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INDUSTRIAL MACHINE SAFETY

TOP 10 DEADLIEST JOBS IN AMERICA

9 INDUSTRIAL MACHINERY

- Machinery Installers
- Repairers
- Maintenance

Chicago, IL –
OSHA fines exceed $81K “improper guarding”

Atlanta, GA –
OSHA fines exceed $133K ”missing machine guards”

Kingston, OK–
OSHA fines exceed $535K “lack of machine guarding”

Green Bay, WI–
OSHA fines exceed $219K “machinery returned to service before providing effective safety guards”

Coshocton, OH–
OSHA fines exceed $235K “did not install machine guards”

Flowery Branch, GA – Worker Killed
Willful violation failure to provide machine guarding

Newark, NJ – Worker Killed
Company failed to install guarding

Omaha, NEB – Worker Killed
Asphyxiated. Dangerous equipment lacking machine guarding

Springfield, MA – Worker Killed
Box-making machine unguarded moving machine parts

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OSHA

CE

ANSI
American National Standards Institute

NFPA®

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RESPONSIBILITIES

OSHA

FEDERAL GOVERNMENT

Occupational
Safety
Health
Administration

STATE GOVERNMENT

CA (California)
MI (Michigan)
OR (Oregon)
MN (Minnesota)

CIVIL ORGANIZATIONS

American
National
Standards
Institute

Robotic
Industries
Association

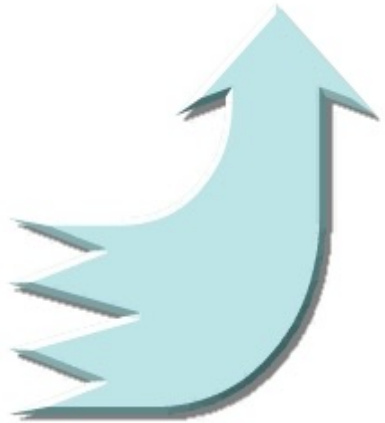
National
Fire
Protection
Association

INDUSTRIAL MACHINES EMPLOYER FINES - 1998

FINES REPRESENT VIOLATIONS OF JUST ONE SAFETY STANDARD

- 2862 Violations
- $1631
- $4.7m

COST OF NON-COMPLIANCE



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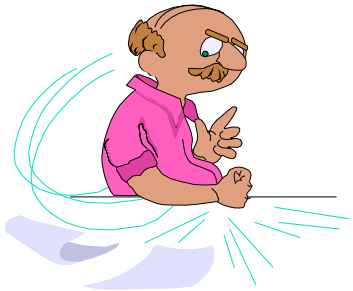
WHAT'S YOUR *HOT BUTTON?*



PROTECT EMPLOYEES

- Safer Work Environment
- Increasing Productivity

COMPLY WITH FEDERAL REGULATIONS

- Reduce Citations & Fines
- Trade Union Agreements

LOWER INSURANCE COSTS

- Claims & Liabilities

TWO HAND CONTROL

NFPA 9.2.5.6

- TWO CONTROL DEVICES REQUIRES CONCURRENT ACTUATION BY BOTH HANDS
- ACTUATION CONTROL DEVICES MUST OCCUR WITHIN .5 SECONDS
- REQUIRES RELEASE OF BOTH DEVICES BEFORE MACHINE IS REINITIATED

OSHA 19100212

GENERAL REQUIREMENTS FOR ALL MACHINES

GUARDING IS *REQUIRED* TO PROTECT OPERATOR & OTHER EMPLOYEES

- ✓ Point of operation
- ✓ Ingoing nip points
- ✓ Rotating parts
- ✓ Flying chips
- ✓ Sparks

Blount County, AL – Sept. 2011 *Worker Killed*
Worker unable to escape when machinery lowered onto him.
Sign said “Do not operate machine while doors are open.”
Doors had been removed in Feb. 2011 and stacked in corner.

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2002 EDTION

ELECTRICAL STANDARD FOR INDUSTRIAL MACHINERY

HISTORIC MAJOR REWRITE IN AN EFFORT TO HARMONIZE THE EXISTING STANDARDS WITH THE EXISTING IEC 60204-1

2002 NFPA 79

APPLIES TO THE FOLLOWING MACHINE TYPES

- MACHINE TOOLS
- PLASTICS MACHINERY
- WOOD MACHINERY
- ASSEMBLY MACHINES
- MATERIAL HANDLING
- INSPECTION/TESTING
- PACKAGING
- PRINTING
- PLASTICS
- SEMICONDUCTOR

CONTROL RELIABILITY

CITED BY THE FOLLOWING US SAFETY STANDARD AGENCIES

The safety device or system or interface is designed, constructed and installed such that a single component within the device or system shall not prevent the stopping action from taking place. But shall prevent a successive system cycle

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NFPA 79

These codes and standards are developed through a consensus standards development process approved by the **A**merican **N**ational **S**tandards **I**nstitute.

By reference, these standards are then enforced by

OSHA (reference 3067)
Concepts & Techniques of Machine Safeguarding

NEW OSHA STANDARDS?

- In 1992 OSHA released this standard for machine safety. It states:

“the guarding devices shall be in conformity with any appropriate standards,”

SAFETY INTERLOCK SWITCHES

- **Are "*POSITIVE-OPENING*"**
- **Are "*TAMPER-RESISTANT*"**
- **Are designed to "*FAIL TO SAFE*"**
- **Are by *recognized* independent safety agencies for safety applications**

NFPA APPLICABLE STANDARDS

9.3.6 Protective Interlock

Defined: Where doors or guards have interlocked switches used in circuits with safety related functions, **the interlocking devices shall be listed safety switches**, have either **positive** (direct) opening operation, or provide similar reliability and prevent the operation of the equipment when the doors or guards are open (difficult to defeat or bypass).

DESIGN TYPE 2
SAFETY SWITCH

Utilizes an actuator
When the actuator is withdrawn, the ***safety*** contacts are forced apart.

Not easily bypassed.

Defined as:

"Any interlock component used in the capacity as a safety interlock, cannot be defeated by a foreign object"

SELECT THE RIGHT SWITCH FOR THE JOB

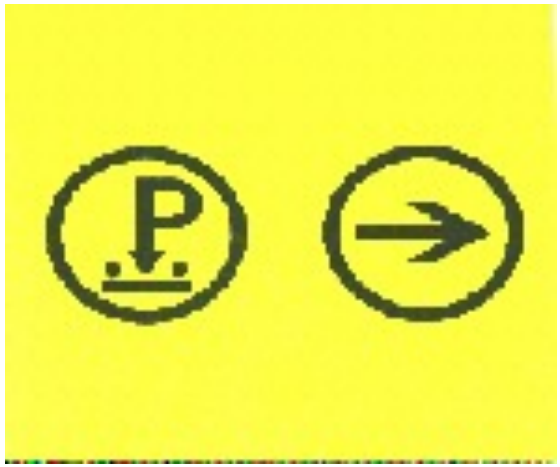
TOP REASONS FOR BYPASS

- •IMPEDE MACHINE OPERATION
- •DIFFICULT TO MAINTAIN
- •EASY TO DO

ONE SWITCH DOES **NOT** FIT ALL

PIZZATO PRODUCTS

- **ISO CERTIFIED**
- **CE COMPLIANT**



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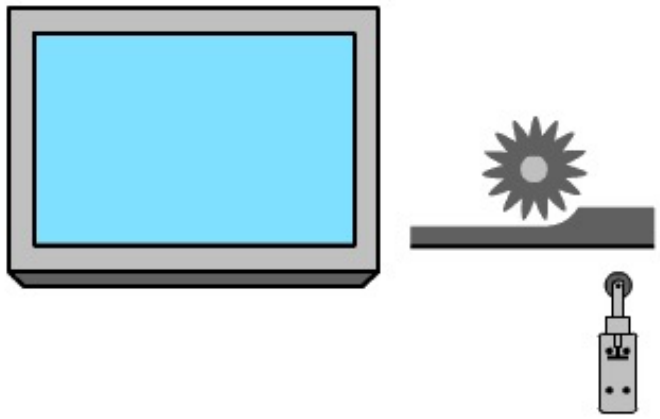
WHAT ARE "POSITIVE-OPENING" AND "POSITIVE BREAK" SAFETY INTERLOCKS?

SO WHAT'S WRONG WITH A LIMIT SWITCH?

