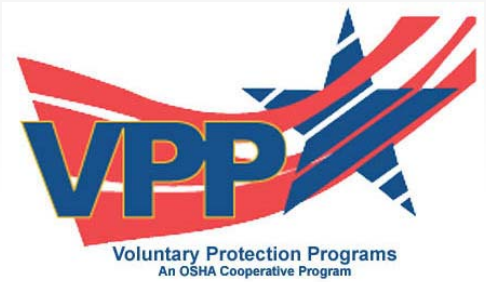
Trends in Machine Guarding Standards

Dan Henman
Vice President Marketing/Sales – ROSS Controls®

Agenda

- Ross Controls Introduction
- Global Machine Safety Standards Trends



The ROSS Controls Story

ROSS HAS A LONG HISTORY OF PRODUCTS FOR MACHINE SAFETY

- Founded in 1921 by Charlie Ross
- 1954 – First double valve ever developed by ROSS
- 1962 – Developed first pneumatic energy isolation device (L-O-X®)
- 2005 – DM^2 ™
- 2013 – MDM2
- 2014 – CM Series 4 way double valves

ROSS Safety Product®

ROSS® Consider it DONE!

Global Facilities

ROSS Controls - Madison Heights

CONSIDERING GLOBAL SAFETY REQUIREMENTS

ROSS Asia - Japan

ROSS Controls - Troy, MI

ROSS UK Ltd.

ROSS Controls - Lavonia, GA

ROSS Europa GmbH - Germany

ROSS South America

ROSS China

ROSS India

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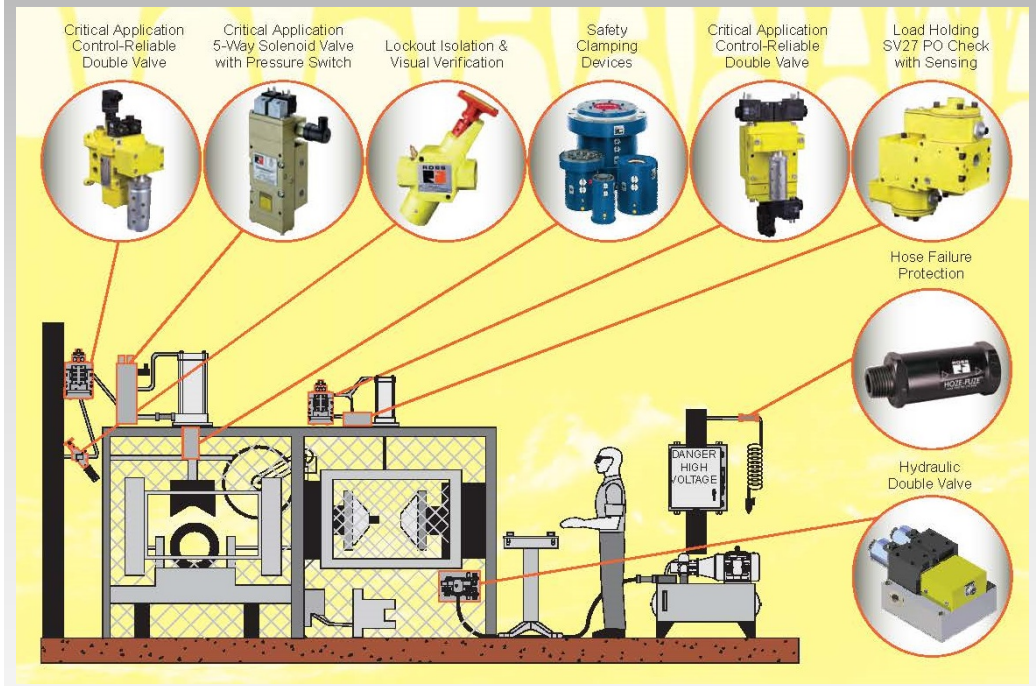
Safety Industry

GLOBAL SAFETY SPECIALISTS IN EACH LOCATION TO STAY CURRENT



GLOBAL SAFETY TEAM

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Safety Standards

ROSS' PARTICIPATION

ANSI FORMS BASIS OF OSHA STANDARDS

Current NAM Committees with ***ROSS Representation***

ANSI B11.0 General Safety Requirements & Risk Assessment

ANSI B11.1 Mechanical Power Press

ANSI B11.2 Cylinder Press

ANSI B11.19 Performance Criteria for Safeguarding

ANSI B11.26 Safety Control Systems for Machine Tools

ANSI Z244 Control of Hazardous Energy - Lockout Tagout

ANSI B155.1 Packaging Machinery

ANSI B151 Plastics Machinery

CSA Z142 Punch Press & Brake Press

CSA Z432 Guarding of Machinery

CSA Z460 Control of Hazardous Energy - Lockout - Tagout

CSA Z434 Robot Safety Standard

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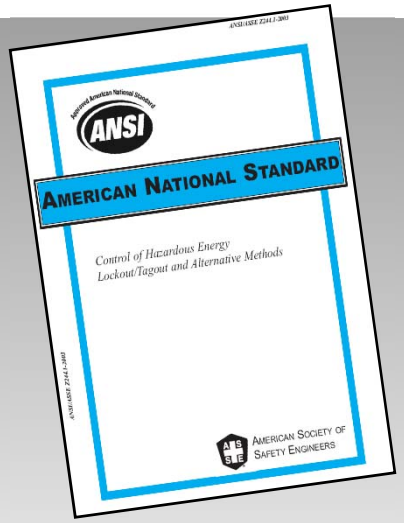

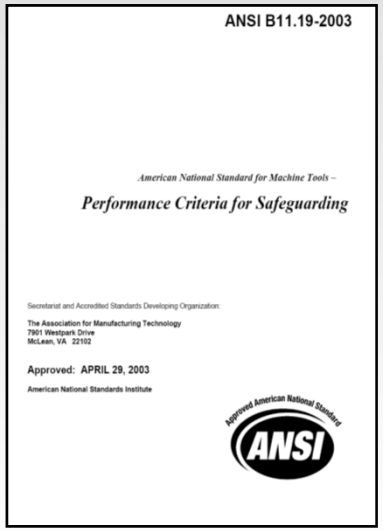

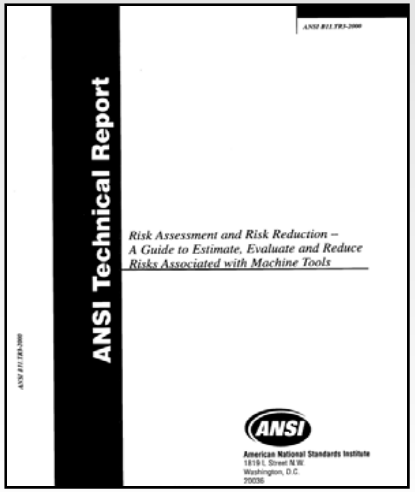

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OSHA Occupational Safety & Health Administration
U.S. Department of Labor

