

Safety Best Practices in the Metal Fabrication Industry

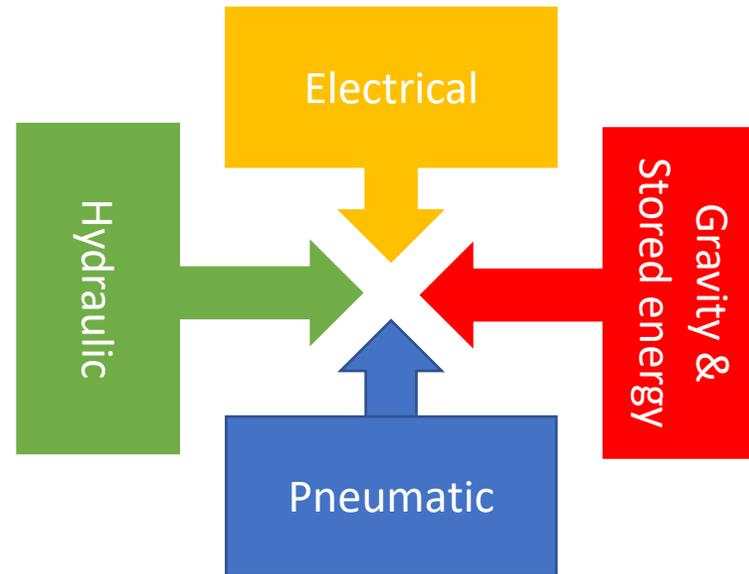


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The metal fabricating industry has many types of machines that use a multiple energy sources that must be considered when designing safety systems.



Many times, companies don't know where to start with safety and don't understand the requirements.

Study finds safety is a path to productivity

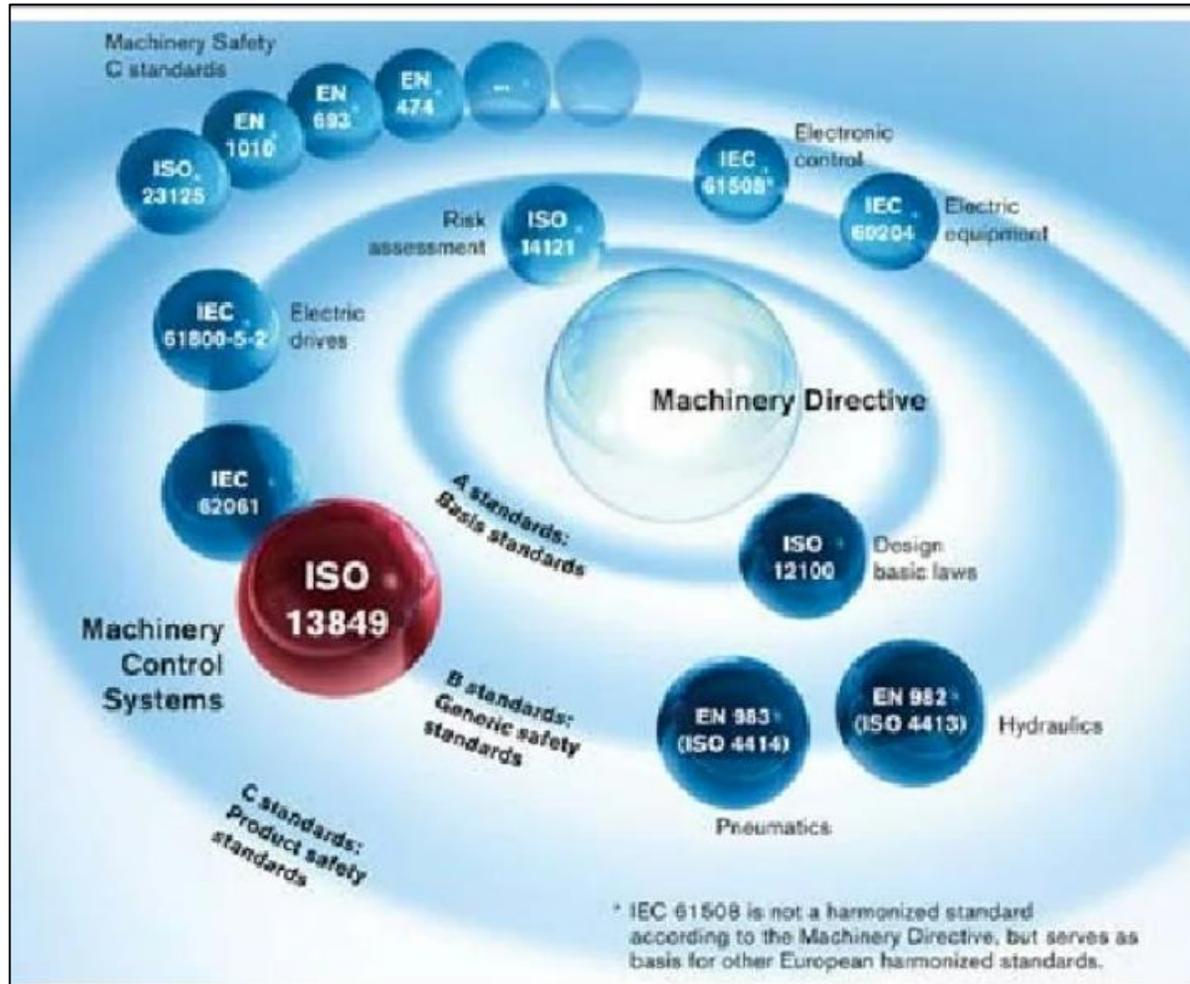
Results of a recent study showed that companies reporting the lowest injury rates also had the best productivity

Results of a study conducted by the Aberdeen Group and sponsored by Rockwell Automation showed that companies reporting the lowest injury rates also had the best productivity. The study found that safety, promoted from the top by senior management, was as an essential element of the workplace culture. The report also showed that best-in-class manufacturers rely on advanced safety technologies and carefully calculated procedures to help maintain high levels of workplace protection.

