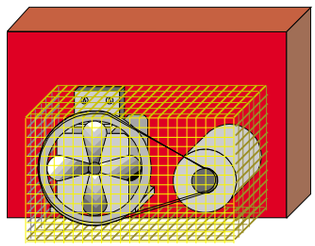
VII - Safety solutions

This chapter discusses some of the different safety solutions you can use with your machinery. A Risk Assessment (see Chapter V) determines what category of protective equipment should be used, but other factors - such as the operation, configuration, size and shape of your machinery - can determine the exact type of protection that is appropriate. Below we show some common solutions with their corresponding safety standards, and discuss their advantages and limitations.

☞ **Users are responsible for understanding and choosing the right solution for them based on their application, local regulations and their risk assessment. This is for information only.**

1 - FIXED ENCLOSURES AND GUARDS

Fixed guarding devices, used permanently to ensure the safety of operators working around dangerous zones or on dangerous machines. They can be in the form of screens, covers or pieces of plastic.



Solution Advantages:

- Permanent guarding
- Low investment
- Long life
- No hazardous projections

Limitations to applicability:

- Access to area for maintenance can be difficult
- Could be removed without detection and not replaced

Standards to follow:

- EN 953 deals with fixed and mobile protectors
- EN 349 deals with minimum gaps to prevent crushing of body parts
- EN 294 and EN 811 define safety distances to prevent operator's limbs from entering dangerous zones
- ANSI B11 standards
- OSHA 1910.212

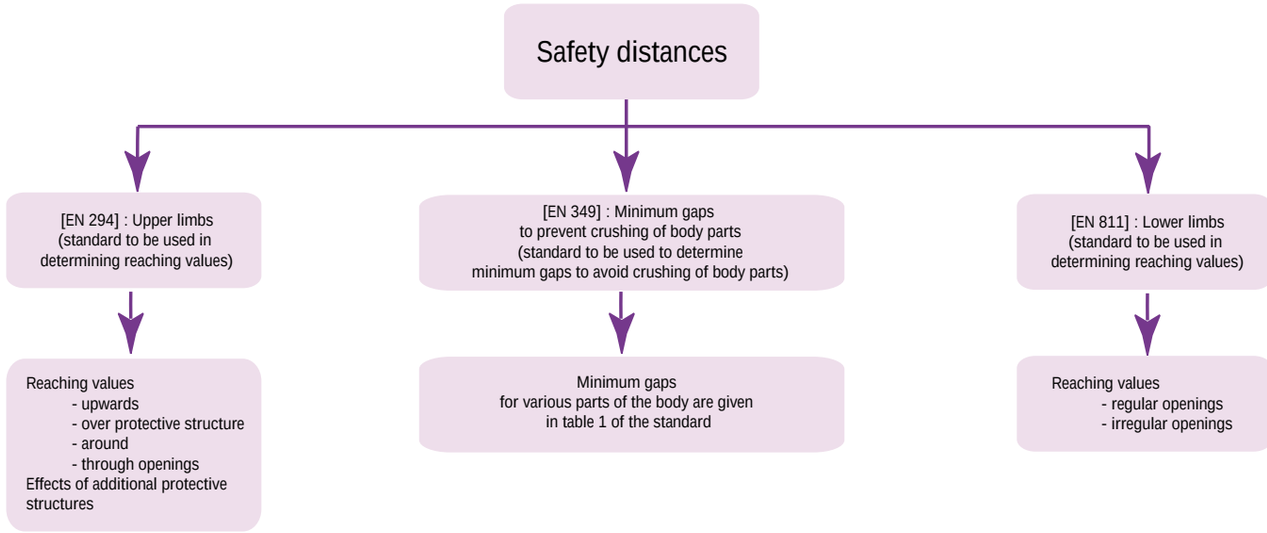


Diagram VII.1

2 - MOVEABLE GUARDS

Moveable guards are usually connected in an interlock arrangement to the machinery control mechanisms. Protection is provided in one of 2 ways:

• **Interlocking,** where the guard cannot open until the machine has stopped operating or while danger exists. Solenoid key-operated safety switches, single or in pairs, are connected to the machine control to prevent the guard from being opened until the machine has stopped. The key is attached to the guard and cannot be removed from the switch until the machinery is stopped and comes to a halt. This is particularly useful where the inertia of the machine may mean that stop time is greater than the time taken to access the dangerous zone, or there is potential machine damage during a machine cycle.