WHEN MOUNTED IN THE NEGATIVE MODE, THE MECHANICAL INTERLOCK SWITCH MAY FAIL TO OPEN WHEN SAFETY RELIANCE IS SUBJECT TO MECHANICAL FAILURE



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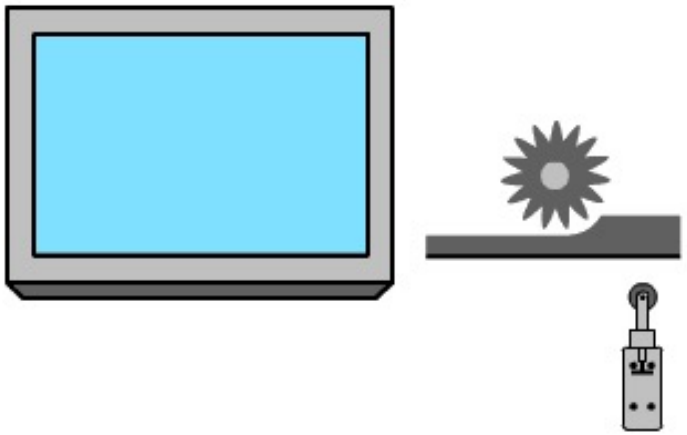
EASILY BYPASSED SPRING FAILURE



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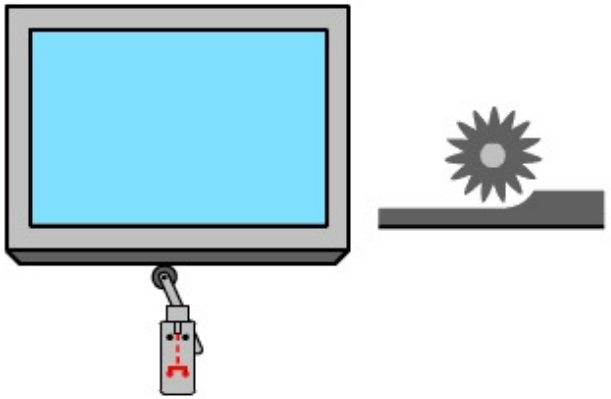
POSITIVE MODE



NFPA 9.3.6

SAFETY SWITCHES SHALL HAVE EITHER **POSITIVE OPENING** OPERATION OR PROVIDE SIMILAR RELIABILITY.....

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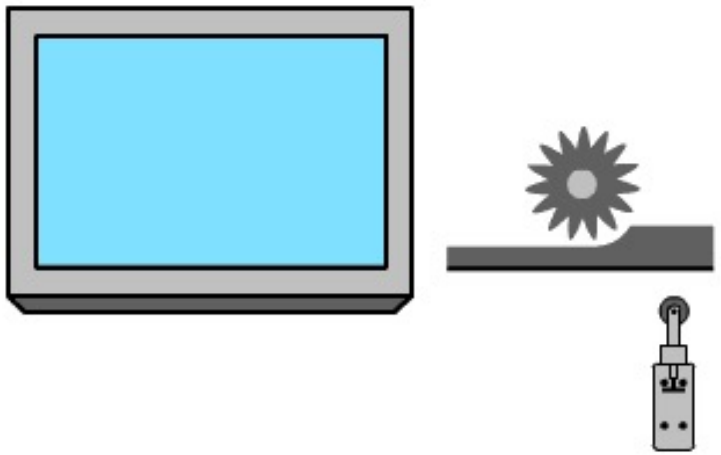
OH! I GET IT NOW
I WILL JUST MOUNT MY
LIMIT SWITCH TO THE
OTHER SIDE OF THE DOOR

LIMIT SWITCHES ARE SUBJECT TO TWO FAILURE MODES

- **SPRING FAILURE**
- **WELDED CONTACT**



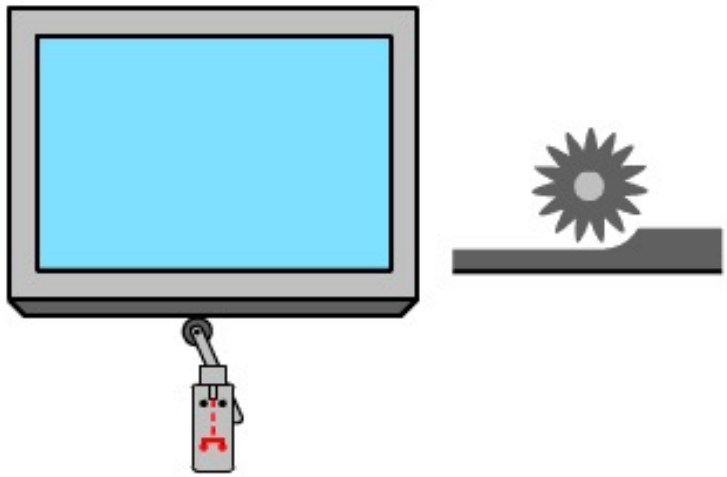
CONTACT WELD

POSITIVE BREAK CONTACTS

NFPA 9.3BB.6

PROTECTIVE INTERLOCKS

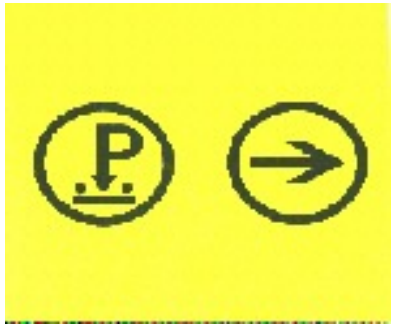
…”INTERLOCKING DEVICES SHALL BE **LISTED AS SAFETY SWITCHES**”



“LISTED SAFETY SWITCHES”

<u>THIRD PARTY TESTED & APPROVED</u>

- ✓ 2500VT SIGNAL WELDS CONTACT
- ✓ POSITIVE MODE OPERATION SEPARATES WELDED CONTACTS



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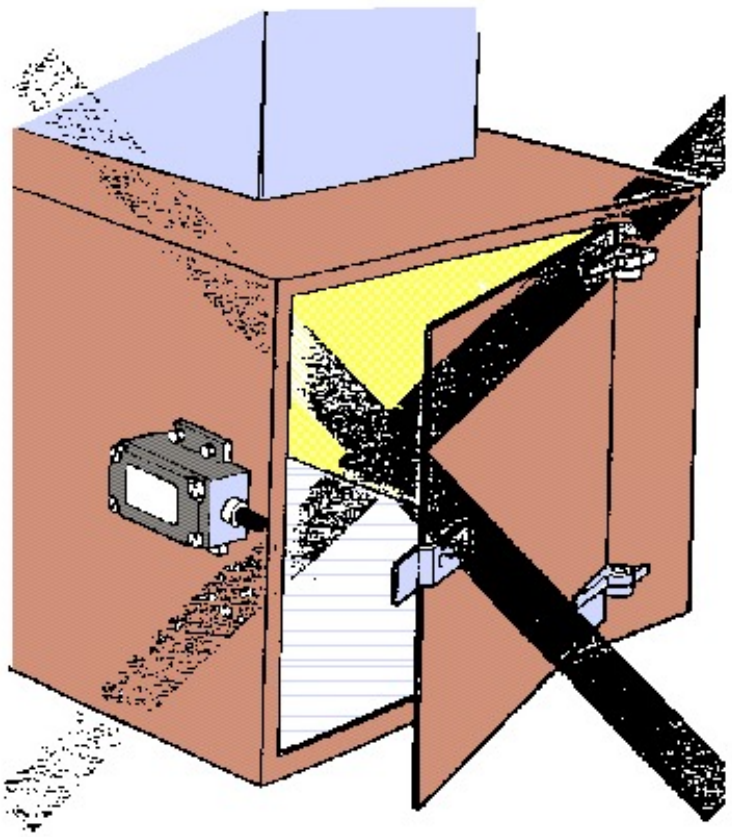

NEGATIVE MODE
EASILY BYPASSED

WORKER KILLED

An employee of Taylor Made Products Inc. of Elroy, Wis., **died Feb. 20 while operating an injection molding machine.**

According to the general manager, one of the machines, a 500 ton press, had a new mold in which parts were sticking. "About and hour before the accident the employee had just spent 45 minutes pulling the part out of the mold." Speculation is that the employee wanted to "take a shortcut" to remove another part while it was still in cycle so he would not have to pull the mold again. A rag was used to circumvent the "safety switch"

2019 INDUSTRIAL MACHINE CASULTIES

 # SERIOUS Industrial Machine Injuries –
4,276

 # Industrial Machine Amputations –
1,507

 # Fatalities From Industrial Equipment Contact –
786

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OSHA WHO DOES OSHA FINE?