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Global Standards
Machine Guarding *Trends*

HARMONIZATION DOESN'T MEAN IDENTICAL

Harmonization of Standards

- Regional standards use the ISO standard as the basis and make adjustments to meet regional requirements such as legal aspects.
- Standards are beginning to speak a similar language and have a similar structure
- Being copied with modifications
  - CSA Energy Isolation = ANSI Energy Isolation
- Robotics ISO 10218 --- First Global Standard with the ANSI and CSA standards based on the ISO standard.

Global Standards
Machine Guarding *Trends*

The Machinery Directive 98/37/EC was replaced with 2006/42/EC on December 29, 2009

EXPANDED THE SCOPE OF WHAT MACHINERY AND COMPONENTS REQUIRE THE CE

- "The New Directive"
  - Requires CE mark on machinery & safety components
  - Compiling the technical construction file (Mtce. Manual, spare parts, risk assessment etc.)
  - Meet the EHSR's
  - Includes safety valves with diagnostics

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Global Standards
Machine Guarding *Trends*

"The New Directive"

THE CE MARK IS THE PASSPORT TO SELL IN THE EU

- **2006/42/EC**

- Does not apply to US Machines but …
  - Global users and OEMs
    - Like to standardize
    - Different machines can affect liability
    - Driving the current global manufacturing market

NORMALLY FOLLOWING THE ANSI STANDARDS WILL RESULT IN CE COMPLAINCE

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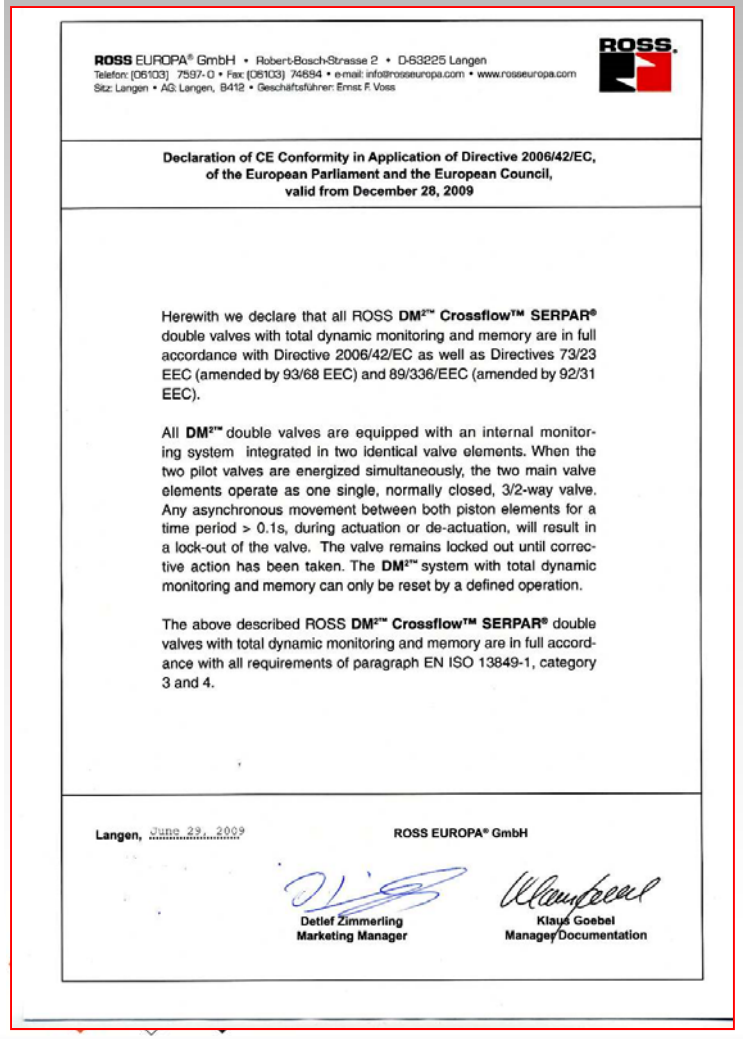
Global Standards
Machine Guarding *Trends*



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Declaration of CE Conformity in Application of Directive 2006/42/EC, of the European Parliament and the European Council, valid from December 28, 2009

Herewith we declare that all ROSS **DM²™ Crossflow™ SERPAR®** double valves with total dynamic monitoring and memory are in full accordance with Directive 2006/42/EC as well as Directives 73/23 EEC (amended by 93/68 EEC) and 89/336/EEC (amended by 92/31 EEC).

All **DM²™** double valves are equipped with an internal monitoring system integrated in two identical valve elements. When the two pilot valves are energized simultaneously, the two main valve elements operate as one single, normally closed, 3/2-way valve. Any asynchronous movement between both piston elements for a time period > 0.1s, during actuation or de-actuation, will result in a lock-out of the valve. The valve remains locked out until corrective action has been taken. The **DM²™** system with total dynamic monitoring and memory can only be reset by a defined operation.

The above described ROSS **DM²™ Crossflow™ SERPAR®** double valves with total dynamic monitoring and memory are in full accordance with all requirements of paragraph EN ISO 13849-1, category 3 and 4.

Langen, June 29, 2009 — ROSS EUROPA® GmbH

Detlef Zimmerling, Marketing Manager — Klaus Goebel, Manager Documentation

EXAMPLE OF ROSS' DECLARATION THAT WE MEET THE MACHINERY, PRESSURE VESSEL AND LOW VOLTAGE DIRECTIVES VIA DESIGNING TO ISO 13849-1

CE

The CE Mark denotes that the manufacturer has declared his product in compliance with the valid directives.