• **Locking**, where opening the guard causes the machine to stop operating. This is sometimes achieved by key operated safety switches, usually operating in opposite modes, linked to instantaneous stop mechanisms. A key attached to the guard is removed from the switch when the guard is opened, initiating the machine stop mechanism. Non key-operated switches can also be used.

Standard EN 1088 is particularly applicable here. It covers:

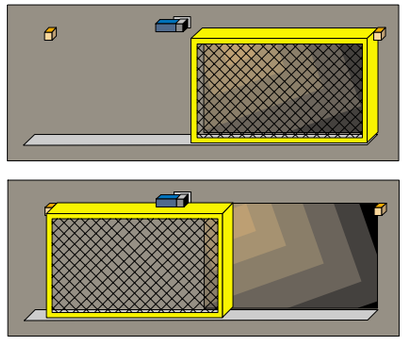
- design and installation of sensors and switches
- reduction of tampering risks
- selection of devices
- positive (or not) maneuver of a switch

Standards to follow:

- EN 294 and EN 811 define safety distances to prevent operators' limbs from entering dangerous zones
- EN 953 deals with fixed and mobile protectors
- EN 1088 defines the safety parameters that must be followed for locking and interlocking devices
- EN 60204 for electric equipment of machines
- OSHA 1910.212

2.1 Moveable Guards Using Safety Electromechanical Switches

Safety switches are associated with moveable guards, placed in front of a dangerous machine and whose purpose is to prevent access to moveable parts and to prevent projection of pieces, chips or oil on machine tools. Locking and interlocking devices must be attached to them. These protective systems are regulated by EN 1088.



Solution Advantages:

- Space gain on access control vs stand off distances for other equipment (e.g. safety light curtains)
- Low investment
- Absolute protection if regularly checked and maintained
- Protection from ejected parts

Limitations to applicability:

- Access to area for maintenance or loading/unloading operations can be difficult
- Additional maintenance required

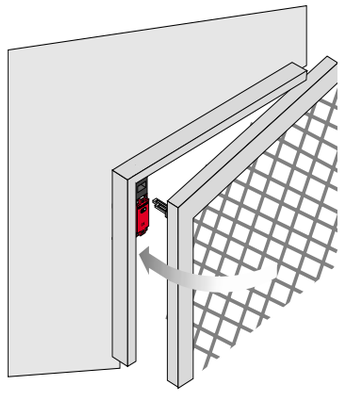
Corresponding Honeywell equipment: any 2 safety switches

(e.g. GKM, GK, GKR/GKL, GSS, 24CE, 924CE + FF-SRD5985, FF-SRS5925, FF-SRS5935, FF-SRS5988)

2.2 Key Operated Switches

Special forms of switches where a key removal will force the NC contact open.

They are used on machines with moveable guards and ensure the guard is in place.



Solution Advantages:

- Reliable positive opening contacts
- Variety of sizes available
- Difficult to defeat
- Additional monitoring protection when guard opened or closed
- Difficult to defeat or tamper with

Limitations to applicability:

- Some limits to applications
- Sealing is incompatible with food and beverage requirements
- Sensitivity to extreme vibrations

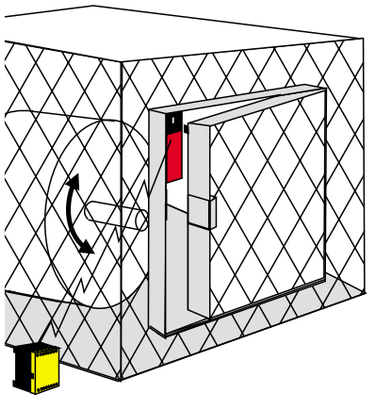
Standards to follow:

- EN 1088 defines the safety parameters that must be followed
- ANSI B11.20

⇨ **Corresponding Honeywell equipment: GKM, GK, GKR/GKL**

3 - ROTATION CONTROL

Rotation control is used on turning machines where rotating movement may be dangerous for operators. It is often used in conjunction with interlocking switches



Rotation control applies primarily in two very specific cases:

- Authorize access to the dangerous zone for a machine adjustment or to find a fault. The control then applies to the rotation speed, since the operator needs the machine to be operating to do the work. The maximum recommended speed is 10% of maximum speed or 50% of slow speed, depending on the equipment.
- Authorize access to the dangerous zone only when the dangerous machine has stopped.

