



Think Automation and beyond...

Guidebook for Designing Emergency Stop Equipment

(Compliant with the revised ISO 13850: 2015, Emergency stop function)



Introduction

ISO 13850 specifies "Safety of machinery—Emergency stop function—Principles for design," a standard (Type-B standards) which describes the safety requirements for designing the emergency stop equipment. ISO 13850 was revised in October 2015, and the revision has a major impact on the design of emergency stop equipment. This guidebook explains the matters that have a significant impact, and shows the guide for designing the equipment.

The emergency stop function is actuated by intended human operation to avert actual or impending emergency situations arising from the behaviour of persons, or from an unexpected hazardous event. For example, since the emergency stop switch is actuated by an intended action in an impending emergency situation, its operability/visibility should be optimized and it should be actuated without hesitation.

In addition, it is also necessary that the stop condition of machine operation resulting from the emergency stop function is maintained until the emergency stop switch is reset by an intended action of operators.

For this reason, this revision has further emphasized human intention. This guidebook contains the excerpts of ISO 13850: 2015. Before designing the emergency stop equipment for machinery, make sure to check the original text of the standard.

Contents

1. Intended actuation	4
1.1 Recommended actuators and nameplates	
1.2 Installation locations of emergency stop devices	
2. Prevention of unintended actuation	7
3. Intended resetting	8
3.1 Importance of human intention	
3.2 Description concerning reset in the instruction manual	
3.3 Unrecommended resetting style	
3.4 Indication of unlatching direction	
4. Prevention of unintended resetting	10
5. Span of control of emergency stop device(s)	11
6. Required performance level (PLr), safety integrity level (SIL)	12
7. Emergency stop function on portable operator control stations	13
Terms and definitions	14

1 Intended actuation

1.1 Recommended actuators and nameplates

The following safety requirements for intended actuation have been in ISO 13850:2006 and 2015.

Safety requirements that have not been revised:

ISO 13850: 2015

4.1.1.2

The emergency stop function shall be available and operational at all times.

4.3.6

The actuator of the emergency stop device shall be coloured RED. As far as a background exists behind the actuator and as far as it is practicable, the background shall be coloured YELLOW.

In addition to the above, the following safety requirement has been added in this revision.

Newly added safety requirement

ISO 13850: 2015

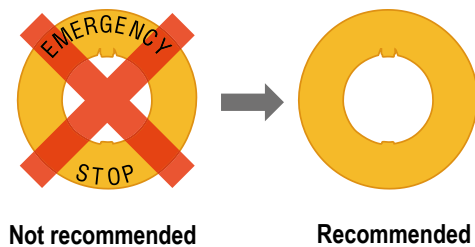
4.3.7

Neither the actuator nor the background should be labelled with text or symbols.

In this revision, it is not recommended to display texts or symbols such as EMERGENCY STOP on the actuator or nameplate of an emergency stop device. In order to accommodate the diversity of first languages of workers due to globalization, the revision aims to enable workers to have the following common recognition without the need to recognize texts or symbols:

A combination of a red actuator and yellow background = Emergency stop device (even if there are no texts/symbols)

Also, when a person intends to actuate an emergency stop device, it is expected that actuation following the recognition of only the color combination of red and yellow is faster than when there are texts/symbols.



Use IDEC's blank nameplates shown below to satisfy the requirement.

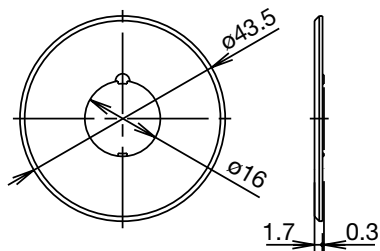
IDEC Emergency Stop Switch Nameplates

Hole Size	Description	Legend	Part No.	Material	Plate Color
ø16	For ø30mm Operator	(blank)	HAAV-0	Polyamide	Yellow
	For ø40mm Operator		HAAV4-0		
ø22	For ø40mm Operator		HWAV-0-Y	Polyamide	
	For ø60mm Operator		HWAV5-0	PBT	
ø30	-		HNAV-0	Polyamide	