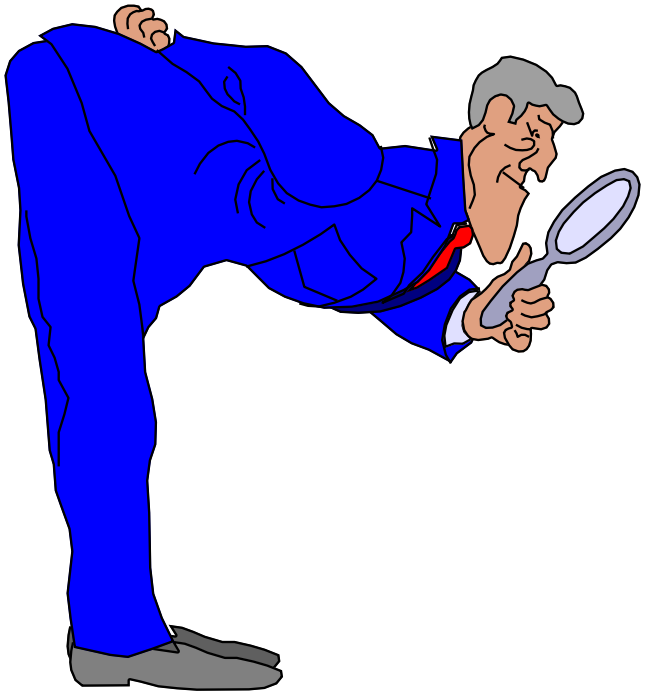
- **THE EMPLOYER *MUST* MAINTAIN A SAFE WORKPLACE**
- **THE OWNER OF THE MACHINE *IS* THE RESPONSIBLE PARTY**
- **THEREFORE THE FINE IS LEVIED ON THE EMPLOYER**

Worker Dies When Caught In Machine OSHA Fines Crucible Metals $249,000

The worker was killed in January 2009 when he lost his footing while attaching a water line to a roller mill and became caught in the machine's rotating shafts. OSHA's inspection found that the machine's moving parts were not guarded against contact.

Crucible history that dates back to 1876, has since filed bankruptcy and is now up for sale.

Questions have been raised as to the company's reluctance to invest in safety measures.



LEGAL ISSUES

SUE THE OWNER OF THE MACHINE?

"State constitution prohibits an employee from maintaining a civil action for damages against his/her employer, as long as the employer is in compliance with Workers' Compensation Laws. The only exception is that an employee may pursue "an employment intentional tort" against the employer.

- **EMPLOYER KNOWLEDGE OF A DANGEROUS CIRCUMSTANCE**
- **KNOWLEDGE THAT THE EMPLOYEE IS EXPOSED**
- **WITH SUCH KNOWLEDGE, REQUIRED THE EMPLOYEE TO PERFORM A DANGEROUS TASK**

BOISE CASCADE

Oregon OSHA launched an investigation after Gordon Cecil was killed while trying to clear a jam in a chipping machine.

Cecil and a co-worker were using a piece of wood to poke at a clog in a chipping machine while the machine's hood guard meant to protect workers was raised. Shortly after hearing the clogged wood release inside the machine, Cecil ran away from the machine and was **struck in the back of the head by a fragment of log ejected by the machine, killing him**.

Investigators said that the safety protocols had been **bypassed with the knowledge of plant supervisors**. Workers had been instructed to use a safety bypass switch on the machine to reduce production downtime when clearing log jams.

PRINTING COMPANY OWNER & PRESSROOM MANAGER *CHARGED WITH INVOLUNTRY MANSLAUGHTER*

SAN FRANSCISCO, CA

Company owner and manager of printing company order to stand trial in connection with the death of a pregnant worker who was crushed to death. She was crushed by a creasing and cutting machine that **suddenly activated** as she reached in to set up a job.

The machine lacked safety devices required by law.

"Employers bear the responsibility for providing safe and healthy conditions for their workers," DA George Cason stated

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Tuna plant charged after worker cooked to death

Felony charges have been filed more than two years after the horrific death of a worker at a California tuna plant. Bumble Bee Foods and two of its employees have been charged with willfully violating safety rules in the death of 62-year-old **Jose Melena, who was cooked to death inside an industrial oven.**

Workers unaware Melena was making repairs inside the pressurized steam cooker loaded 12,000 pounds of tuna into it and turned it on.

The company could be fined up to $1.5 million, and the **plant's director of operations and former safety manager could get three years in prison each**. **"Prosecutors and investigators from my office have begun rolling out to major industrial incidents involving serious worker injuries and death," - district attorney**

OEM RESPONSIBILITES

THE MACHINERY MANUFACTURER MARKETS THE PRODUCT WITH THE UNDERSTANDING THAT IT MEETS CURRENT SAFETY STANDARDS.

IT IS ADVISABLE TO MEET CURRENT STANDARDS, HOWEVER,

NOTHING PREVENTS THE SALE OF AN UN-SAFE MACHINE

CIVIL RECOURSE

LAWSUIT

Current insurance structure in the USA covers the Employer in the event of an accident. This is referred to as Workman's Compensation. In other words, the employee cannot sue his employer.

This leaves the **OEM ultimately responsible for creating an unsafe machine**. The injured party now sues the OEM.

BASIS FOR A CIVIL LAWSUIT

As OSHA is a federal standard, it cannot be used in a civil lawsuit.

Therefore, recognized Civil Agencies' standards are cited as justification of a lawsuit.

These agencies include:

- **ANSI**
- **NFPA**
- **RIA**

Man Loses Arm to Defective Machine Wins Settlement

A 52-year-old man working on a machine was caught in an exposed pinch point and lost his left arm below the elbow.

Suit was brought against the manufacturer alleging the design of the machine was defective and violated a particular ANSI standard.

The plaintiff presented a model machine manufactured with a safety device that would have prevented the accident.

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NEW STANDARDS
OLD MACHINES

MATTISON TECHNOLOGIES

A jury recently awarded an injured worker $7.3 million in a product liability judgment-never mind that Mattison produced and **sold the machine in 1948** and that it worked safely until the 1991 accident.

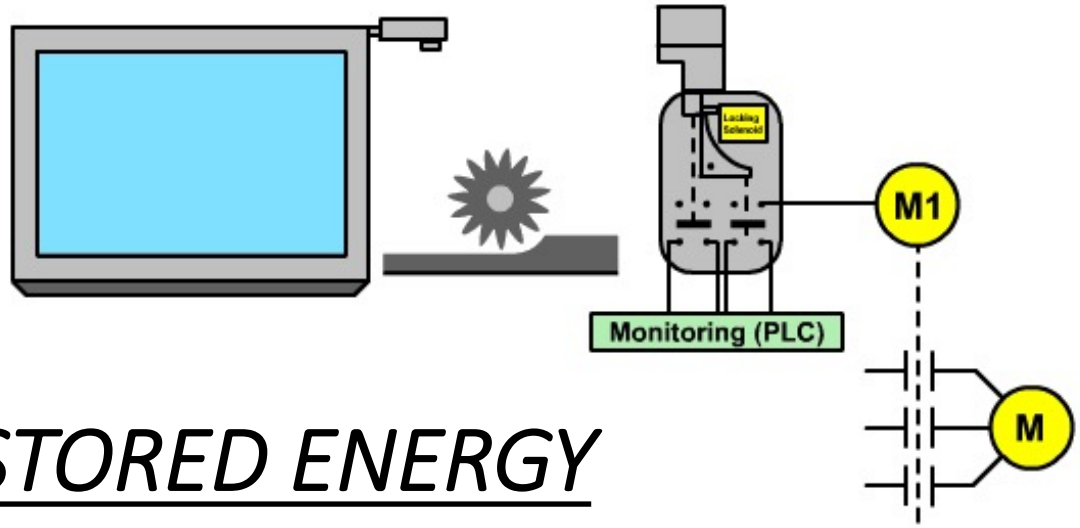
No Federal Statute of Limitation
On Industrial Machines.

PROTECT MACHINES
PROTECT PRODUCTION

- ***RESTRICTED AREAS***
- ***RESTRICTED PROCESSES***
- ***CRITICAL OPERATIONS/MACHINES***

HAZARD MUST BE ELIMINATED UPON OPENING OF THE SAFETY GUARD

- CENTRIFICAL MOTION
- HEAT
- RADIATION
- PRESSURE
- THERMAL
- ELECTRIC



STORED ENERGY

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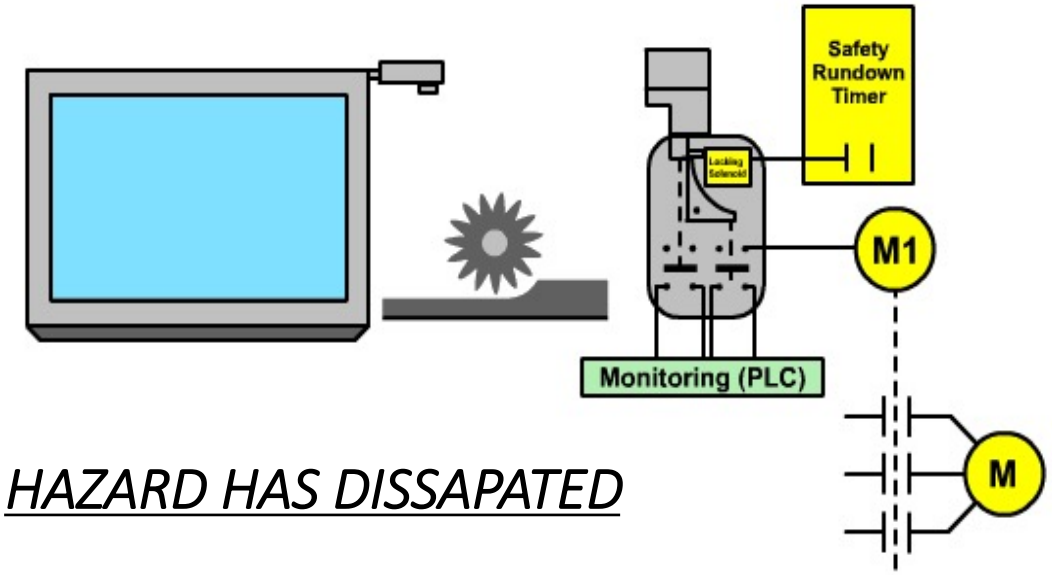
ANSI
American National Standards Institute

ANSI B11.19-2002

The interlocked section of the interlocked barrier guards shall be prevented from opening until hazardous motion has ceased, or shall be located such that an individual cannot reach the hazard before its cessation



HAZARD HAS DISSAPATED

WHAT ELSE CAN GO WRONG?