Solution Advantages:

➠ Very specific for application to machines with rotation movement

Limitations to applicability

➠ Due to its specific role, it does not apply to all types of machines

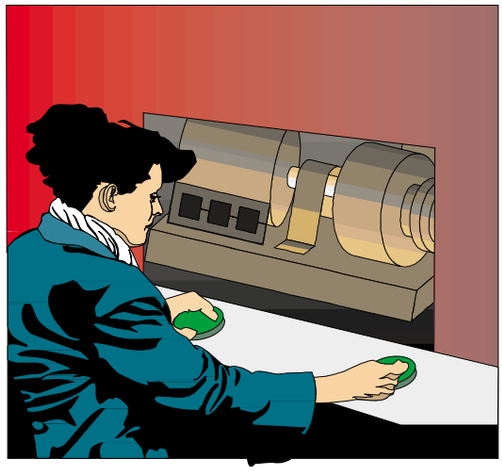
Standards to follow:

- EN 292-2 for general requirements
- Standard EN 418 for Category 1 Emergency stops
- RIA ANSI Robotic Standard
- OSHA 1910.212

⇨ **Corresponding Honeywell equipment: FF-SR05936 / GKR/GKL**

4 - TWO-HAND CONTROL

This equipment protects the operator's hands during the dangerous phase of the machine by controlling 2 hand-actuated switches. These devices are used mostly to control machines where only one operator is present.



Two-hand controls are widely used in production facilities. Located away from the dangerous zone the operator cannot start the machine cycle without simultaneous actuation of two independent devices. Two-hand controls are often installed in conjunction with other safety devices for added protection in case of third party access.

A minimum distance between the two-hand control and the dangerous zone is required and is calculated according to a precise formula. In Europe, EN 999 standard requires:

S = 1,6 (t1 + t2) + 250 where t1 = response time for protective equipment and t2 = time needed by machine to stop dangerous movement, or

S = 1,6 (t1 + t2) if the risk of operator's limb encroachment is eliminated when the control is activated, where S ≥ 100 mm / 3.94 in.

Solution Advantages:

- Low investment
- Takes up little space
- Easy to install
- Easy-to-use starting

Limitations to applicability

- Guarantees only hand protection
- Does not provide third party protection
- Significant potential ergonomic impact

Standards to follow:

EN 574 deals with two hand controls.

It defines three types of two-hand control, the selection of which is determined by the risk assessment.

These shall have the following features:

Type I - This type requires:

- The provision of two control devices requiring the concurrent actuation by both hands;
- Continuous actuation during the hazardous condition; and
- Machine operation shall cease on release of either control device when hazardous conditions are still present.

Type II - A Type I control requiring the release of both control devices before machine operation may be reinitiated

Type III - A Type II control requiring concurrent actuation of the control devices as follows:

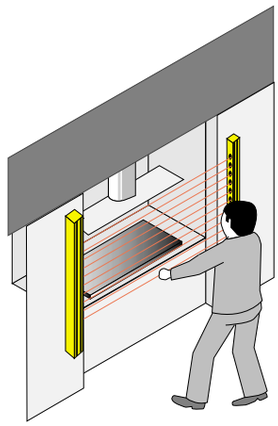
- It shall be necessary to actuate the control devices within a certain time limit of each other (0,5 s);
- Where the time limit is exceeded, both control devices shall be released before operation may be initiated. Type III is further classified as III A, III B, III C (see page 234).

⇨ **Corresponding Honeywell equipment: FF-SR25980 + any 2 independent initiating devices (e.g. push-button, capacitive switch)**

5 - ELECTROSENSITIVE PROTECTIVE EQUIPMENT (ESPE)

5.1 Safety Light Curtains

These devices are photoelectric barriers composed of several infrared beams aligned on a emitting column and a receiving column. Cutting just one of the beams is sufficient to detect penetration in the dangerous zone, activating the barrier. This will deactivate the outputs linked to the emergency stop of the dangerous machine.



Photoelectric safety light curtains form a barrier of parallel infrared beams which are successively activated according to a multiplexing process with a high scanning speed. A specific beam provides precise synchronization. The normal protection height depends on the number of beams and the distance separating the lenses. There are normally 3 different restart modes as described in Chapter VI.