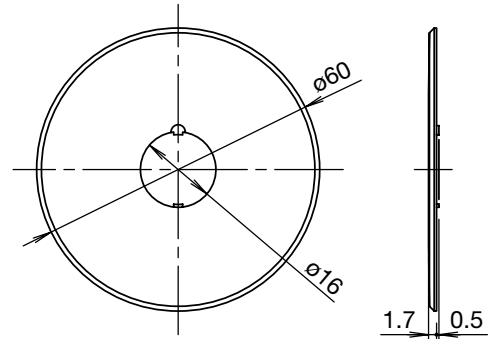
Dimensions

For $\phi 16$ Emergency Stop Switches

For $\phi 30$ mm Operator
HAAV-0

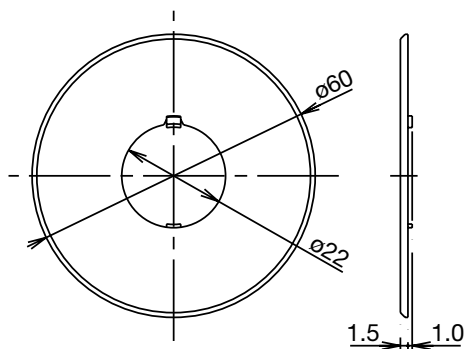


For $\phi 40$ mm Operator
HAAV4-0

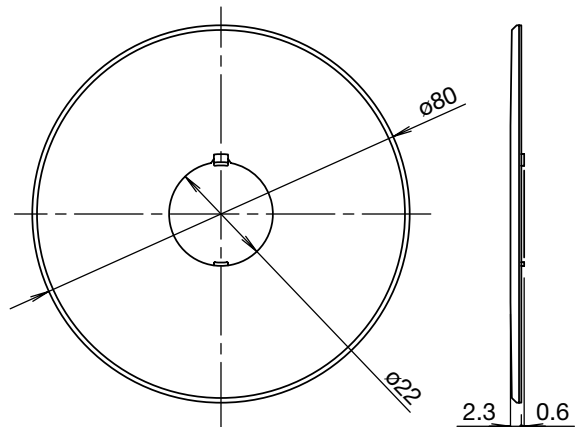


For $\phi 22$ Emergency Stop Switches

For $\phi 40$ mm Operator
HWAV-0-Y

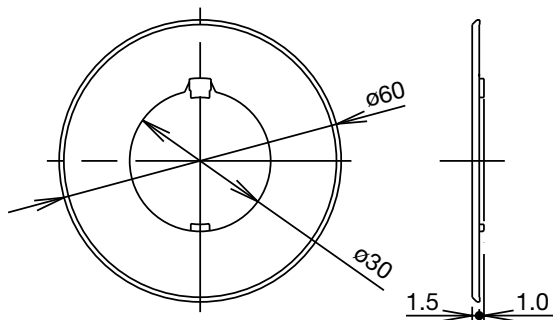


For $\phi 60$ mm Operator
HWAV5-0



For $\phi 30$ Emergency Stop Switches

HNAV-0



All dimensions in mm.

1.2 Installation locations of emergency stop devices

Before the revision, there was a safety requirement concerning the installation location of emergency stop devices.

Safety requirements that have not been revised:

ISO 13850: 2015

4.3.2

An emergency stop device shall be located:

- at each operator control station, except where the risk assessment indicates that this is not necessary;
- at other locations, as determined by the risk assessment

In this revision, examples of installation locations are specified.