- **E STOP CONTACT WELD**
- **WELDED MOTOR CONTACTOR**
- **WIRE JUMPERS**
- **SHORT CIRCUIT**
- **LOOSE WIRES**

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LAST THING YOU WANT TO GO WRONG!!!

SINGLE SELF-MONITORED CONTACT BLOCK

CONTROL FUNCTIONS IN THE EVENT OF A FAILURE

GENERAL REQUIREMENTS

NFPA 9.4.1

Where failures or disturbances in the electrical equipment can cause a hazardous condition or damage to the machine or the work in progress, measures shall be taken to minimize the probability of the occurrence of such failures or disturbances.

SAFETY MODULES

"In the event of any single failure perform as follows:

NFPA 9.4.3

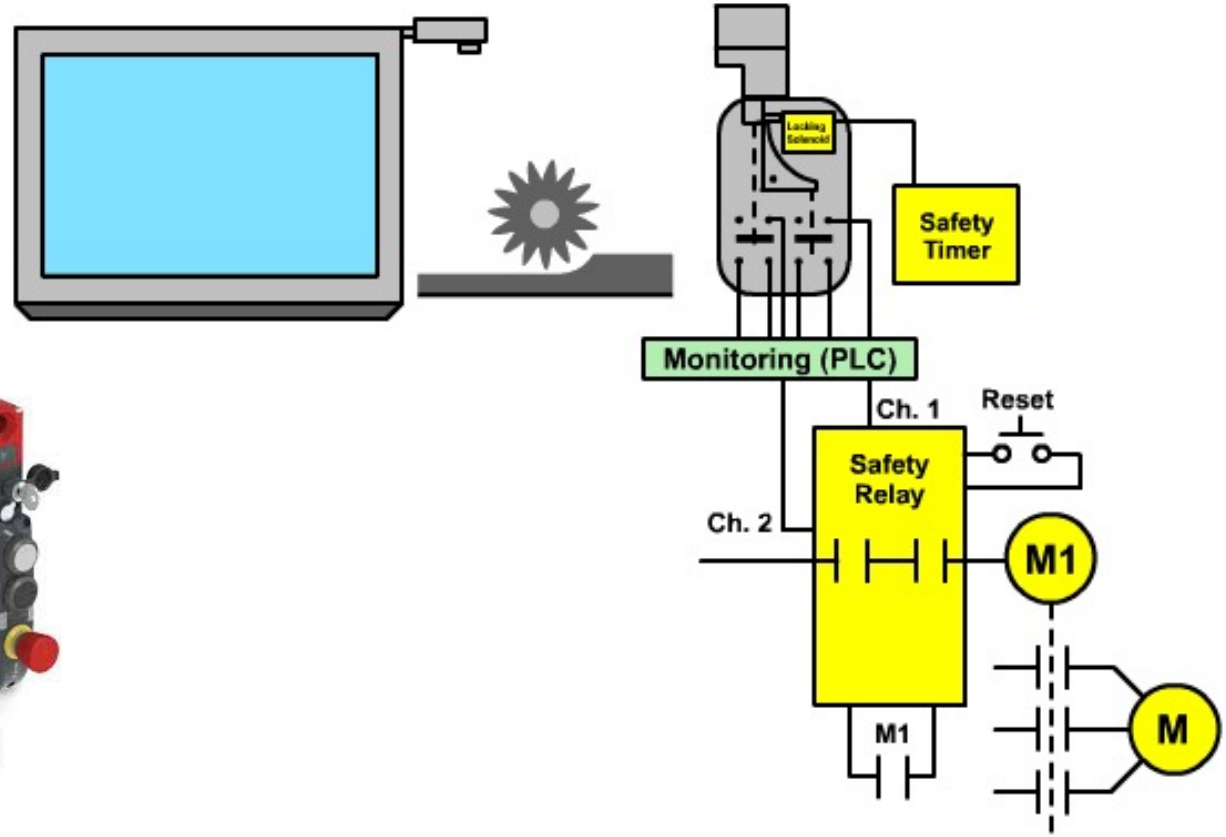
- Lead to the shutdown of the system in a safe state
- Prevent subsequent operation until the component failure has been corrected
- Prevent unintended startup upon correction of failure
- Be designed in conformance with approved standard that provides requirements for such system

SAFETY MODULES

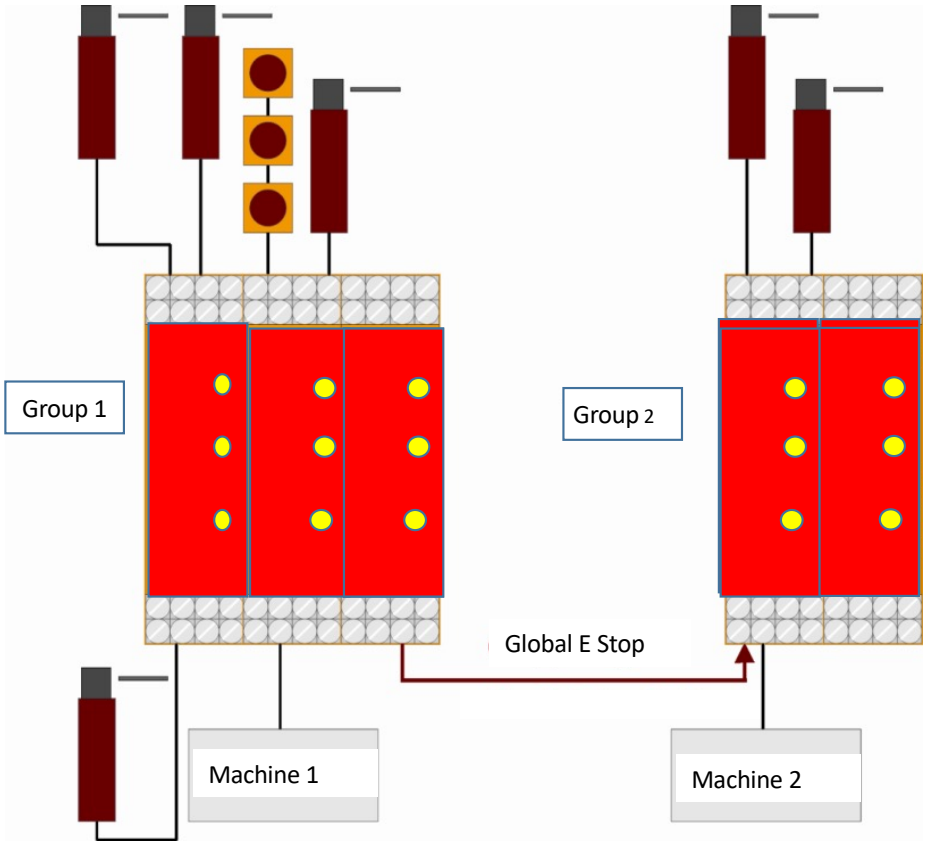
FEATURES

- ✓ DUAL CHANNEL
- ✓ POSITIVELY GUIDED RELAYS
- ✓ STOP CATEGORY 0
- ✓ STOP CATEGORY 1
- ✓ FEEDBACK LOOP CIRCUIT
- ✓ OUTPUT EXPANDERS
- ✓ DIVERSE REDUNDANCY

TYPICAL INTEGRATION



Single Function Safety Modules



PROTECTIVE INTERLOCK

NFPA 9.4.6

.."shall have either positive (direct) opening operation, or provide similar reliability and prevent the operation of the equipment when the guards are open. Difficult to defeat."

ARE THESE SWITCHES SAFE?