The respective resolutions of the different light curtains permit the detection of an approaching finger, hand, limb or body. Depending on the characteristics of the machine being guarded, its environment and the type of safety demanded, a light curtain may be installed according to a normal, parallel or angular approach. For all round perimeter detection, it is common to use mirrors with low loss reflection to ensure a sufficient scanning range.

Solution Advantages:

- ➠ High reliability due to self-controlled positive safety
- ➠ Optical alignment and output indicators
- ➠ Long scan distances possible
- ➠ Stable and precise scanning time
- ➠ Largely immute to electrical interference, ambient light and welding projections
- ➠ Control-reliable system performance

Limitations to applicability:

- ➠ Minimum safety distance
- ➠ Takes up space
- ➠ Often necessary to add fixed guarding as well

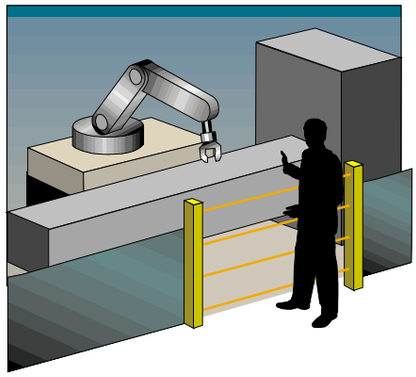
Standards to follow:

- EN 294 and EN 811 define safety distances to prevent operator's limbs from entering dangerous zones
- EN 954-1 for interface
- EN 999 for determining adequate safety distance
- EN 1050 for risk evaluation
- IEC/EN 61496-1/2 determines the general requirements applicable to active protective electrosensitive and optoelectronic equipment
- OSHA 1910.212
- ANSI B11.20

⇨ **Corresponding Honeywell equipment: FF-SYA, FF-SB, FF-SLC, FF-LS, 3LCE, adaptable to any type of application**

5.2 Single And Multi Beam Systems

These systems create a perimeter around a machine to control access. They are designed for detecting operators' bodies. Use of mirrors creates different forms of perimetric protection.



Solution Advantages:

- Flexibility
- Can protect large areas
- Relatively low investment
- Control reliable system performance

Limitations to applicability

- Mirrors take up space
- Additional measures necessary to control inside of safety zone before restart

Standards to follow:

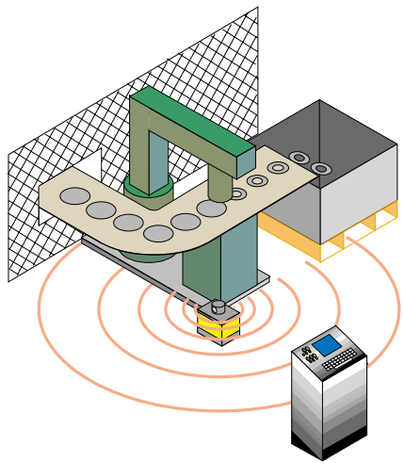
- EN 954-1 for interface
- EN 999 deals with the speed of hands/arms/other body parts in relation to the safety systems
- IEC/EN 61496-1/2 determines the general requirements applicable to active protective electrosensitive and optoelectronic equipment
- OSHA 1910.212
- ANSI B11.20

⇨ **Corresponding Honeywell equipment: FF-SPS4, FF-SCAN, FF-SYA60, FF-SB15, FF-SLC18**

5.3 Laser Scanners

Laser scanners protect a zone around a dangerous machine. As soon as an object greater than 70 mm / 2.76 in in diameter (e.g. foot, leg) is detected, the device initiates a stop signal for the safety control system of the machine.

Moreover, these devices offer an advanced alarm function when people approach the dangerous zone. This can avoid unwanted stops because people can be warned before entering the dangerous zone.



Solution Advantages:

- Easy to program a protection zone with a complex shape
- Alarm zone protects against unwanted stoppages
- Can protect large areas
- Control reliable system performance

Limitations to applicability:

- Sensitive to polluted environments
- Optimized for protection of large areas

Standards to follow:

- EN 954 deals with safety related control systems
- IEC/EN 61496-1 for ESPE
- pr EN 61496-3 defines some particulars of these systems:
  - the target is normalized to a black velvet target with a diameter of at least 70 mm / 2.76 in) and 1.8 % reflectivity
  - obligation to control the cleanliness of the window. Most of this standard's environmental requirements (vibrations, EMC, etc.) are similar to Type 4 safety barriers
- ANSI B19.20

⇨ Corresponding Honeywell equipment: FF-SE

6 - PRESSURE SENSITIVE PROTECTIVE DEVICES (PSPD)

6.1 Safety Mats

Safety mats protect a zone around a dangerous machine. As soon as a minimum pressure of 30 kg / 66 lbs is reached (typically the applied weight by stepping on), the control unit interrupts the cycle of the machine.