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Global Standards
Machine Guarding *Trends*

International Electrotechnical Commission (IEC)
International Organization for Standardization (ISO)

WTO MEMBERS ARE PART OF IEC & ISO

Member Countries of WTO

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Global Standards
Machine Guarding *Trends*

STANDARDS TEND TO BE DIVIDED INTO 3 TYPES

- Type A
  - Basic safety standards and terminology – i.e. Risk Assessment
- Type B
  - B1 – Standards on safety aspects – Machine Guarding
  - B2 – Standards on safety components – Light Curtains
- Type C
  - Specific machine requirements – Mechanical Power Press, Packaging …

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Global Standards
Machine Guarding *Trends*

NEARLY THE SAME EXCEPT WITH PHSR

STANDARD	USA	Canada	Europe	Brazil	Australia	China	Japan	India
Electrically Operated Valves	UL 429	CSA 22.2 No 139						
Control Of Hazardous Energy (Lockout)	ANSI Z244	CSA Z460	ISO 14118	NR 12	AS 4024			
Safeguarding of Machinery	ANSI B11.19	CSA Z432	ISO 13849			GB 17957	JIS B9700	
Safety Reqs and Risk Assessment	ANSI B11.0		ISO 12100				Article 18	IS 11016
Power Press Safety Regulation	ANSI B11.1	CSA Z142	EN 692	FOLLOW EN & NOW ISO			No 116	
Cylinder Press Regulation	ANSI B11.2	CSA Z142	EN 13736					
Robots	ANSI 15.06	CSA Z434	ISO 10218					
Packaging Machinery	ANSI B155.1		EN 415 1-9					
Plastics Machinery	ANSI B151.1		EN 422					
Hollow glass			EN 13042					
Safety Control Systems	ANSI B11.TR6		BG					
Pneumatic Systems	ISO 4414		ISO 4414			ISO 4414		
Two Hand Control			ISO 13851					
Pneumatic Fluid Power Testing			ISO 19973					

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Global Standards
Machine Guarding *Trends*

Emergency Stop:

EXTREMELY SIMILAR

- ANSI B11.19
- ANSI/NFPA 79
- ISO 13850

Global Standards
Machine Guarding *Trends*

- All New Standards require a Risk Assessment as their foundation for machine safeguarding to fully address the hazards.

- ANSI B11.0
- ANSI B155.1
- ANSI Z244
- ISO 12100
- ISO 13849
- ISO 10218
- RIA 15.06
- CSA 432
- CSA 434
- CSA 460

Global Standards
Machine Guarding ***Trends***

Risk Assessment Requirements:

Performed by:
- OEM
- Integrator
- End User

RISK ASSESSMENT IS A PROCESS
OEM must understand operation
i.e. Is the machine loaded by a person or robot?

Must consider:
- Foreseeable misuse
- Failure Modes
- Severity, Frequency, Probability

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Machine Guarding Hierarchy

FROM ANSI B11.0

Table 3 — The Hazard Control Hierarchy

Most Preferred

Protective Measure	Examples	Influence on Risk Factors	Classification
Elimination or Substitution	• Eliminate pinch points (increase clearance) • Intrinsically safe (energy containment) • Automated material handling (robots, conveyors, etc.) • Redesign the process to eliminate or reduce human interaction • Reduced energy • Substitute less hazardous chemicals	• Impact on overall risk (elimination) by affecting severity and probability of harm • May affect severity of harm, frequency of exposure to the hazard under consideration, and/or the possibility of avoiding or limiting harm depending on which method of substitution is applied.	Design Out
Guards and Safeguarding Devices	• Barriers • Interlocks • Presence sensing devices (light curtains, safety mats, area scanners, etc.) • Two hand control and two-hand trip devices	• Greatest impact on the probability of harm (Occurrence of hazardous events under certain circumstance) • Minimal if any impact on severity of harm	Engineering Controls
Awareness Devices	• Lights, beacons, and strobes • Computer warnings • Signs and labels • Beepers, horns, and sirens	• Potential impact on the probability of harm (avoidance) • No impact on severity of harm	Administrative Controls
Training and Procedures	• Safe work procedures • Safety equipment inspections • Training • Lockout / Tagout / Tryout	• Potential impact on the probability of harm (avoidance and/or exposure) • No impact on severity of harm	
Personal Protective Equipment (PPE)	• Safety glasses and face shields • Ear plugs • Gloves • Protective footwear • Respirators	• Potential impact on the probability of harm (avoidance) • No impact on severity of harm	

Least Preferred

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Risk Assessment – EN 954

S - Severity of Injury

S1 — *Slight (reversible)*

S2 — *Serious (non-reversible)*

Take the worst case injury into account. If this is no more than a slight cut or bruise, then select S1. If the consequences are more severe, up to and including death, then select S2.

F - Frequency & Duration of Exposure

F1 — *Seldom*

F2 — *Frequent to continuous and/or long exposure*

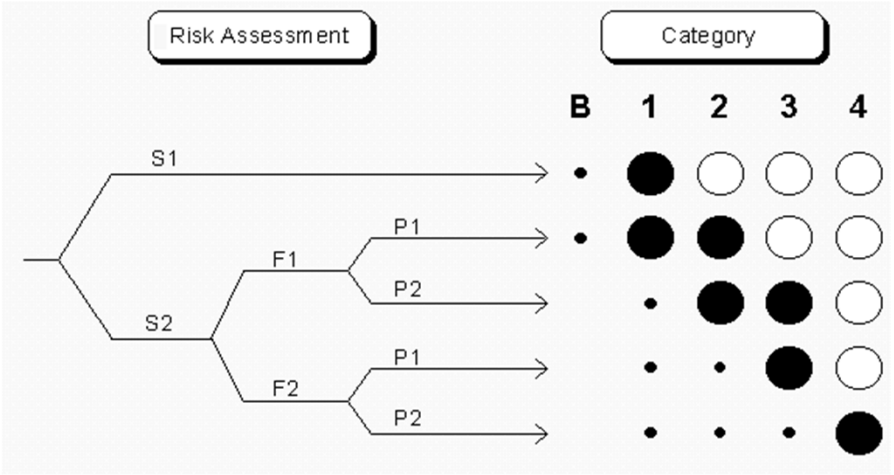
Select F2 if a person is exposed to the hazard frequently. It is irrelevant whether it is the same person or a different person. Select F1 if access is only required from time to time and the exposure time is short.