Newly added safety requirement

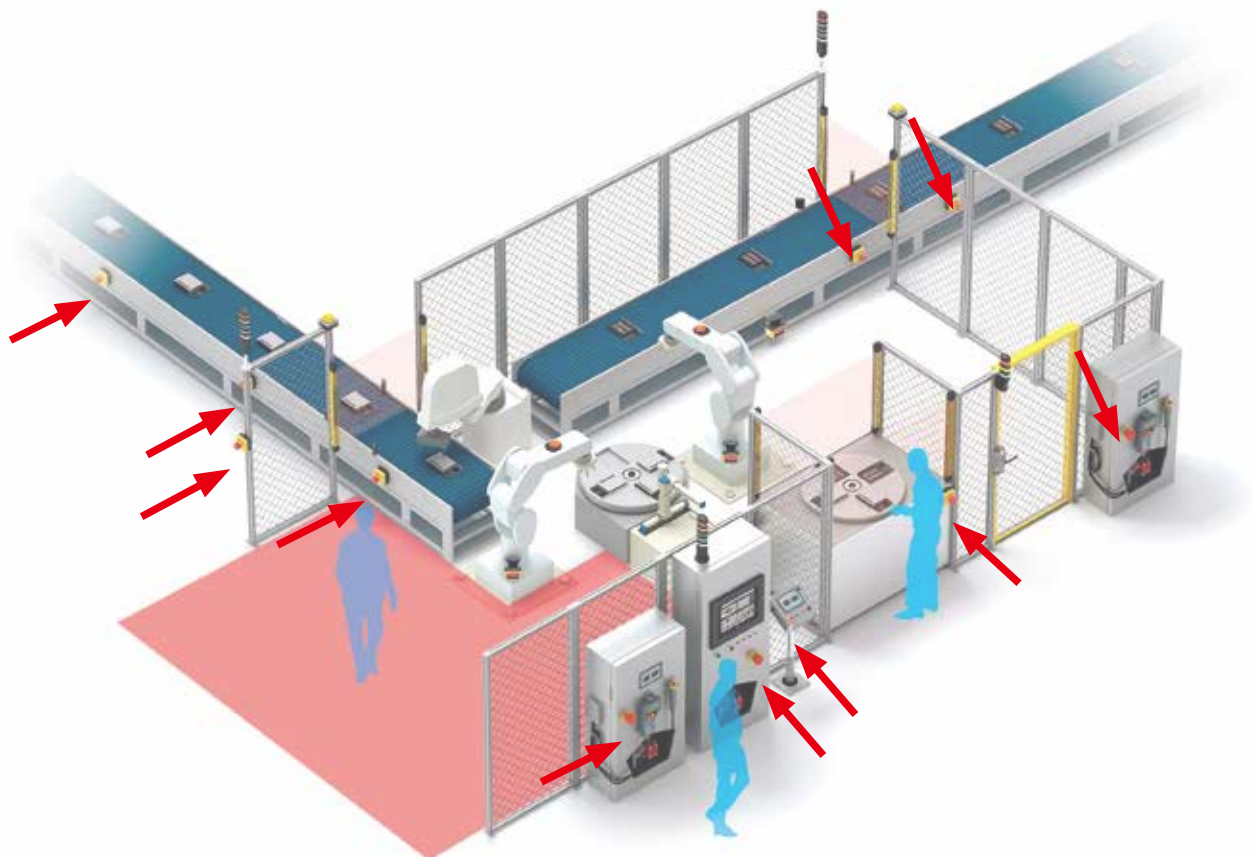
ISO 13850: 2015

4.3.2

An emergency stop device shall be located:

- at other locations, as determined by the risk assessment, e.g.:
- at entrance and exit locations;
- at locations where intervention to the machinery is needed, e.g. operations with a hold-to-run control function;
- at all places where a man / machine interaction is expected by design (loading / unloading zone for example).

The actuator of emergency stop device intended to be actuated by hand should be mounted between 0.6 m and 1.7 m above the access level (e.g. floor level, platform level).



For new and/or existing machines, confirm that the above safety requirements are satisfied.

2. Prevention of unintended actuation

For machinery subject to ISO/IEC standards such as machine tools and food machinery, using a switch guard (used synonymously with protective shroud, a term and definition added in this revision) with an emergency stop switch has not been permitted so far. However, in this revision, the use of a protective shroud has been permitted under certain conditions*, because the "Prevention of unintended actuation of emergency stop devices" is added as a safety requirement, and a protective shroud is defined as one of the means of realizing it.

* Conditions: when it is impossible to prevent unintended actuation at the installation locations, which is included in the following safety requirement

Newly added safety requirement

ISO 13850: 2015

3.7

protective shroud

Mechanical measure provided to reduce the possibility of unintended actuation of an emergency stop device.

Conditions permitting the use of a protective shroud are as follows.

Newly added safety requirement

ISO 13850: 2015

4.5

Prevention of unintended actuation of an emergency stop device

The emergency stop device shall be designed to avoid unintended actuation.

So far as practicable, unintended actuation shall be prevented by location rather than the use of other application design measures.

The actuation of the emergency stop device shall not be impaired. To prevent unintended actuation of the emergency stop device some precautions can be taken, e.g.:

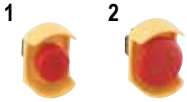


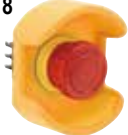
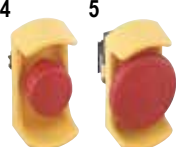
- locate the emergency stop device away from foreseeable heavily trafficked areas,
- select the type of emergency stop device,
- select appropriate size or shape of the emergency stop device, or
- mount the emergency stop device within a recessed surface of the surrounding control panel.

