TECHNICAL ARTICLE

Tips on choosing appropriate E-Stop Technology for your Machine Safety Application

Pamela Horbacovsky, OMRON

An emergency stop – or E-Stop – is an essential component of safety systems, particularly when it comes to machine safety. Usually in the form of a retentive pushbutton, an E-Stop functions as either a Category 0 or Category 1 stop. The required e-stop category is determined by conducting a risk assessment of the machine it is attached to. When they are used, the role of E-stops is to shut the machine down quickly and safely in the event of a hazardous situation.

Selecting an E-Stop Technology

There here are strict guidelines concerning the compliance of emergency stop pushbuttons, the bulk of which are focused on making the button easy to access and press. However, there are certain applications in which even a standards-compliant pushbutton may not be the ideal solution. These applications can usually be improved with a technology known as a rope switch. With that said, here is some guidance for when designing a system that uses pushbutton e-stops.

Compliance requirements for E-Stop pushbuttons

In many machine safety applications, a pushbutton will suffice. An emergency stop pushbutton must be colored red and must be mounted upon a bright yellow background. The yellow background must be a minimum of 3mm beyond the mounting collar and visible beyond the control actuator according to ANSI B65.1-2005.

The actuator of a pushbutton-operated device is required to have a mushroom-head shape. Flush or membrane-style switches are not permitted, and neither are graphical representations of a button on an HMI or flat panel display. While the coloring is designed to ensure that it can be easily located, the purpose of the mushroom-head shape is to make it easy to push.

E-stop pushbuttons need to be located at each operator control station and at any other location where an emergency stop would be required. The buttons must be self-latching, meaning that they can only be reset manually. They also need to have direct opening operation. As with all E-stop devices, a pushbutton must remain unguarded.

Figure 1 – Red Mushroom-head Retentive E-Stop Buttons

When to use rope switches as an alternative to pushbuttons

In applications that involve several operators working alongside a conveyor, it might not work well to have multiple E-stop pushbuttons at each work site. Instead, the most workable solution might be a rope switch, which is a cord of braided plastic-coated wire that's installed horizontally across the points of hazard generated by rotating machinery and conveyor motion.

A rope switch can cover the entire machine, and anyone at any spot on the conveyor can pull it. When pulled, it causes the attached switch to generate an emergency stop. For operators working in environments with explosives and similar hazards, rope switches are often the best choice, as these promote a stronger and more robust enclosure.

Common E-Stop Button Characteristics

Emergency stops are a must-have a for any safety system, as they are often the last resort for stopping or mitigating a major accident on the factory floor. We've discussed the specific requirements for the layout, color, shape of an E-stop pushbutton, but there are also several requirements for E-stop behavior that need to be considered. (Keeping in mind that there may also additional regulatory requirements depending on local regulations, industry, and the facility type/location.)

1. The E-stop must have positive operation.

Emergency stops must be designed so that, upon their activation, dangerous movements and operations of the machine will be stopped as quickly as possible without creating additional hazards. If they aren't activated, then the machine must stay running by default. This is what's meant by "positive operation."

2. The E-stop function must be available and in operation at all times.

At every operator station, there must be an emergency stop ready to be activated whenever necessary. The effects of an E-stop – namely, the ceasing of hazardous machine motion – must be maintained until the device can be manually reset according to ISO 13850-2006. This prevents machinery from starting up prematurely while the situation is being investigated.

3. There can't be a padlock on the E-stop.

Having a padlock on the emergency stop device gives the impression of lockout/tagout (LOTO), which is a terrible application for an E-stop. Requirements for lockout stipulate that the hazardous energy sources must be physically isolated or blocked, and control systems that include interlocks and emergency stops are unable to meet these requirements in full.

4. The E-stop shouldn't stand in for other necessary safety measures.

Key safeguarding measures and functions such as light curtains, interlock devices and comprehensive safety training for operators must not be overlooked simply because an

emergency stop is in place. These measures are just as important and should always be part of the risk reduction strategy for a machine.