Solution Advantages:

- Robust: Resists severe environmental conditions (dust, large particles, oil, etc.)
- High durability
- Low maintenance
- Simple ergonomic, does not change work /rhythm modes
- Control reliable system performance

Limitations to applicability:

- Not economical for large floor zones
- Surface beneath must be flat
- Mats cannot be cut, giving inflexibility

Standards to follow:

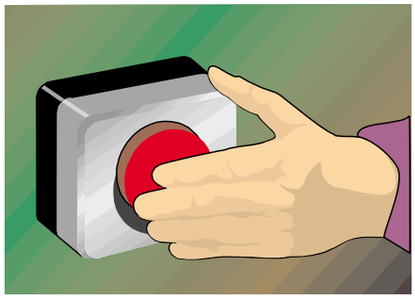
- EN 954-1 for interface
- EN 999 for computing the minimum safety distance to give the control unit time to react to a presence and cut the cycle of the machine
- EN 1760-1 concerns pressure sensitive devices: mats, floors, edges and bars
- ANSI B11.19

⇨ **Corresponding Honeywell equipment: FF-SM, with positive safety mode**

7 - EMERGENCY STOP SYSTEMS

7.1 E-Stop Push-Buttons

Along with two-hand controls, the emergency stop function is widely used. In case of danger, the machine stops its dangerous motion when the emergency stop button is activated. These buttons must be placed in sufficient number around the machinery so as to be accessible to all people.



Solution Advantages:

- Easy to use
- Immediate response time
- Flexible installation
- Control reliable system performance
- Minimizes the consequences of a hazardous situation

Limitations to applicability:

- Installation position in regard to dangerous zone is significant
- Requires several devices to cover a large zone
- Requires a voluntary action to be actuated
- Limits injury severity but typically does not prevent it
- As primary protection, can ONLY be used for low risk machinery

Standards to follow:

- EN 292-2 for the general principles of design
- EN 1037 covers protection against unexpected start-up
- EN 60204-1: Electrical equipment of machines - General requirements
- NFPA 79
- ANSI B11.20 Manufacturing system/cells

Standards to follow (continued):

- EN 418 is specific to emergency stops and defines three categories:
  - ***Category 0***: stopping by immediate suppression of the power on the actuators (non controlled stop). With this standard the components must be electromechanically cabled and the function must not depend on an electronic logic or a transmission by network.
  - ***Category 1***: controlled stop by maintaining the power on the actuators to stop the machine, then cutting the power when the machine is stopped. Cutting power to the actuators must be assured and done with electromechanical components.
  - ***Category 2***: controlled stopping by maintaining power on the actuators.

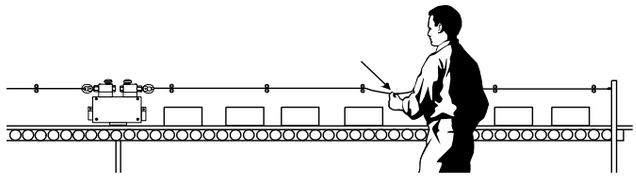
Only Category 0 and 1 are allowed for emergency stop circuitry.

Category 2 can be used for other forms of stopping (for example stopping movement with a safety light curtain).

⇨ **Corresponding Honeywell equipment: FF-SRS5924 / FF-SRS5934 / FF-SRS5925 / FF-SRS5935 / SRS5988 + E-stop push-button (customer supplied)**

7.2 Cable Pull Safety Switches

Cable pull switches provide a way to manually shutdown the system on a large machine or on a conveyor line.