The use of a protective shroud around the emergency stop device should be avoided, except when necessary to prevent unintended actuation and other measures are not practicable.

A protective shroud shall not have any sharp corners or edges or rough surfaces which could lead to injury. Corners and edges shall be de-burred and surfaces shall be smooth to the touch.

If it is determined that a protective shroud is necessary after considering the safety requirements in Section 4.3.2 and 4.5 above, choose one from the following combinations of IDEC switch guards and emergency stop switches. The following combinations have been approved by TÜV Rheinland for complying with the requirements of emergency stop switches with a protective shroud, specified by ISO 13850: 2015.

Combination of emergency stop switch and switch guard compliant with ISO 13850: 2015

Shape	Switch Guard Part No.	Applicable Model	Shape	Switch Guard Part No.	Applicable Model
<p>ø16</p> 	XA9Z-KG1	1: XA1E-BV3 : XA1E-BV4 2: XA1E-LV3 : XA1E-LV4	<p>ø22</p> 	HW9Z-KG5	6: XW1E-BV4 : XW1E-LV4 : XW1E-TV4 7: XW1E-BV5
<p>ø22</p> 		3: XW1E-BV4 : XW1E-LV4 : XW1E-TV4	<p>ø30</p> 		XN9Z-KG1
<p>ø22</p> 	HW9Z-KG4	4: XW1E-BV4 : XW1E-LV4 : XW1E-TV4 5: XW1E-BV5	<TÜV Rheinland Japan Ltd confirmed>		

3. Intended resetting

3.1 Importance of human intention

The following safety requirement has been added in this revision.

Newly added safety requirement

ISO 13850: 2015

4.1.1.2

The emergency stop function shall be reset by intentional human action. Resetting of the emergency stop function shall be operated by disengagement of an emergency stop device.

As described above, human's intention is given an importance to the resetting of emergency stop function.

3.2 Description concerning reset in the instruction manual

The following safety requirement has been added in this revision.

Newly added safety requirement

ISO 13850: 2015

4.1.4

Disengagement (e.g. unlatching) of the emergency stop device

The instructions for use of the machine shall state that, after actuation and before disengaging the device(s), the machinery shall be inspected in order to detect the reason for actuation.

The actuation of an emergency stop device means that there is a possibility that emergency situation has arisen. Therefore, before disengaging the emergency stop device, it is necessary to confirm that the safety conditions of the machinery are being observed. Make sure that the instruction manual states the necessity of inspecting the machinery after actuation and before disengaging the emergency stop device.

3.3 Unrecommended resetting style

The following safety requirement has been added in this revision.

Newly added safety requirement

ISO 13850: 2015

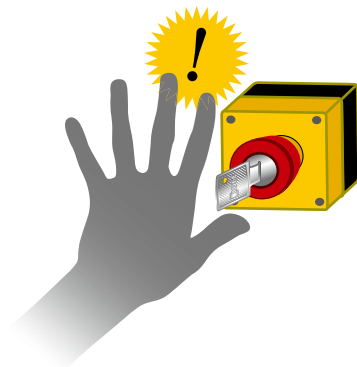
4.3.6

Emergency stop device requiring a key on the actuator to be disengaged (unlatched) should be avoided. When an emergency stop actuator can only be disengaged by using a key, to avoid injuries to hands;

- Instruction for use of the machine shall describe the correct use of the key.
- Provide a warning that the key should only be in the actuator of the device to disengage the actuator.

This safety requirement was added because when you operate the emergency stop switch in an emergency situation while a key is inserted in an actuator, there is a possibility of injuring your hand with the key. Therefore, the use of the key unlatching emergency stop switch is no longer recommended in this revision.

In addition, when using IDEC's key unlatching emergency stop switches after performing a risk assessment, follow the above safety requirement.



3.4 Indication of unlatching direction

The following safety requirement has been added in this revision.

Newly added safety requirement

ISO 13850: 2015

4.3.7

When it is necessary to identify the direction of unlatching of the actuator (button) then this identification shall have the same or nearly the same colour as the actuator.

Actuators of many emergency stop devices show the direction of unlatching with arrows. However, if the arrow is too conspicuous, some workers may mistakenly think that the arrow indicates the direction of actuating the emergency stop switch.

