts, if applicable, shall not open, and the latching mechanism shall not unlatch.

7.7 Latching, resetting and impact tests

7.7.1 General

The three sample emergency stop devices which have successfully completed the tests of 7.6 shall be used for the following tests.

The requirements of 6.2.1 are verified by testing each sample in accordance with 7.7.2, 7.7.3 and 7.7.4. The sample shall also be tested in accordance with 7.7.5 where applicable.

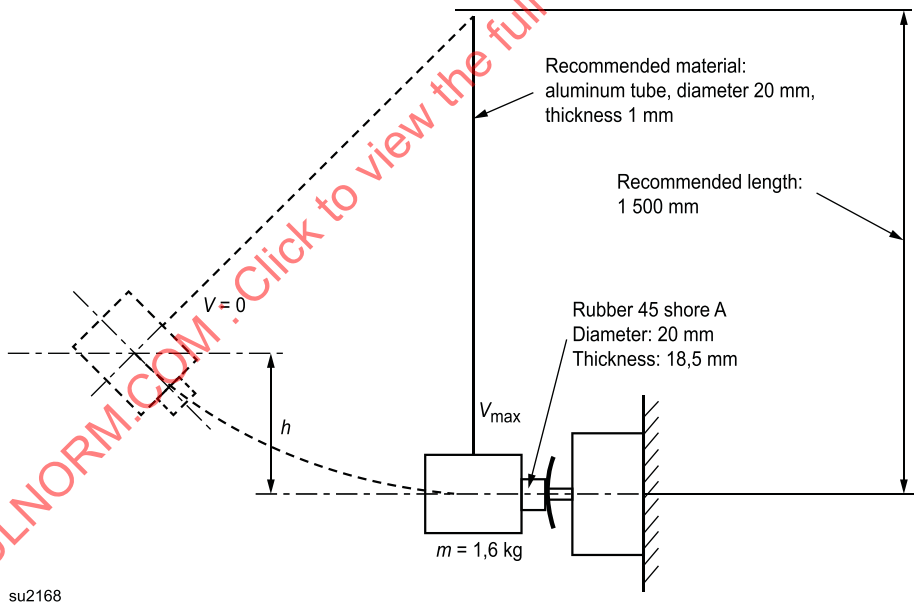
7.7.2 Opening test

The actuator of the emergency stop device shall be moved slowly just to the point where latching occurs.

The normally closed contacts shall then be open. This shall be verified by an impulse voltage test at 2 500 V (see details in K.8.3.4.4.1 of IEC 60947-5-1:2016).

7.7.3 Latching test for button-type emergency device

To simulate the typical human actuation of a button-type switch, the emergency stop device and its actuator shall be mounted and tested by a pendulum-type hammer as shown in Figure 1. The support of the device under test shall not move more than 0,1 mm when the shock is applied (see IEC 60068-2-75).



NOTE The 1,6 kg mass does not include the mass of the aluminium tube.

Figure 1 – Hammer for tests

The relationship between the emergency stop mounting hole and the hammer height (*h*) is given in Table 2.

Table 2 – Relationship between the emergency stop mounting hole and the hammer height

Largest dimension of mounting hole mm	Hammer height (*h*) mm
D16: $16{,}2^{+0{,}2}_{0}$	60 if the actuator diameter is < 30 mm 75 if the actuator diameter is ≥ 30 mm
D22: $22{,}3^{+0{,}4}_{0}$	75
D30: $30{,}5^{+0{,}5}_{0}$	75

For mounting holes having dimension other than in Table 2 the hammer height shall be 75 mm.

For non-circular mounting holes, the largest dimension of the mounting hole (i.e. for a rectangular hole, the diagonal) shall be used to determine the hammer height.

For an emergency stop button not mounted in a single hole:

– if the actuator diameter (or largest dimension) is less than 30 mm, use the values for D22 mm;

– if the actuator diameter (or largest dimension) is equal to or greater than 30 mm, use the values for D30 mm.

The actuator shall be unlatched prior to each strike.

The hammer shall be released whilst stationary.

To ensure that the hammer is released whilst stationary, it is recommended that a magnetic or other holding mechanism is used.

This test shall be performed three times.

After each strike, the actuating system shall be latched.