P – Possibility of Avoiding the Hazard

P1 — *Possible under specific conditions*

P2 — *Less possible*

Determine the possibility of avoiding the hazard if the monitoring & control devices used (such as light curtains) failed. This is generally related to the speed at which the hazard moves, proximity to the hazard, level of training, and expertise of operators. If, in your opinion, the operator could recognize the hazard and avoid injury, select P1. Otherwise, select P2



Legend

Preferred Category. Some risk levels offer two selection possibilities. If the equipment is clean and dry and the levels of maintenance and inspection of the safety related system are high, select the lower category. Otherwise, select the higher.

Possible Lower Category. In some applications the designer can select a lower category by using other safeguard measures, such as hard guarding.

More than required for the relevant risk

UNOFFICIAL DEFINITIONS – EN 954-1

Category B is like flying in a home built ultra-light.

Category 1 is like flying in a Cessna single engine plane with no engine instruments.

Category 2 is having an engine out light on the same single engine plane.

UNOFFICIAL DEFINITIONS

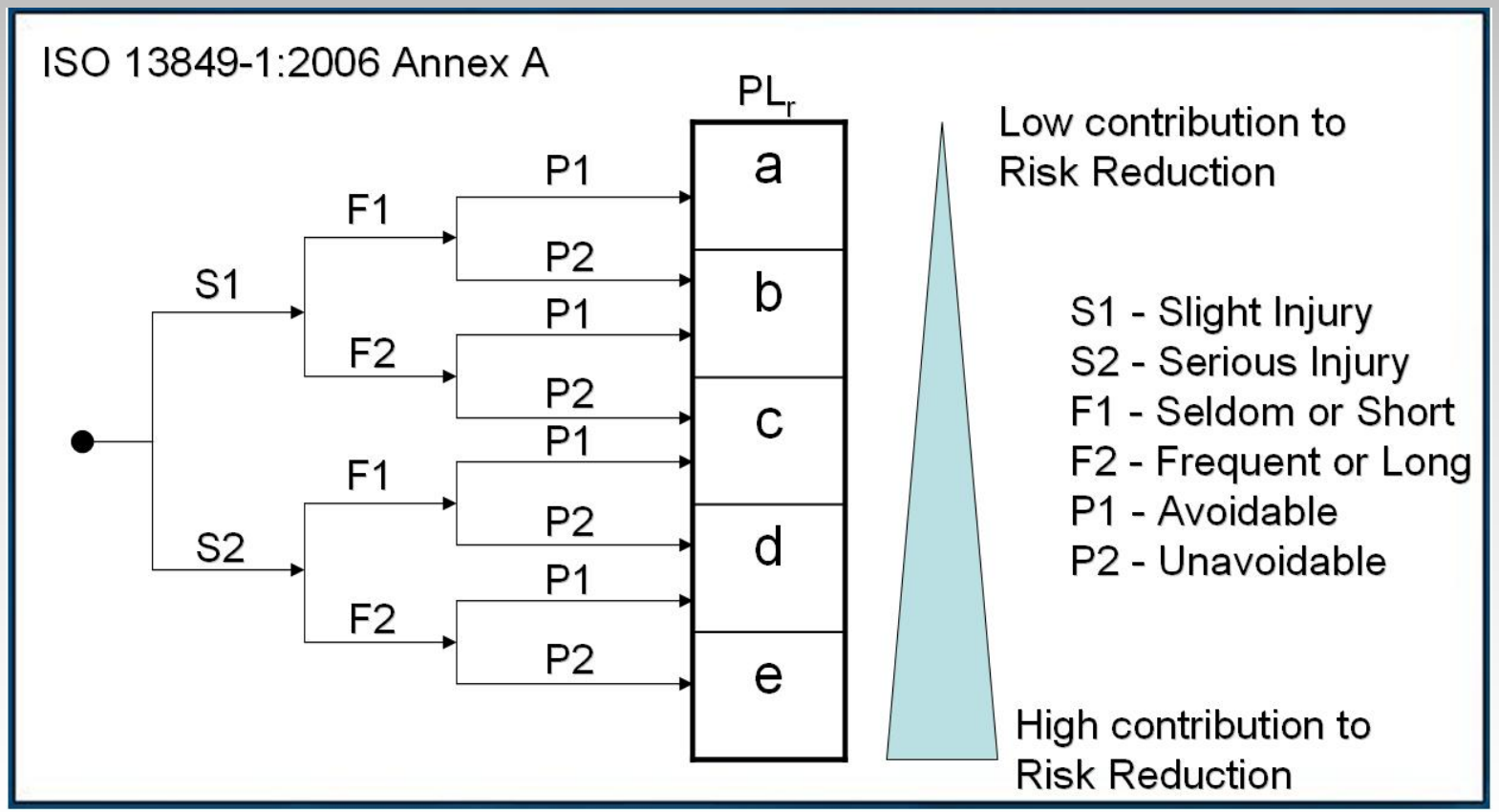
Category 3 is moving up to a twin engine plane with full engine instrumentation, but no co-pilot.

Category 4 is a twin with a co-pilot and full instruments that he monitors.

Risk Assessment – ISO 13849

ISO 13849 SUPERCEDED EN 954

ADDS REALIABILITY FACTORS



Consider it DONE!

Control Integrity

Table 4 — Approximate Relationships Between Levels in ANSI B11.TR6 and Other Relevant Standards

Risk Reduction	System Architecture				
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
ANSI B11.TR6 (ISO 13849-1:1999)	ANSI B11.0	Robotics Industry (RIA R15.06 / CSA Z434)	CATEGORY (ISO 13849-1:1999)	SIL (IEC 61508)	Performance Level (ISO 13849-1: 2006
Highest: Requirements of B and the use of well-tried safety principles shall apply. Safety-related parts shall be designed, so that a single fault in any of these parts does not lead to a loss of the safety function, and the single fault is detected at or before the next demand upon the safety function, but that if this detection is not possible, an accumulation of undetected faults shall not lead to loss of the safety function.	Highest: Redundancy w/ continuous self-checking (e.g., Dual channel w/ continuous monitoring)	R1 / R2A (Control reliable)	4	3	e
Intermediate / High: Requirements of B and the use of well-tried safety principles shall apply. Safety-related parts shall be designed, so that a single fault in any of these parts does not lead to the loss of the safety function, and whenever reasonably practicable, the single fault is detected.	Intermediate / High: Redundancy w/ self-checking upon start-up (e.g., Dual channel w/ monitoring at cycle/start-up)	R2A / R2B (Control reliable / Single channel with monitoring)	3	3 to 2	d or c
Low / Intermediate: Requirements of B and the use of well-tried safety principles shall apply. Safety function shall be checked at suitable intervals by the machine control system.	Low / Intermediate: Redundancy that may be manually checked (e.g., Dual channel w/ optional manual monitoring)	R2B / R2C (Single channel with monitoring / Single channel)	2	2 to 1	b
Lowest: Requirements of B shall apply. Well-tried components and well-tried safety principles shall be used.	Lowest: Single channel	R3A (Single channel)	1	0	a
B: SRP/CS and/or their protective equipment, as well as their components, shall be designed, constructed, selected, assembled and combined in accordance with relevant standards so that they can withstand the expected influence. Basic safety principles shall be used.		R3B / R4 (Simple)	B		a