Solution Advantages:

- Visible system
- Accessible from everywhere
- Long length covered
- E-stop means all along a conveyor line
- Relatively low investment

Limitations to applicability

- Requires a voluntary action to be actuated
- Limits injury severity but typically does not prevent it
- As primary protection, can ONLY be used for low risk machinery

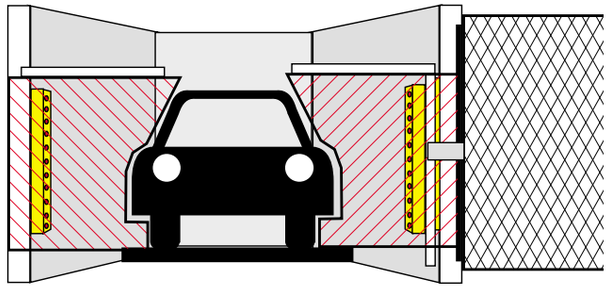
Standards to follow:

- EN 292 for the general principles of design
- EN 418 is specific to emergency stops (see under emergency stop control)
- EN 1037 covers protection against unexpected start-up
- EN 60204-1: Electrical equipment of machines - General requirements
- ANSI B20.1: conveyors

⇨ **Corresponding Honeywell equipment: CLS / 2CLS / CLSX + FF-SRS5924 / FF-SRS5934 / FF-SRS5925 / FF-SRS5935 / FF-SRS5988**

8 - MUTING SYSTEMS

A muting system is an interface between the Electrosensitive Protective Equipment and the control circuitry of a dangerous machine, on which the muting of the protective equipment is necessary at certain steps of the process. However, should an operator interrupt the beams, the machine stops its dangerous motion.



The muting system is most often used for conveyor applications (loading, unloading, etc.). A known object (for example a car) with particular dimensions travelling at a pre-determined speed can be distinguished from a person on the basis of size (a person will not be able to actuate the 2 sensors simultaneously) or time interval between triggering sensors. The known object is permitted to pass without triggering a stoppage, but other intrusions (for example from an operator) will cause a stoppage. If a known object is in the field of inhibition, the solution should be designed so that any other object or person entering will trigger a stoppage.

Solution Advantages:

- Well adapted to travelling type applications or presses
- Great detection reliability
- Flexibility of implementation

Limitations to applicability

- Specific to each application (distances to be calculated, etc.)
- Requires rigour in installation

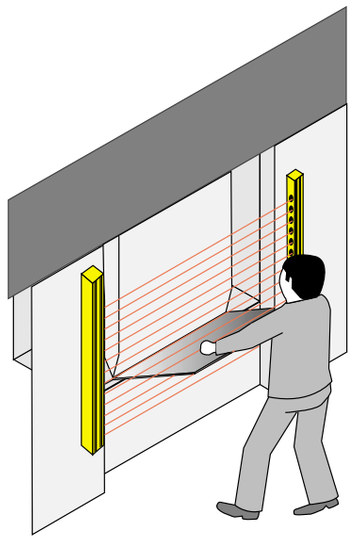
Standards to follow:

- EN 954-1 deals with safety related control systems
- IEC/EN 61496-1 determines the general requirements applicable to active protective electrosensitive equipment
- ANSI B11.20: Manufacturing system/cells

⇨ Corresponding Honeywell equipment: FF-SRM, FF-SLM

9 - BLANKING

Blanking is an optional feature on some safety light curtains where some beams within the sensing field need to be inhibited either permanently or randomly. There are two types of blanking: fixed blanking or floating blanking.



With **fixed blanking**, light beams in an area where a fixture penetrates the light field can be disabled, allowing stationery objects to protrude into the light curtain sensing field.

A typical example would be where a fixture such as a conveyor or work table extends into the light field. With fixed blanking, the light beam that would normally have detected the fixture is disabled. However, if penetration occurs anywhere above or below the blanked beam, the light curtain will send a stop signal to the machinery.