Therefore, in order not to confuse workers at the time of a prompt actuation, arrows indicating the direction of unlatching should not be too conspicuous. Use IDEC's emergency stop switches shown below to satisfy the requirements.



ø16 X6 series



ø16 XA series



ø22 XW series



ø30 XN series

4. Prevention of unintended resetting

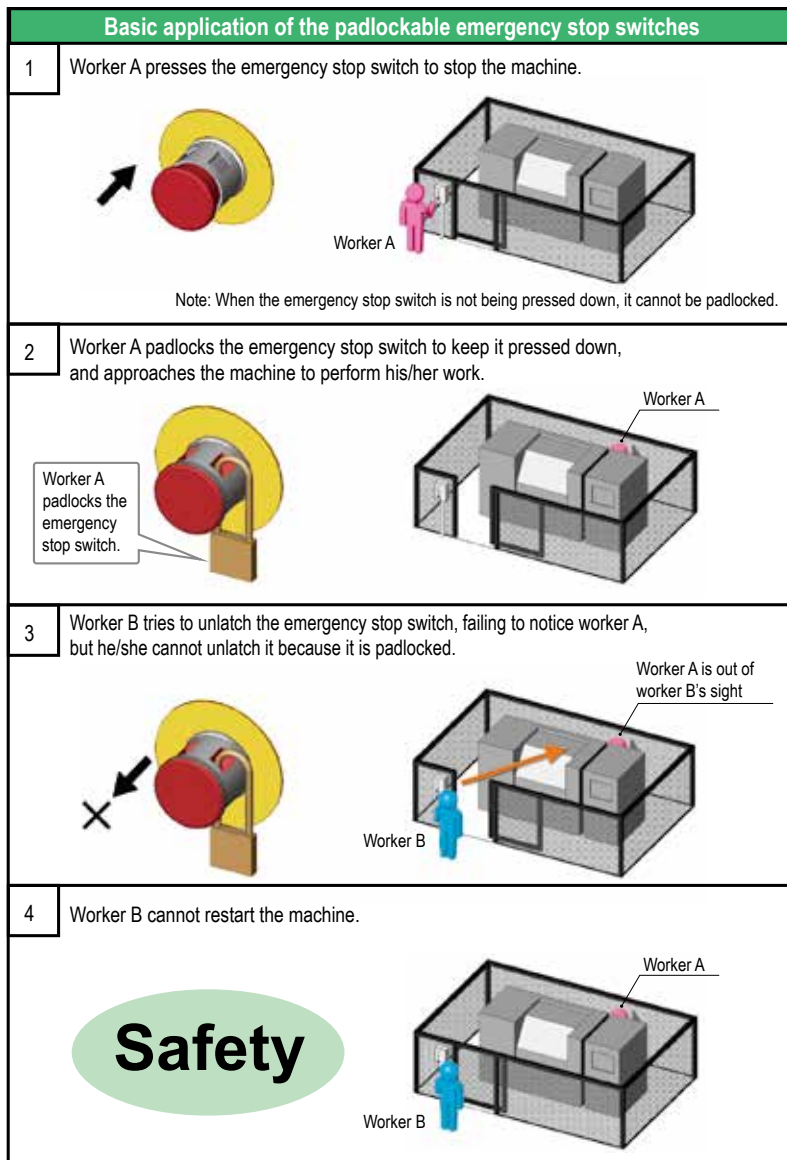
In this revision, the prevention of an unintended reset operation is not specified explicitly as a safety requirement. However, "Prevention of unintended reset operation" and the "Intended reset operation" in Section 3 are both important. In order to prevent unintended resetting, the key reset type emergency stop switches, shown in Section 3.3, have conventionally been used. As mentioned above, this is no longer recommended.

Another measure to prevent unintended resetting is the use of padlockable emergency stop switches. As described below, after actuating the emergency stop switch, each worker padlocks the switch with his/her own padlock and carries that key to prevent unauthorized resetting by other workers.

IDEC has the following padlockable emergency stop switches.