5. The E-stop should ideally be activated just twice per year.

Assuming that there's no need to stop hazardous motion in a given year, then the emergency stop should only be activated twice over this time period for the purpose of manual testing. Some manufacturers set things up so that operators use the E-stop for routine machine shutdowns, but this is a standards violation and will lead to the early breakdown of the device.

Figure 2 – A commonly used e-stop button installation

Figure 2 shows a typical e-stop button installation that is used for machinery. Notice the red retentive mushroom head push button, with the yellow collar behind it identifying it as an emergency stop. This particular model uses a "twist to release" feature. Depending on the machinery application, this button may also be paired with a Machine Safety Relay and/or a larger line-stop based e-stop system.

Interested in learning more about e-stops and their applications? Additional whitepapers can be found on the OMRON website at https://automation.omron.com . There are also a large collection of technical standards documents and regulations that must be followed when it comes to e-stops. Your local OMRON application specialist can help you navigate the e-stop requirements for your local area.

About the Author

Pamela Horbacovsky is currently the Product Manager for Safety at OMRON Automation Americas and has previously served as OMRON's Safety & Services Sales Leader for Mexico. Before Omron, she worked for Magna CIMS and Formex, as an Automation Engineer leading the design and implementation of assembly lines. Her educational background includes a degree in Electronic Engineer at the National University of Cordoba, Argentina, an MBA from EUDE Business School and she is a certified Functional Safety Engineer for Machine Safety by TUV Rhineland. Contact: pamela.horbacovsky@omron.com

TECHNICAL ARTICLE

Primer on Machine Safety E-Stop Categories

By Graham Nasby, City of Guelph Water Services

Since we have an article on best practices when it comes to selecting e-stop technology, it seems only natural to have a brief primer on machine safety "emergency stop" categories. In North America, the terminology for emergency stop "category" typically originates from these published technical standards: IEC-60204-1 and NFPA-79 among others. Depending on the geographic area or industry, there may also be additional local technical standards as well. For example, in Canada the CSA C22.2 No. 301 technical standard applies.

Yes, terminology does matter. Each of these standards does have specifically defined terms about how to refer to emergency stop systems, and specifically safety stop systems. For example, in these standards, an e-stop is referred to as a "stop category". The word "emergency" is more a descriptor of how/when the stop is being called upon to function.

As a best practice, an e-stop should only be used for actual emergency situations. During normal operations, the preferred way of shutting down equipment should always be to use its normal control system and/or normal operator input. A category-rated rated stop system should only be used emergency situations. For many pieces of equipment, the emergency stop may also not be preferable since it will often prioritize quick stopping of equipment for safety, rather than a slower stop to avoid equipment damage.

Here is a summary of the typical "stop categories" used:

	IEC 60204–1[1]	NFPA 79[2]	CSA C22.2 No. 301[3]
0	stopping by immediate removal of power to the machine actuators (i.e. an uncontrolled stop)	is an uncontrolled stop by immediately removing power to the machine actuators.	stopping by immediate removal of power to the machine actuators (i.e., an uncontrolled stop;
1	a controlled stop with power available to the machine actuators to achieve the stop and then removal of power when the stop is achieved;	is a controlled stop with power to the machine actuators available to achieve the stop then remove power when the stop is achieved.	a controlled stop with power available to the machine actuators to achieve the stop and then removal of power when the stop is achieved;
2	a controlled stop with power left available to the machine actuators.	is a controlled stop with power left available to the machine actuators.	a controlled stop with power left available to the machine actuators.

This article is only a brief summary. A longer discussion of these standards and how they apply to "safety stop" categories, can be found in Doug Dixon's excellent article on Machine Safety 101 entitled "Emergency Stop Categories"[4]. As with all safety systems, it is always recommended to check with a specialist that is familiar with the specific requirements of the local jurisdiction of the installation.

[1] IEC 60204–1, Safety of machinery – Electrical equipment of machines – Part 1: General requirements (aka EN 60204–1)
[2] NFPA 79, Electrical Standard for Industrial Machinery
[3] Industrial electrical machinery. CSA Standard C22.2 No. 301. 2016.
[4] https://machinerysafety101.com/2010/09/27/emergency-stop-categories/