DIFFERENT RISK ASSESSMENTS

COMMON GOAL – SET SAFETY REQUIREMENTS

Global Standards
Machine Guarding *Trends*

GLOBAL USERS AND PRODUCT MANUFACTURERS ARE DRIVING THESE TRENDS TO HAVE UNIFORMITY


INTERNATIONAL STANDARD ISO 13849-1

Second edition 2006-11-01

Safety of machinery — Safety-related parts of control systems —
Part 1:
General principles for design

Sécurité des machines — Parties des systèmes de commande relatives à la sécurité —
Partie 1: Principes généraux de conception

Reference number ISO 13849-1:2006(E)

© ISO 2006

Global users choose the “highest” standard

- o Tend to be ISO due to legal requirements
- o Desire one machine globally
- o Should not have lesser safety requirements depending upon country
- o Allows for global design standards

OEMs design to customer specs

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Lockout Tag-Out ***Trends***

OSHA 1910.147 The control of Hazardous energy

ANSI Z244 Lockout/Tagout

- Lockout whenever a body part is put into a point of operation
- Production related issues may be performed using “alternative measures which provide effective protection”.

Lockout/Tagout OSHA

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Alternative Measures

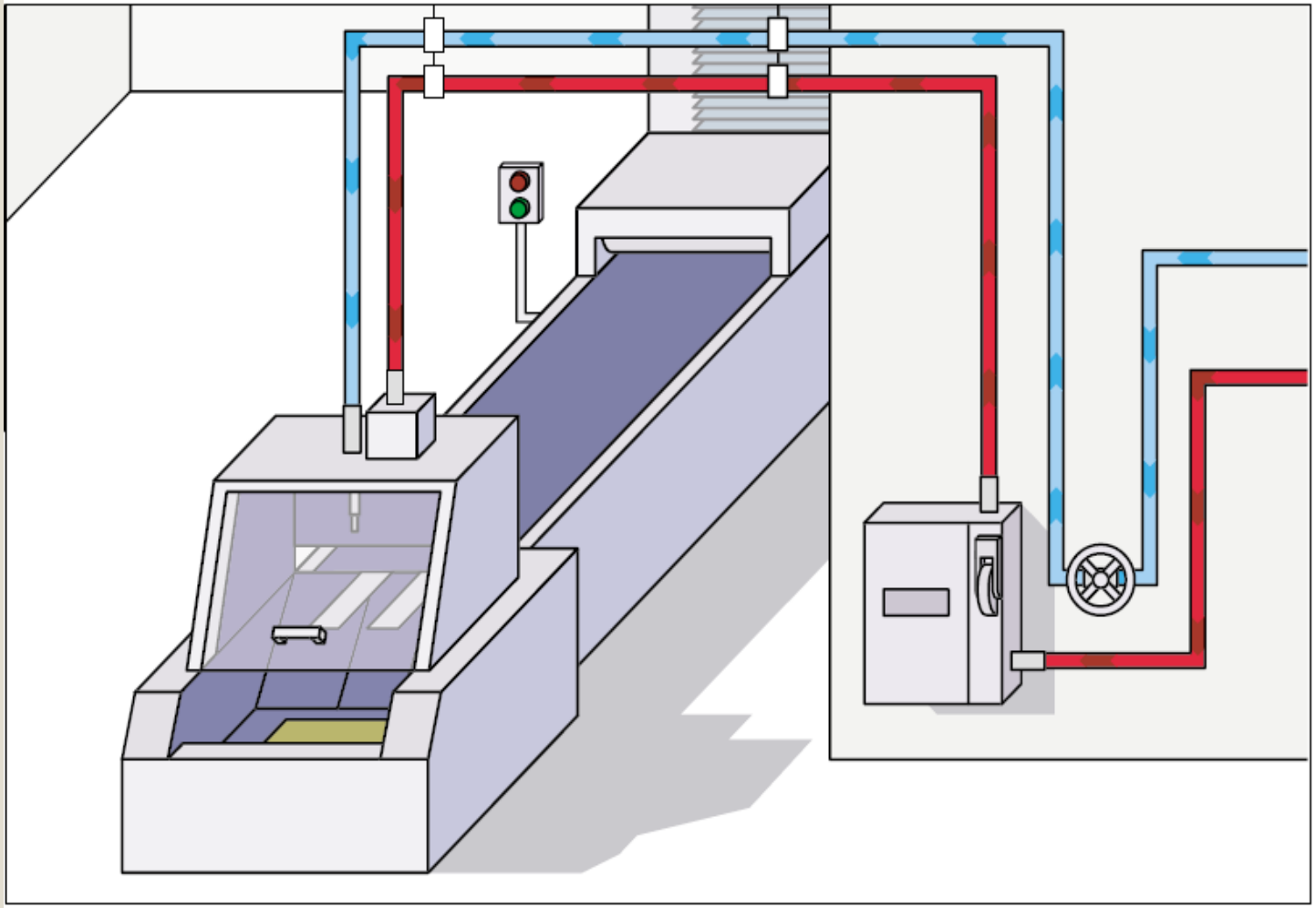
May only be used for tasks that are part of the normal production and operation