XN series

Padlockable Emergency Stop Switches



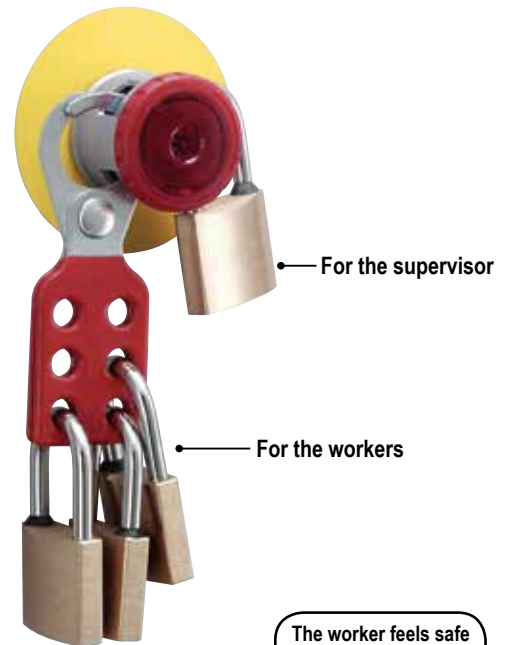
* The supervisor confirms safety status before resetting.

An application example for higher safety

<Installation example>

Supervisor : one person

Worker : three persons



The worker feels safe because he/she is carrying the padlock key!



5. Span of control of emergency stop device(s)

In principle, when actuating an emergency stop device, the entire machine should be stopped. However, as an exception, this revision has introduced a new concept of the "Span of control" to partially stop the machine as shown below.

Newly added safety requirement

ISO 13850: 2015

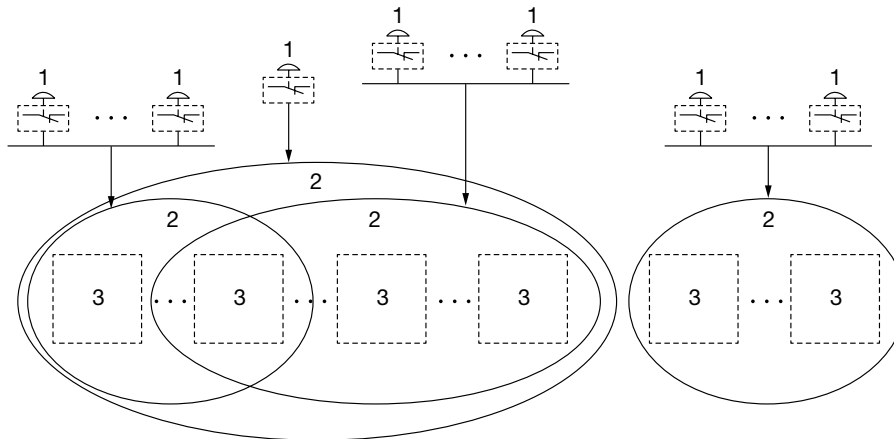
4.1.2

The span of control of each emergency stop device shall cover the whole machine. As an exception, a single span of control may not be appropriate when, for example, stopping all linked machinery could create additional hazards or unnecessarily affect production. Each span of control can cover section(s) of a machine, an entire machine or a group of machines.

Examples demonstrating the concept of span of control

Key:

- 1: emergency stop device
- 2: span of control
- 3: section of machine or machine



4.1.2.1

More than one span of control can be applied, if the following requirements are met:

- the spans of control shall be clearly defined and identifiable;
- emergency stop devices shall be readily associated with the hazard requiring an emergency stop;
- the span of control of an emergency stop device shall be identifiable at the operating position of each emergency stop device;
- actuation of an emergency stop device shall not create additional hazard(s) or increase the risk(s), in any span of control;
- actuation of an emergency stop device in one span of control shall not prevent the initiation of an emergency stop function in another span of control;
- information for use of the machine shall include information on the span of control of emergency stop device.

In this revision, it has become possible to precisely set the span of the machine that is stopped by emergency stop devices according to the actual situation.

Confirm the above safety requirement before setting the span of control.

6. Required performance level (PLr), safety integrity level (SIL)

In this revision, the minimum required performance level (PLr) and safety integrity level (SIL) required for the emergency stop function are specified as follows.

Newly added safety requirement

ISO 13850: 2015

4.1.5

Emergency stop equipment

4.1.5.1

The safety related parts of the control system or subsystems which perform the emergency stop function shall comply with the relevant requirements of ISO 13849-1 and/or IEC 62061. Determination of the Performance Level (PL) or SIL required should take into account the purpose of the emergency stop function, but the minimum required is PLr c or SIL 1.