- Magnet Switches
- Hall Effect Switches
- J Plugs
- Proximity Switches
- Optical Switches
- Pressure Sensitive

NON-CONTACT SWITCHES

Qualifiers

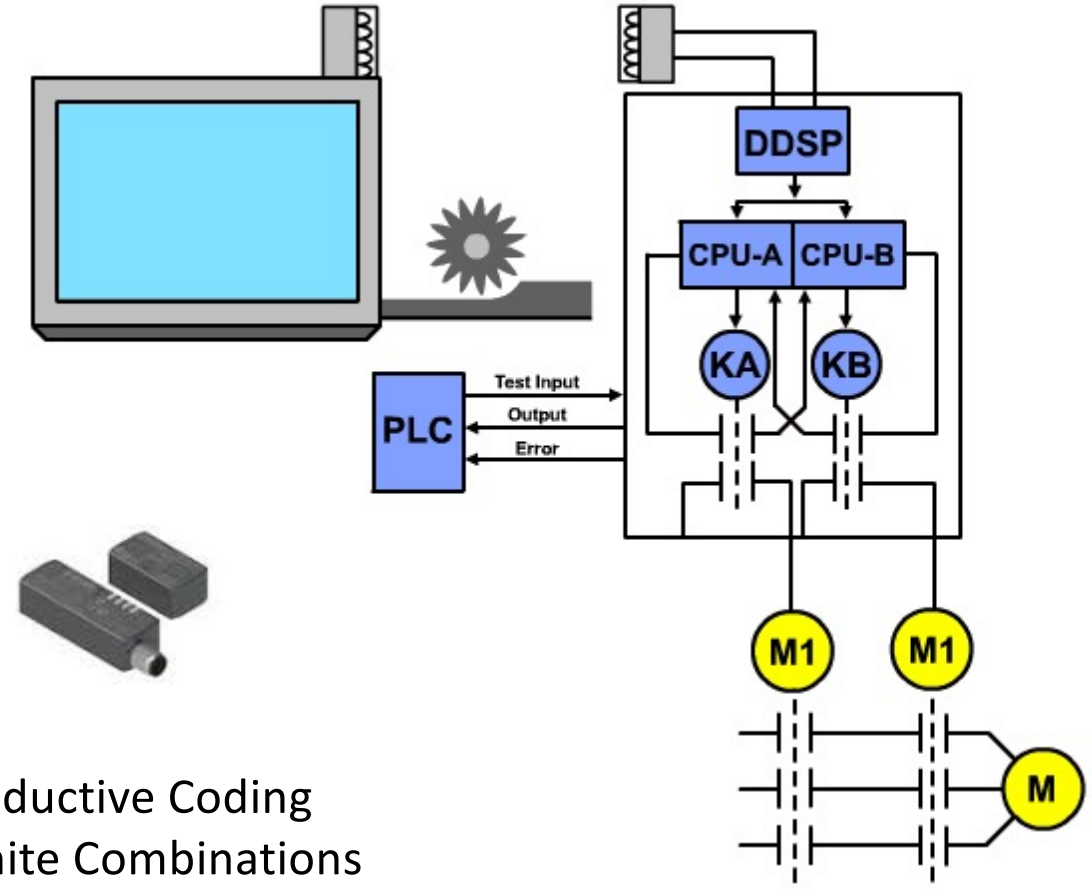
- NOT EASILY DEFEATED THEREFORE "*CODED*"
- MUST BE AS RELIABLE AS A DIRECT OPENING OPENNING SAFETY SWITCH

SAFETY SYSTEM

CODED SENSORS ARE REQUIRED TO MEET THE "*NOT EASILY BYPASSED*"

A "SAFETY MODULE" INSURES ITS RELIABILITY

TYPICAL INSTALLATION



Inductive Coding
Infinite Combinations

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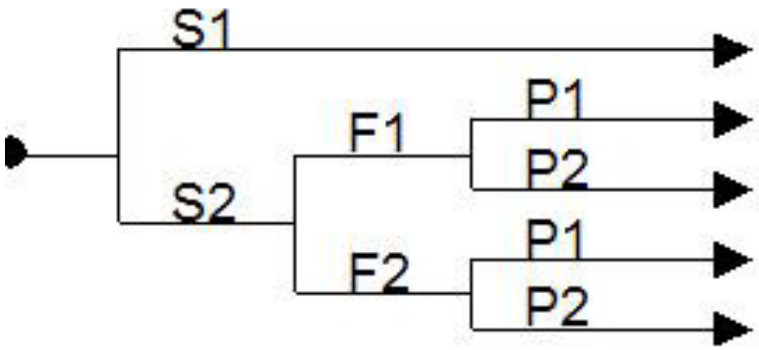
LEVELS OF RISK ASSESSMENT CHART



B	1	2	3	4
•	●	O	O	O
•	●	●	O	O
	•	●	●	O
	•	•	●	O
	•	•	•	●

Convergence of two methods determines Performance Level

EN 954-1 *Deterministic*

Proven methods

- Safety Functions
- Risk Chart
- Categories

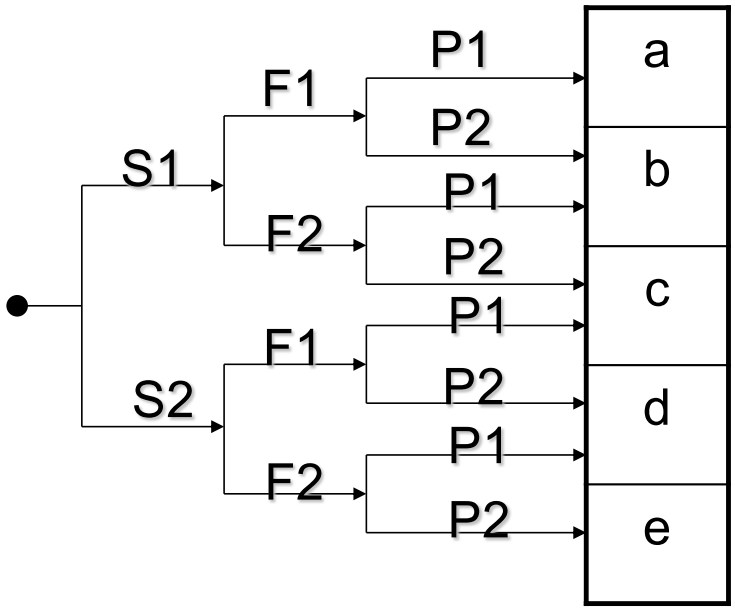
ISO 13849-1 *Probabilistic*

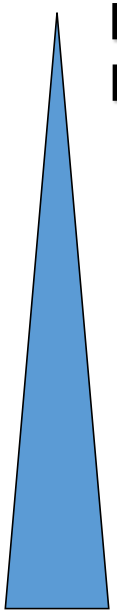
New Concepts

- Quantification: component reliability and test quality
- Common cause failure

ISO 13849-1

ISO 13849-1:2006 Annex A





Low contribution to Risk Reduction

S1 - Slight Injury
S2 - Serious Injury
F1 - Seldom or Short
F2 - Frequent or Long
P1 - Avoidable
P2 - Unavoidable

High contribution to Risk Reduction

Which Switch Will Last 20 Years?

BOTH WILL!

ISO 13849-1:2006(E)

Table C.1 — International Standards dealing with $MTTF_d$ or B_{10d} for components

	Basic and well-tried safety principles according to ISO 13849-2:2003	Other relevant standards	Typical values: $MTTF_d$ (years) B_{10d} (cycles)
Mechanical components	Tables A.1 and A.2	—	$MTTF_d$ = 150
Hydraulic components	Tables C.1 and C.2	EN 982	$MTTF_d$ = 150
Pneumatic components	Tables B.1 and B.2	EN 983	B_{10d} = 20 000 000
Relays and contactor relays with small load (mechanical load)	Tables D.1 and D.2	EN 50205 IEC 61810 IEC 60947	B_{10d} = 20 000 000
Relays and contactor relays with maximum load	Tables D.1 and D.2	EN 50205 IEC 61810 IEC 60947	B_{10d} = 400 000
Proximity switches with small load (mechanical load)	Tables D.1 and D.2	IEC 60947 EN 1088	B_{10d} = 20 000 000
Proximity switches with maximum load	Tables D.1 and D.2	IEC 60947 EN 1088	B_{10d} = 400 000
Contactors with small load (mechanical load)	Tables D.1 and D.2	IEC 60947	B_{10d} = 20 000 000
Contactors with nominal load	Tables D.1 and D.2	IEC 60947	B_{10d} = 2 000 000
Position switches independent of load [a]	Tables D.1 and D.2	IEC 60947 EN 1088	B_{10d} = 20 000 000
Position switches (with separate actuator, guard-locking) independent of load [a]	Tables D.1 and D.2	IEC 60947 EN 1088	B_{10d} = 2 000 000
Emergency stop devices independent of the load [a]	Tables D.1 and D.2	IEC 60947 ISO 13850	B_{10d} = 100 000
Emergency stop devices with maximum operational demands [a]	Tables D.1 and D.2	IEC 60947 ISO 13850	B_{10d} = 6 050
Push buttons (e.g. enabling switches) independent of the load) [a]	Tables D.1 and D.2	IEC 60947	B_{10d} = 100 000

For the definition and use of B_{10d}, see C.4.

NOTE 1 B_{10d} is estimated as two times B_{10} (50 % dangerous failure).

NOTE 2 "Small load" means, for example, 20 % of the rated value (for more information, see EN 13849-2).