- Routine
- Repetitive
- Integral to the manufacturing process

Examples: jam clearing, tool changes, lubrication, roll polishing

Allen-Bradley

ElectroGuard™
Safety
Isolation
System
Bulletin 2030



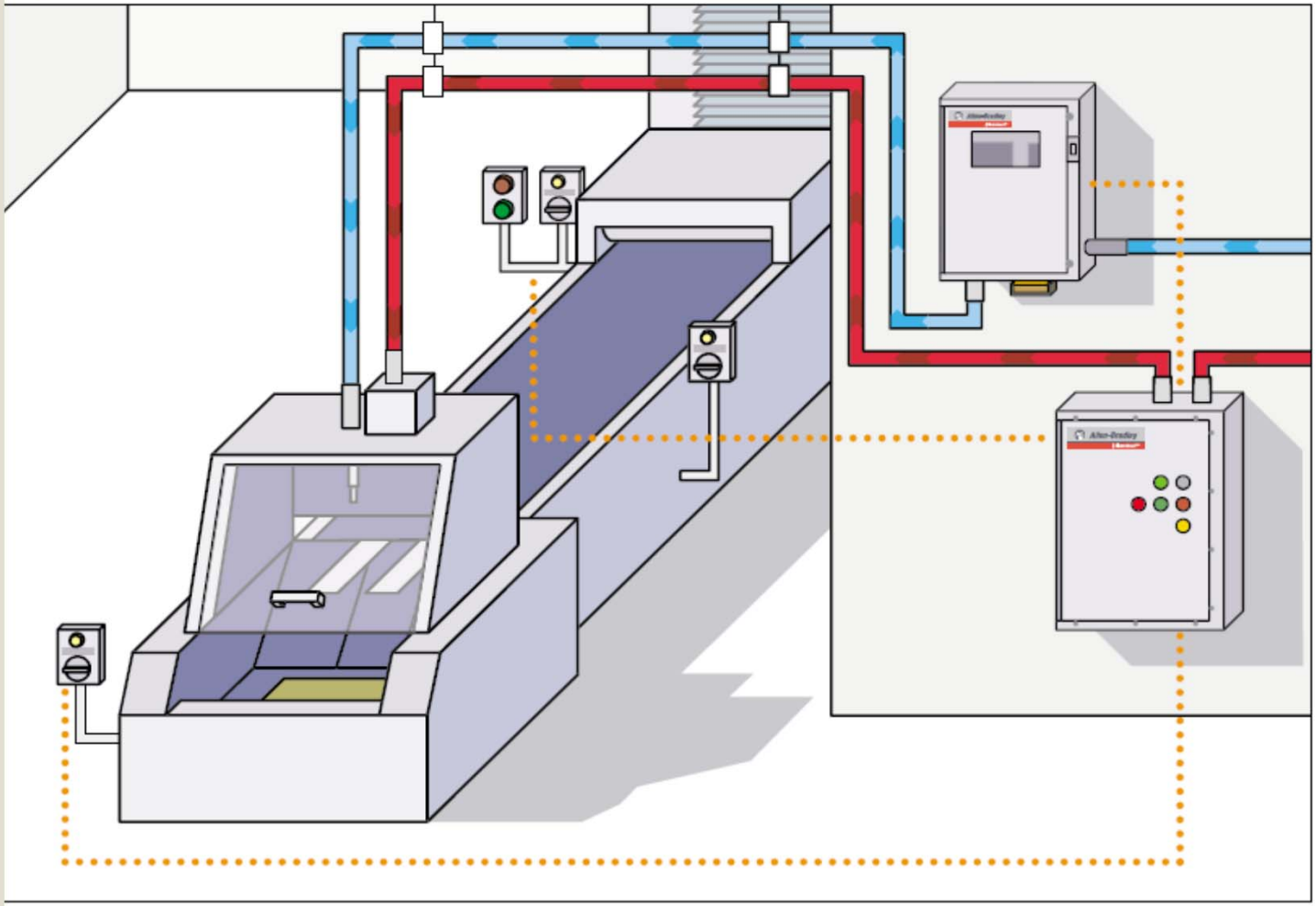
When a process jam occurs, the operator must travel around between the start/stop station and the energy isolation devices (LOTO) and the jam, to get production running again. The clearing of the jam is only a small portion of the production down time; the remaining time is spent on the proper LOTO procedure. Operator travel time and manually locking of two isolation devices is a large portion of the total recovery time.

Time: 70 seconds

Allen-Bradley

ElectroGuard™ Safety Isolation System

Bulletin 2030

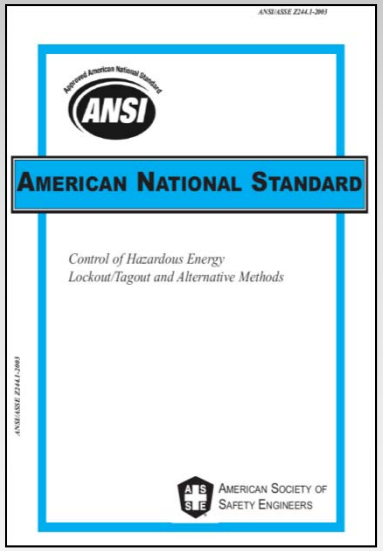


The ElectroGuard system is installed in place of the manual isolation devices, while multiple Remote Lockout Stations are installed near the machine access locations. With this simplified LOTO procedure and close proximity of the Remote Lockout Stations, the clearing of a jam is now a large percentage of the production down time.

Time: 35 seconds

Alternative Measures

- Process Requirements (3 steps)
  - Risk assessment
  - Hierarchy of control defined
  - Control circuit integrity defined



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Risk Reduction

Control circuit integrity (Z244)

a) Negligible Risk Potential - Infrequent exposure, low injury severity
  – Single channel hardwired circuit

b) Low Risk Potential – Frequent exposure and low injury severity
  – Dual channel hardwired circuit

c) Medium Risk Potential – ANY exposure to serious injury
  – Dual channel hardwired circuits that are redundant and monitored

d) High risk potential – ANY exposure to catastrophic injury
  – Requires control reliable components”

Alternative Measures Summary

- Must use traditional lockout for maintenance
- Alternative lockout for production (routine, repetitive, & integral)
  - Requires risk assessment
  - Concerned with hazardous energy
  - Control reliable systems can be an effective means
  - Exclusive control by the employee

Alternative Measures

Lockout costs (time related):

- Initial problem occurs
- Troubleshooting the true problem
- Locating repair parts
- Lockout all energy sources
- Repair installation
- Restart

Alternative Measures

ROI

Alternative lockout reduces the risk of an employee missing a LOTO for one energy source when he is rushed.

Alternative lockout reduces the time required to put the machine into a safe mode.