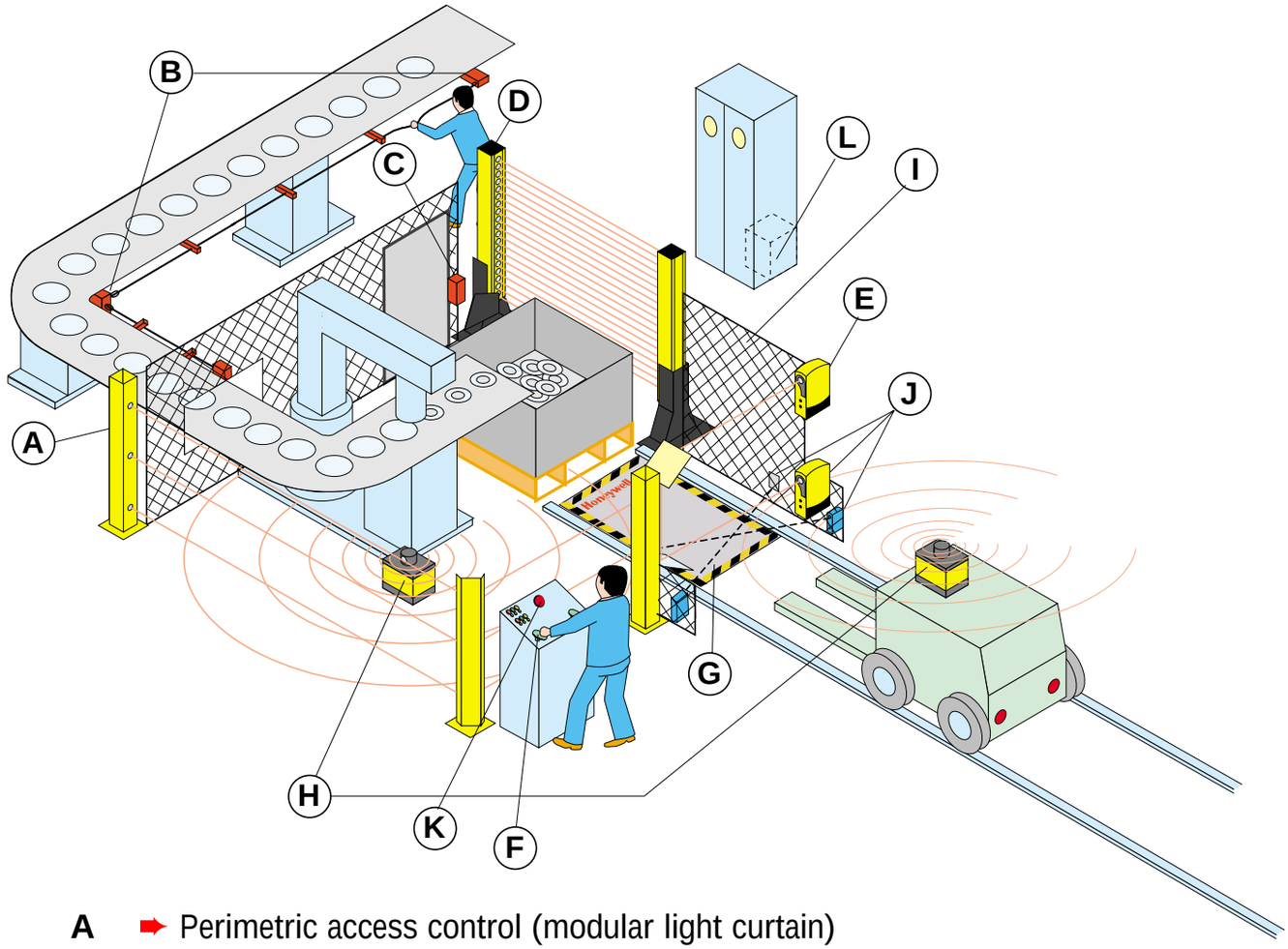
Floating blanking provides a means for the random bypass of only one beam of the light curtain. It is useful in those applications where objects such as air ejected parts randomly travel through or withing the sensing field. The floating blanking option may only be used when material or parts within the sensing field take up a space smaller than a certain value, related to the light curtain's resolution. Larger objects would block more than one light beam at a time. As a result, the light curtain would generate a stop command. Floating blanking automatically alters the resolution of the light curtain, and therefore the safety distance for mounting must be increased.

Standards to follow:

- EN 954-1 deals with safety related control systems
- IEC/EN 61496-1 determines the general requirements applicable to active protective electrosensitive equipment

⇨ **Corresponding Honeywell equipment: Detector 3**

Applications



A ➨ Perimetric access control (modular light curtain)

B ➨ Cable-pull safety switch

C ➨ Key-operated safety switch for interlock

D ➨ Safety light curtain for point-of-operation protection

E ➨ Access control (single through scan safety beam with deflection mirrors)

F ➨ Two-hand controls

G ➨ Safety mat for presence control in dangerous zones

H ➨ Laser scanner for presence control in dangerous zones

I ➨ Fixed guarding

J ➨ Muting sensors

K ➨ Emergency-stop control

L ➨ Safety modules for machine interfacing