ISO 13849-1 and IEC 62061 are cited as normative references for functional safety in this revision. Make sure to perform risk assessment before designing emergency stop equipment and provide appropriate PLr or SIL. A minimum of PLr c or SIL 1 is required for emergency stop function.

Also, in the support software SISTEMA (*1) for the safety evaluation according to ISO 13849-1 and/or IEC 62061, the following emergency stop switches of IDEC are registered. When considering PL and SIL, use SISTEMA (*1) as necessary.

SISTEMA for IDEC Emergency Stop Switches (*1) Registered Status (as of December 2018)

Product	Name	B10d (Times)	MTTFd (Year)	DC (%)	Category	PL	PFHd	SIL	Type			Remarks
									element	block	subsystem	
Emergency Stop Switch	1 XA (Unibody)	1.0E+05	-	-	-	-	-	-	✓			<ul style="list-style-type: none"> Emergency stop switch compliant with EN60947-5-5 NC contact has direct opening function (IEC60947-5-1 Annex K)
	2 XA (Detachable)		-	-	-	-	-	-	✓			
	3 X6 (Unibody)		-	-	-	-	-	-	✓			
	4 XW Series		-	-	-	-	-	-	✓			
	5 XN Series		-	-	-	-	-	-	✓			
	6 HW (Unibody)		-	-	-	-	-	-	✓			
	7 HW (Detachable)		-	-	-	-	-	-	✓			

*1: Developed and distributed by DGUV/IFA, and can be downloaded from:
<http://www.dguv.de/ifa/praxishilfen/practical-solutions-machine-safety/software-sistema/index.jsp>

7. Emergency stop function on portable operator control stations

The following safety requirement in the prior version of ISO 13850 has been deleted.

Old safety requirement

ISO 13850: 2006

4.1.1

Deleted safety requirement

When emergency stop devices can be disconnected (e.g. portable teaching pendants) or when machinery can be partially isolated, care should be taken to avoid confusion between active and inactive control devices.

The following safety requirement has been added.

Newly added safety requirement

ISO 13850: 2015

4.3.8

When emergency stop devices are installed on detachable or cableless operator control stations (e.g. pluggable portable teaching pendants), at least one emergency stop device shall be permanently available (e.g. in a fixed position) on the machine.

In addition, at least one of the following measures shall be applied to avoid confusion between active and inactive emergency stop devices:

- device colour changing through illumination of the active emergency stop device;
- automatic (self-actuating) covering of inactive emergency stop devices; where this is not practicable, manually-applied covering may be used, provided that the cover remains attached to the operator control stations;
- provision of proper storage for detached or cableless operator control stations.

The instructions for use of the machine shall state, which measure has been applied in order to avoid confusion between.

The above safety requirement aims to prevent accidents when mistakenly operating the inactive emergency stop devices on the detachable teach pendants or cableless operator control stations. Make sure to take the above safety requirements into consideration when choosing a detachable teach pendants or cableless operator control station.

Terms and definitions (ISO 13850: 2015)

3.1

emergency stop (E-stop)

emergency stop function

function which is intended to

- avert arising or reduce existing hazards to persons, damage to machinery or to work in progress, and
- be initiated by a single human action

3.2

emergency stop equipment

safety related parts of a control system which perform the emergency stop function

Note 1: Typically emergency stop equipment is divided into input, processing and output elements.

3.3

emergency stop device

manually actuated control device used to initiate an emergency stop function.

3.5

safety function

function of a machine whose failure can result in an immediate increase of risk(s)

3.6

span of control of emergency stop device(s)

predetermined section of the machinery under control of specific emergency stop device(s)

3.7

protective shroud

mechanical measure provided to reduce the possibility of unintended actuation of an emergency stop device.

3.8

emergency situation

hazardous situation needing to be urgently ended or averted

Note: An emergency situation can arise during normal operation of the machine (for example due to human interaction or as a result of external influences) or as a consequence of a malfunction or failure of any part of the machine.

Conclusion

This guidebook is a summary of the newly added safety requirements in ISO 13850: 2015 "Safety of machinery—Emergency stop function—Principles for design" from our point of view. Make sure to confirm the original ISO 13850: 2015, as well as the relevant laws, regulations, and standards according to your applications.



Think Automation and beyond...

Head Office

6-64, Nishi-Miyahara-2-Chome,
Yodogawa-ku, Osaka
532-0004, Japan

 www.idec.com