TIME = MONEY

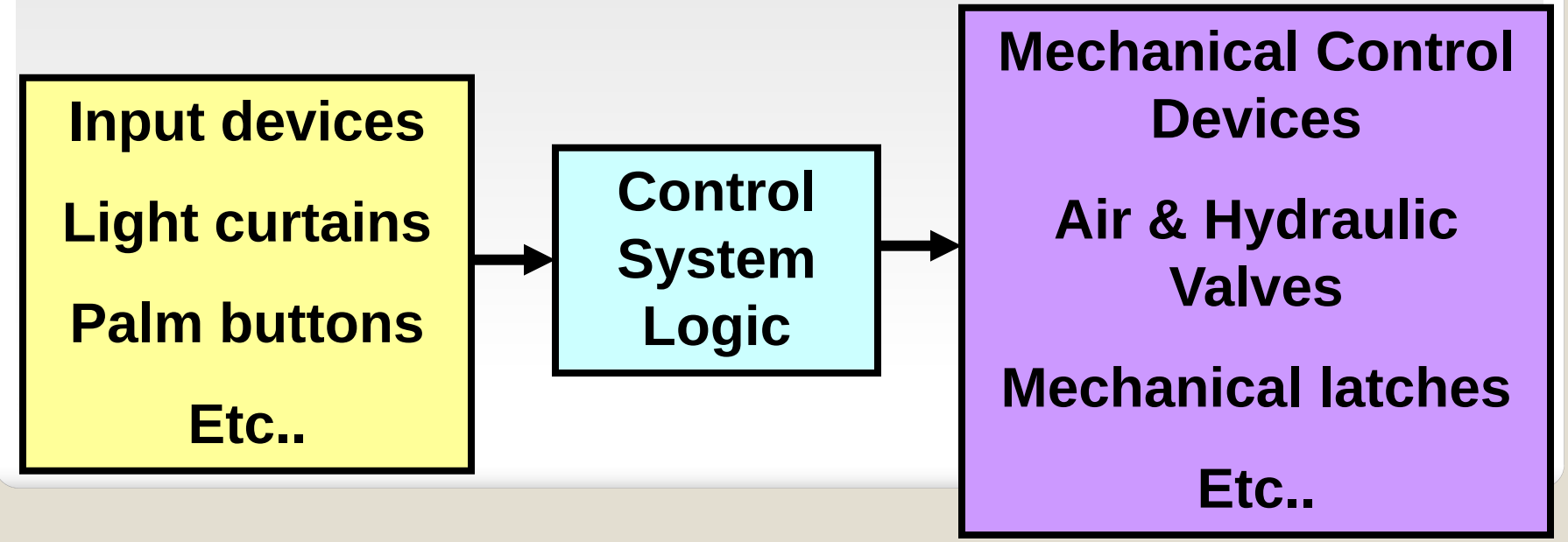
SAFETY + PRODUCTIVITY

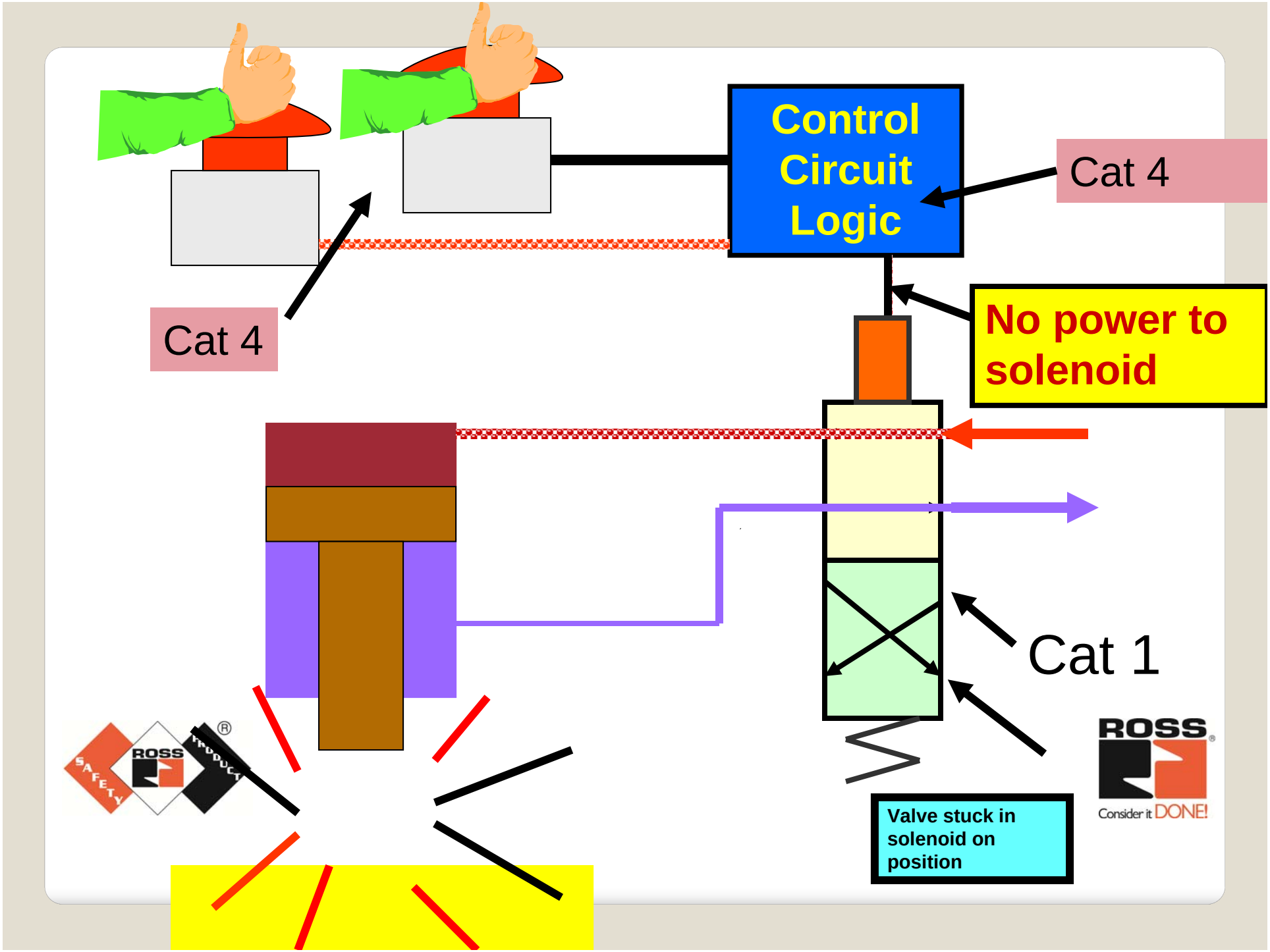
Consider it DONE!