[a] If fault exclusion for direct opening action is possible

Generic MTTFd for electrical components. Information provided by ISO 13849-1 2006

ISO 13849-1 *vs.* IEC 62061

SAFETY SYSTEM	ISO 13849-1	IEC 62061
Hydraulic	Applicable	Not Applicable
Pneumatic	Applicable	Not Applicable
Mechanical	Applicable	Not Applicable
Electrical	Applicable	Applicable
Electronics	Applicable	Applicable
Programmable Electronics	Applicable	Applicable

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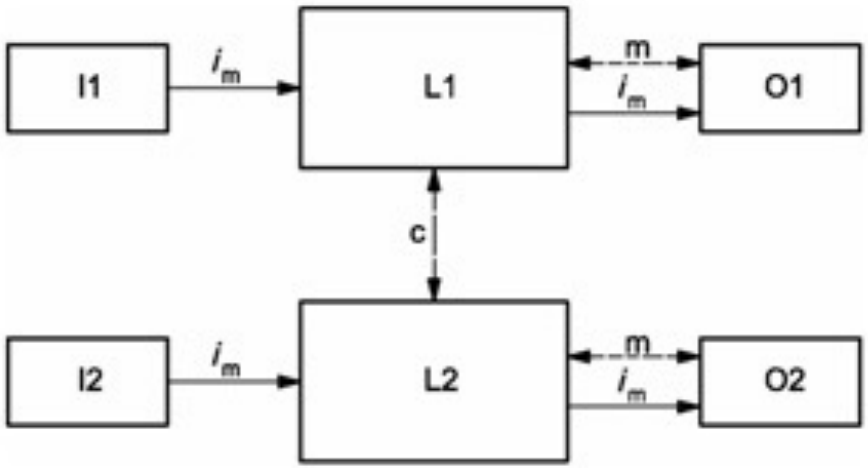
Required Safety Performance

ISO 13849 Performance level	Older EN 954-1 Categories	ANSI/RIA 15.06 CSA Z434	EN 62061 Safety Integrity Level
PL a/b	Cat. B/1	Single Channel	
PL b/c	Cat. 2	Single Channel w/ Monitoring	SIL1
PL d/e	Cat. 3	Control Reliable	SIL2
PL e	Cat. 4	Control Reliable	SIL3

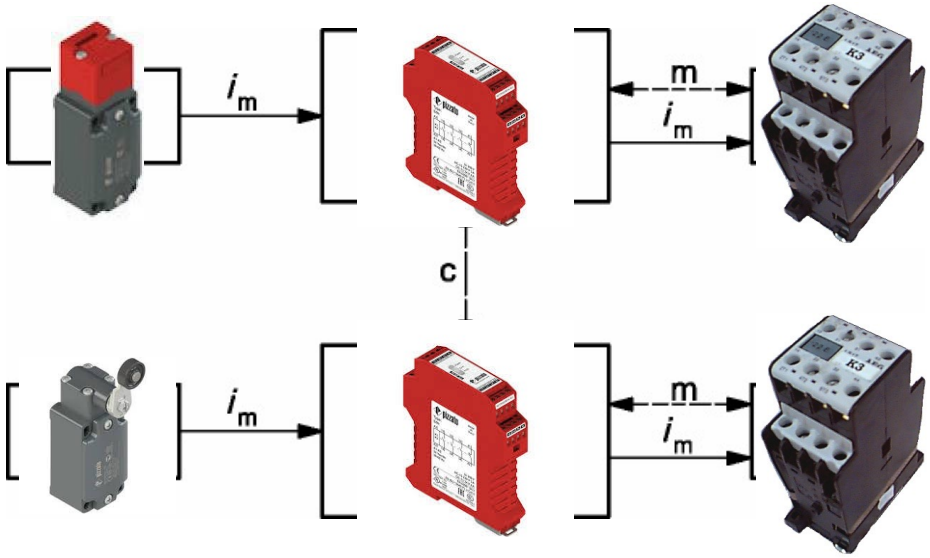
ISO 13849-1
Section 6.2.6 Category 3

"category 3 shall be designed so that a single fault in any of these parts does not lead to the loss of the safety function."

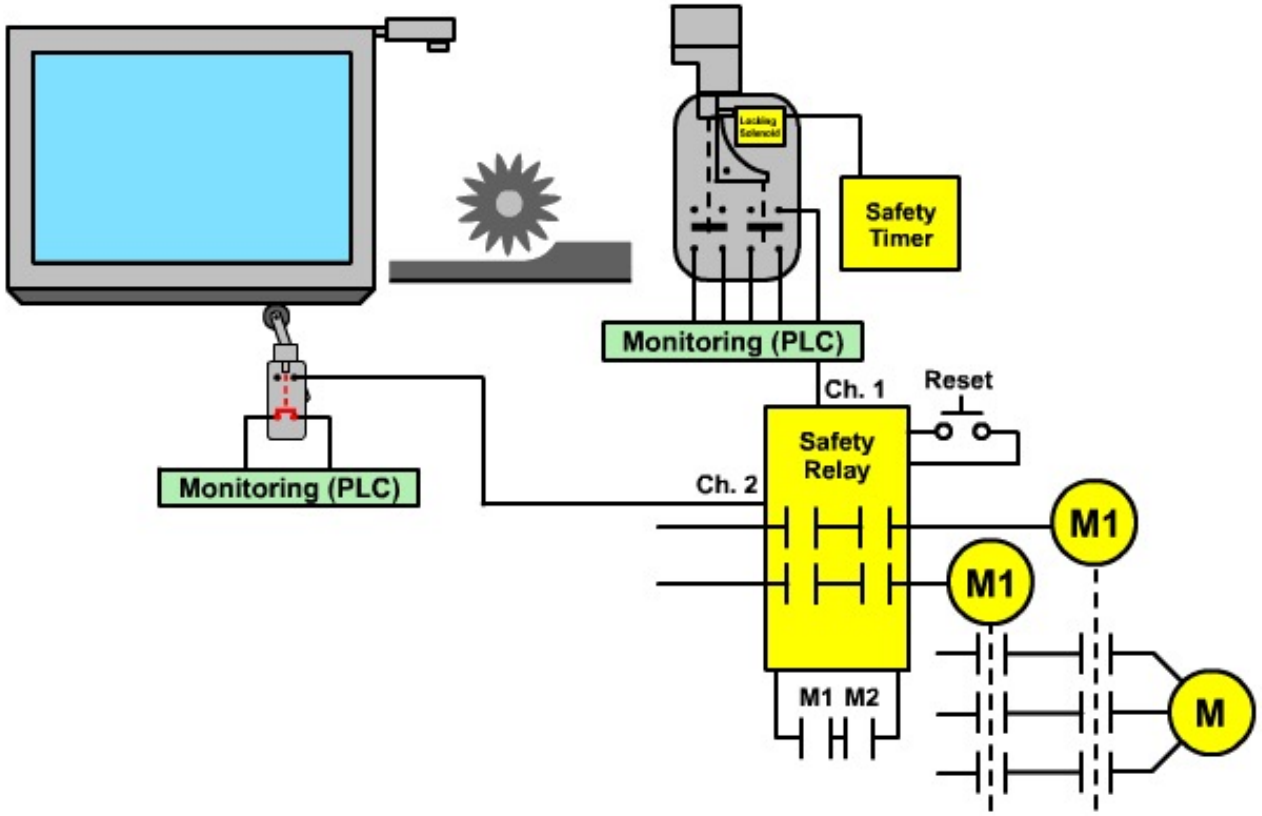


ISO 13849-1
Section 6.2.6 Category 3

"category 3 shall be designed so that a single fault in any of these parts does not lead to the loss of the safety function."



HIGH LEVEL RISK



ISO 14119

Defeat in a reasonable foreseeable manner

This definition includes removal of switches or actuators using tools that are needed for the intended use of the machine or readily available.