Control System

The Control system does NOT END with the wire!

It includes all components involved in performing the safety function; sensors, manual input, and mode selection elements, interlocking and decision-making circuitry, and output elements that control machine operating devices or mechanisms.




Control Circuit Logic
Cat 4
Cat 4
No power to solenoid
Cat 1
Valve stuck in solenoid on position
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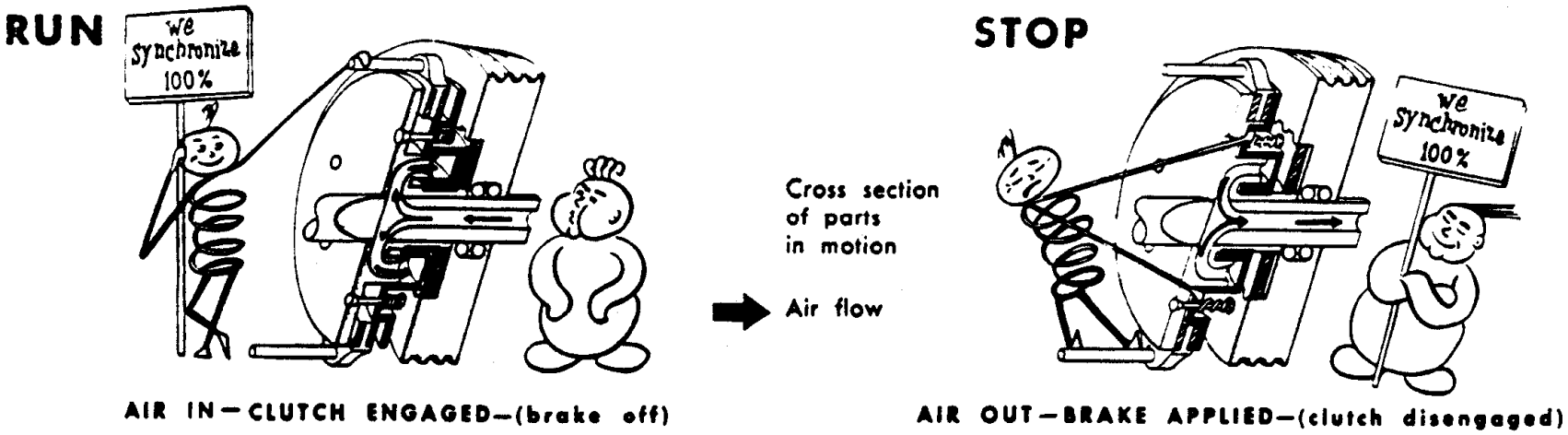
Clutch/Brake Controls for Mechanical Power Presses



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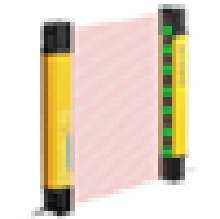
Safety Math

4+4+1 = ?

1

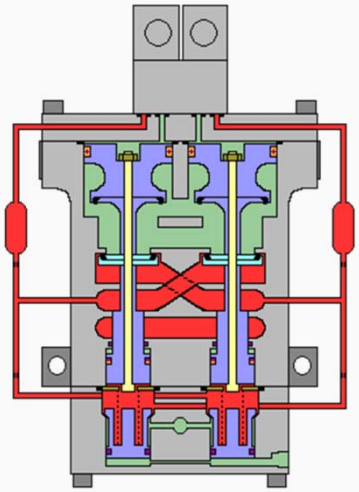
Light Curtain Safety Input

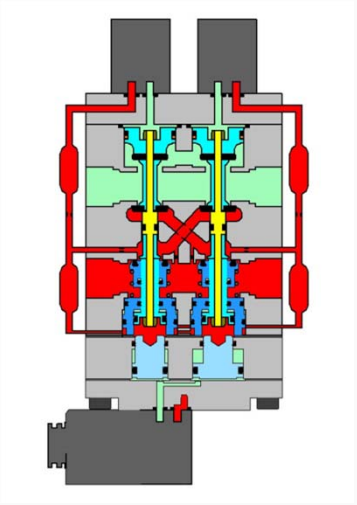


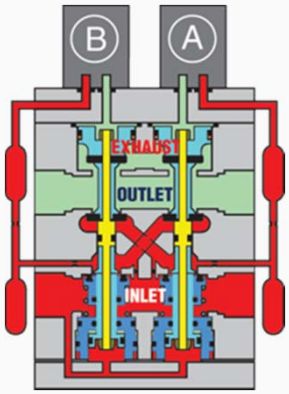
Safety PLC Logic

Standard Valve

CONTROL RELIABLE ENERGY ISOLATION VALVES "PNEUMATIC SAFETY RELAY"







Machine Guarding

B11.19 Highlights

Section 6 General Safeguarding Requirements:

Requires monitoring of all safety circuit applications involving stopping distances where the **stopping time** might change based on the systems components (**sticky valve**, worn spring on a switch, etc.)

Safety Valves

ANSI B155.1 Packaging Machinery Standard

7.2.9.2 Stop functions

- When pneumatic or hydraulic elements are incorporated into a safety stopping function, the circuit design and component selection shall be appropriate for the required level of safety performance. Devices that produce a hazard shall have power removed during a stop function, provided a greater hazard is not created in the process.

Global Standards
Machine Guarding *Trends*

- Introduction of Functional Safety (ISO/IEC)
  - B11.26 - based on TR6 revision
- Harmonizing IEC 62061 & ISO 13849
  - Equate SIL & PL
- ANSI harmonization

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Global Standards
Machine Guarding *Trends*

Monitored Power Systems approved by OSHA

Companies want to perform more tasks using alternative measures

Low voltage lockout systems

NEW TREND (ROI – WITH VALUE ADDED SAFETY SYTEMS SAFE WORK ENVIRONMENT FOR EMPLOYEES PLUS INCREASE PRODUCTIVITY BY THE INCREASE IN UPTIME)

ROSS SAFETY PRODUCT®

ROSS® Consider it DONE!

CONTROL INTEGRITY DOES NOT END WITH WIRE

Global Machine Guarding Standards

THANK YOU

SAFETY ROSS PRODUCT®

VPP

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