- Screw Drivers
- Wrenches
- Hexagon Keys
- Pliers

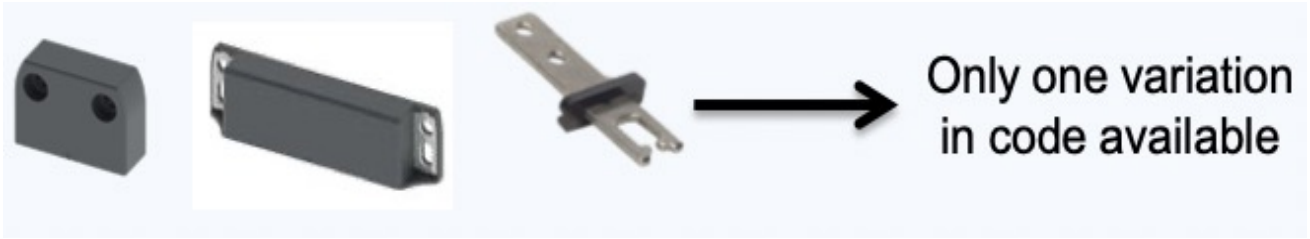
Readily available objects for substitute actuation include:

- Keys
- Coins
- Adhesive Tape
- String & Wire
- SPARE KEYS for the safety interlock

ISO 14119 – Coding of Actuators

Low Coding:

1-9 Variations Available



Medium Coding:

10-1000

High Level Coding:

1000+

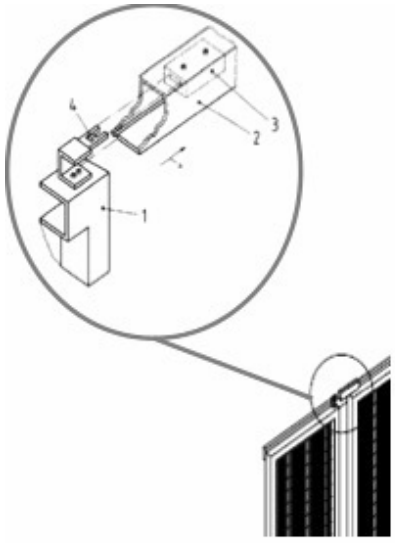
ISO 14119

If foreseeable motivation for defeat exists,

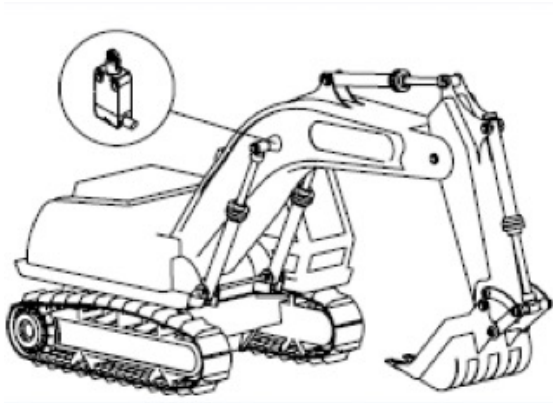
additional measures are required:

Out of Reach

Obstruction/Shielding



Hidden Position



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Worker Killed by Malfunctioning Robot

Golden State Foods, Irvine, CA

July 23, 2009

A 40-year-old woman was crushed to death as she attempted to remove a box that had lodged in box sorting machinery.

Witnesses said after the robot grabbed the woman, fellow workers tried to free her but it was too late.

The machine apparently has sensors that are designed to prevent this type of accident.

EXAMPLE

SIL assignment using methodology IEC 62061

HAZARD: Crushing between robot and hard guarding

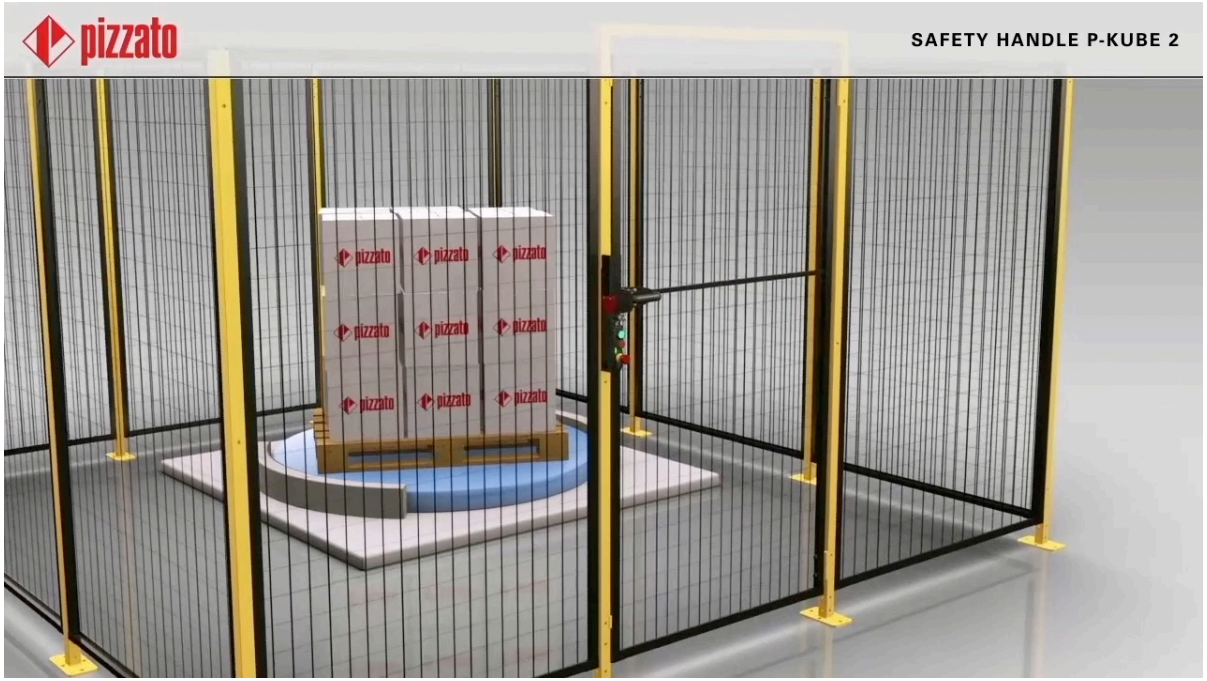
OPERATION: Robot operates in box sorting area.

Cell has a single guard door access.

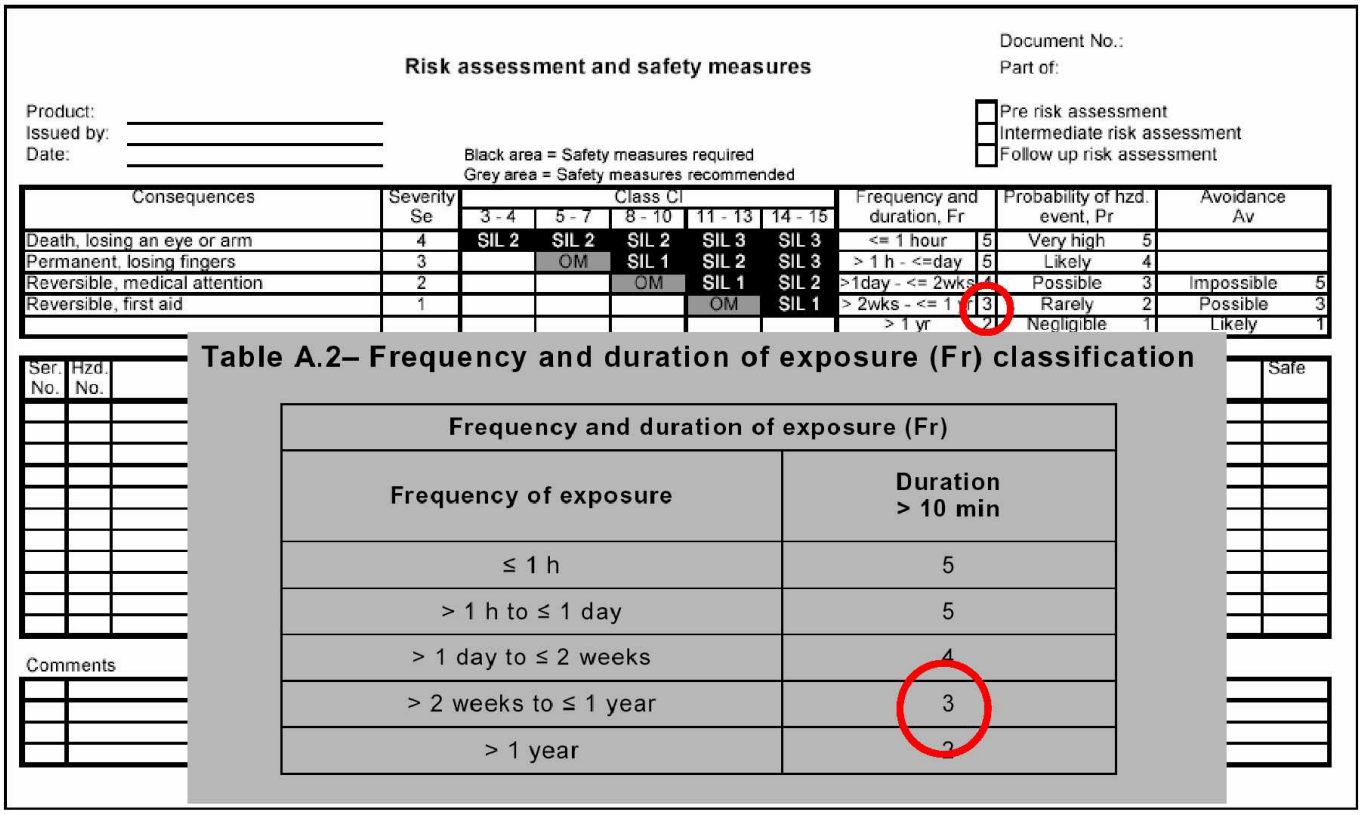
SRCF (Description of **S**afety **R**elated **C**ontrol **F**unction)

SRCF
Description of **S**afety **R**elated **C**ontrol **F**unction)

Worker initiates request to open procedure with gate control. Once the motion has stopped safety system is unlocked, allowing worker entry.



SIL assignment using methodology IEC 62061



Risk assessment and safety measures

Document No.:
Part of:

Product:
Issued by:
Date:

☐ Pre risk assessment
☐ Intermediate risk assessment
☐ Follow up risk assessment

Black area = Safety measures required
Grey area = Safety measures recommended

Consequences	Severity Se	Class Cl 3 - 4	5 - 7	8 - 10	11 - 13	14 - 15	Frequency and duration, Fr		Probability of hzd. event, Pr		Avoidance Av	
Death, losing an eye or arm	4	SIL 2	SIL 2	SIL 2	SIL 3	SIL 3	<= 1 hour	5	Very high	5		
Permanent, losing fingers	3		OM	SIL 1	SIL 2	SIL 3	> 1 h - <=day	5	Likely	4		
Reversible, medical attention	2			OM	SIL 1	SIL 2	>1day - <= 2wks	4	Possible	3	Impossible	5
Reversible, first aid	1				OM	SIL 1	> 2wks - <= 1 yr	3	Rarely	2	Possible	3
							> 1 yr	2	Negligible	1	Likely	1

Ser. No.	Hzd. No.		Safe

Comments

Table A.2– Frequency and duration of exposure (Fr) classification

Frequency and duration of exposure (Fr)	
Frequency of exposure	**Duration > 10 min**
≤ 1 h	5
> 1 h to ≤ 1 day	5
> 1 day to ≤ 2 weeks	4
> 2 weeks to ≤ 1 year	3
> 1 year	2

SIL assignment using methodology IEC 62061

Risk assessment and safety measures

Document No.:
Part of:

Product:
Issued by:
Date:

☐ Pre risk assessment
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Black area = Safety measures required
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Consequences	Severity Se	Class Cl 3 - 4	5 - 7	8 - 10	11 - 13	14 - 15	Frequency and duration, Fr		Probability of hzd. event, Pr		Avoidance Av	
Death, losing an eye or arm	4	SIL 2	SIL 2	SIL 2	SIL 3	SIL 3	<= 1 hour	5	Very high	5		
Permanent, losing fingers	3		OM	SIL 1	SIL 2	SIL 3	> 1 h - <=day	5	Likely	4		
Reversible, medical attention	2			OM	SIL 1	SIL 2	>1day - <= 2wks	4	Possible	3	Impossible	5
Reversible, first aid	1				OM	SIL 1	> 2wks - <= 1 yr	3	Rarely	2	Possible	3
							> 1 yr	2	Negligible	1	Likely	1

Ser. No.	Hzd No.	Hazard	Se	Fr	Pr	Av	Cl	Safety measure	Safe

Comment

Table A.3– Probability (Pr) classification

Probability of occurrence	Probability (Pr)
Very high	5
Likely	4
Possible	3
Rarely	2
Negligible	1

SIL assignment using methodology IEC 62061

Risk assessment and safety measures

Document No.:
Part of:

Product:
Issued by:
Date:

☐ Pre risk assessment
☐ Intermediate risk assessment
☐ Follow up risk assessment

Black area = Safety measures required
Grey area = Safety measures recommended

Consequences	Severity Se	Class Cl					Frequency and duration, Fr		Probability of hzd. event, Pr		Avoidance Av	
		3 - 4	5 - 7	8 - 10	11 - 13	14 - 15						
Death, losing an eye or arm	4	SIL 2	SIL 2	SIL 2	SIL 3	SIL 3	<= 1 hour	5	Very high	5		
Permanent, losing fingers	3		OM	SIL 1	SIL 2	SIL 3	> 1 h - <=day	5	Likely			
Reversible, medical attention	2			OM	SIL 1	SIL 2	>1day - <= 2wks	4	Possible	3	Impossible	5
Reversible, first aid	1				OM	SIL 1	> 2wks - <= 1yr	3	Rarely	2	Possible	3
							> 1 yr	2	Negligible	1	Likely	1

Ser. No.	Hzd. No.	Hazard	Se	Fr	Pr	Av	Cl	Safety measure	Safe

Table A.4– Probability of avoiding or limiting harm (Av) classification

Probabilities of avoiding or limiting harm (AV)	
Impossible	5
Rarely	3
Probable	1

SIL assignment using methodology IEC 62061

Risk assessment and safety measures

Document No.:
Part of:

Product:
Issued by:
Date:

☐ Pre risk assessment
☐ Intermediate risk assessment
☐ Follow up risk assessment

Black area = Safety measures required
Grey area = Safety measures recommended

Consequences	Severity Se	Class Cl 3 - 4	5 - 7	8 - 10	11 - 13	14 - 15	Frequency and duration, Fr		Probability of hzd. event, Pr		Avoidance Av	
Death, losing an eye or arm	4	SIL 2	SIL 2	SIL 2	SIL 3	SIL 3	<= 1 hour	5	Very high	5		
Permanent, losing fingers	3		OM	SIL 1	SIL 2	SIL 3	> 1 h - <=day	5	Likely	4		
Reversible, medical attention	2			OM	SIL 1	SIL 2	>1day - <= 2wks	4	Possible	3	Impossible	5
Reversible, first aid	1				OM	SIL 1	> 2wks - <= 1 yr	3	Rarely	2	Possible	3
							> 1 yr	2	Negligible	1	Likely	1

Ser. No.	Hzd. No.	Hazard	Se	Fr	Pr	Av	Cl	Safety measure	Safe

Comments

Table A.1 – Severity (Se) classification

Consequences	Severity (Se)
Irreversible: death, loosing an eye or arm	4
Irreversible: broken limb(s), loosing a finger(s)	3
Reversible: requiring attention from a medical practitioner	2
Reversible: requiring first aid	1

SIL assignment using methodology IEC 62061

Risk assessment and safety measures

Document No.:
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Issued by:
Date:

☐ Pre risk assessment
☐ Intermediate risk assessment
☐ Follow up risk assessment

Black area = Safety measures required
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Consequences	Severity	Class Cl					Frequency and duration, Fr		Probability of hzd. event, Pr		Avoidance Av	
		3 - 4	5 - 7	8 - 10	11 - 13	14 - 15						
Death, losing an eye or arm	4	SIL 2	SIL 2	SIL 2	SIL 3	SIL 3	<= 1 hour	5	Very high	5		
Permanent, losing fingers	3		OM	SIL 1	SIL 2	SIL 3	> 1 h - <=day	5	Likely			
Reversible, medical attention	2			OM	SIL 1	SIL 2	>1day - <= 2wks	4	Possible	3	Impossible	5
Reversible, first aid	1				OM	SIL 1	> 2wks - <= 1 yr	3	Rarely	2	Possible	3
							> 1 yr	2	Negligible	1	Likely	1

Ser. No.	Hzd. No.	Hazard	Se	Fr	Pr	Av	Cl	Safety measure	Safe
		Crushing	4	3	5	5	13		

Comments

REF: ISO 13849-1 - PLe
IEC 62061 – SIL3

Traditionally Referred to as GATE BOXES

Robotic Harmonized Standards

ANSI/RIA 15.06 (2012)

Adopted ISO 10218-1 & ISO 10218-2:2011 in 2012

- Risk assessment follow either:
  - ANSI B11.0
  - ISO12100

- Selecting Robot safeguarding devices:
  - TR 15.406

- Wiring your safeguarding control devices use ISO 13849-1 to validate that the PL needed as been achieved & validation of the control circuit

NFPA 79
ANSI B11.0 Risk Assessment & Risk Reduction

NFPA 9.4.1.1

GENERAL REQUIREMENTS

…”The electrical control circuits shall have an appropriate level of performance that has been determined from the risk assessment of the machine.”

Annex I.1.2.2

ANSI B11.0 Risk Assessment & Risk Reduction

RISK ASSESSMENT

ANSI American National Standards Institute

ANSI B11.0

- SEVERITY OF HARM
- PROBABILITY OF OCCURANCE
- EXPOSURE TO HAZARD
- PERSONNEL WHO PERFORM TASKS
- MACHINE/TASK HISTORY
- WORKPLACE ENVIRONMENT
- HUMAN FACTORS
- RELIABILITY OF SAFETY FUNCTIONS
- POSSIBILITY TO DEFEAT
- ABILITY TO MAINTAIN PROTECTIVE MEASURES

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IT'S UP TO YOU!

- **ENCORE PERFORMANCE**
  - LIVE SEMINAR AT YOUR FACILITY
- **SAMPLES ARE AVAILABLE**
  - SIXTY DAY TRIAL PERIOD
- **RISK ASSESSMENT/RISK REDUCTION**
  - ***HELP IS AVAILABLE***

THANK YOU FOR ATTENDING OUR SAFETY SEMINAR!

Local PIZZATO Distributor

All Major Marketing Areas

Local Factory Support

Nationwide

Seminar Presentation

Michael D. Ladd *with* PIZZATO USA

Thank you for your attention