Good safety is good business. However, this has not always been the case, with many manufacturers generally believing that each investment made in safety had a negative impact on efficiency and productivity.

Today, this view has changed with many top performing manufacturers proving that with contemporary safety automation technology, protection of workers on the plant floor can boost productivity, and the bottom line.

Best in class companies are following International Standards because they have plants across many regions and they want to be compliant everywhere.



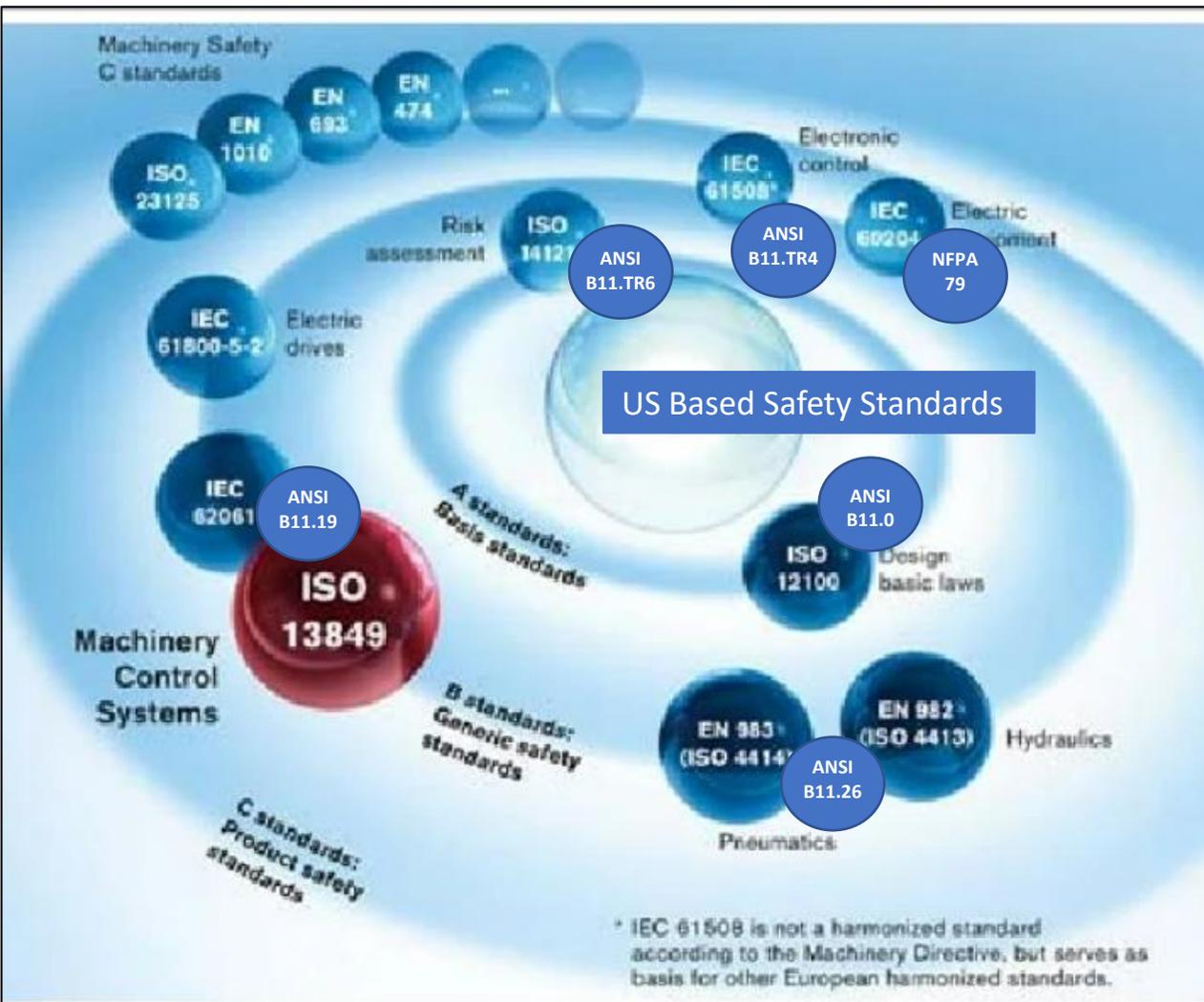
- ISO12100 Risk Assessment
- ISO13849-1 & 2 Design & Validation
- IEC62061
- IEC61508
- IEC61800-5-2
- IEC60204
- ISO4414 Pneumatic Safety
- ISO4413 Hydraulic Safety

These International Standards are closely harmonized with many of the US standards

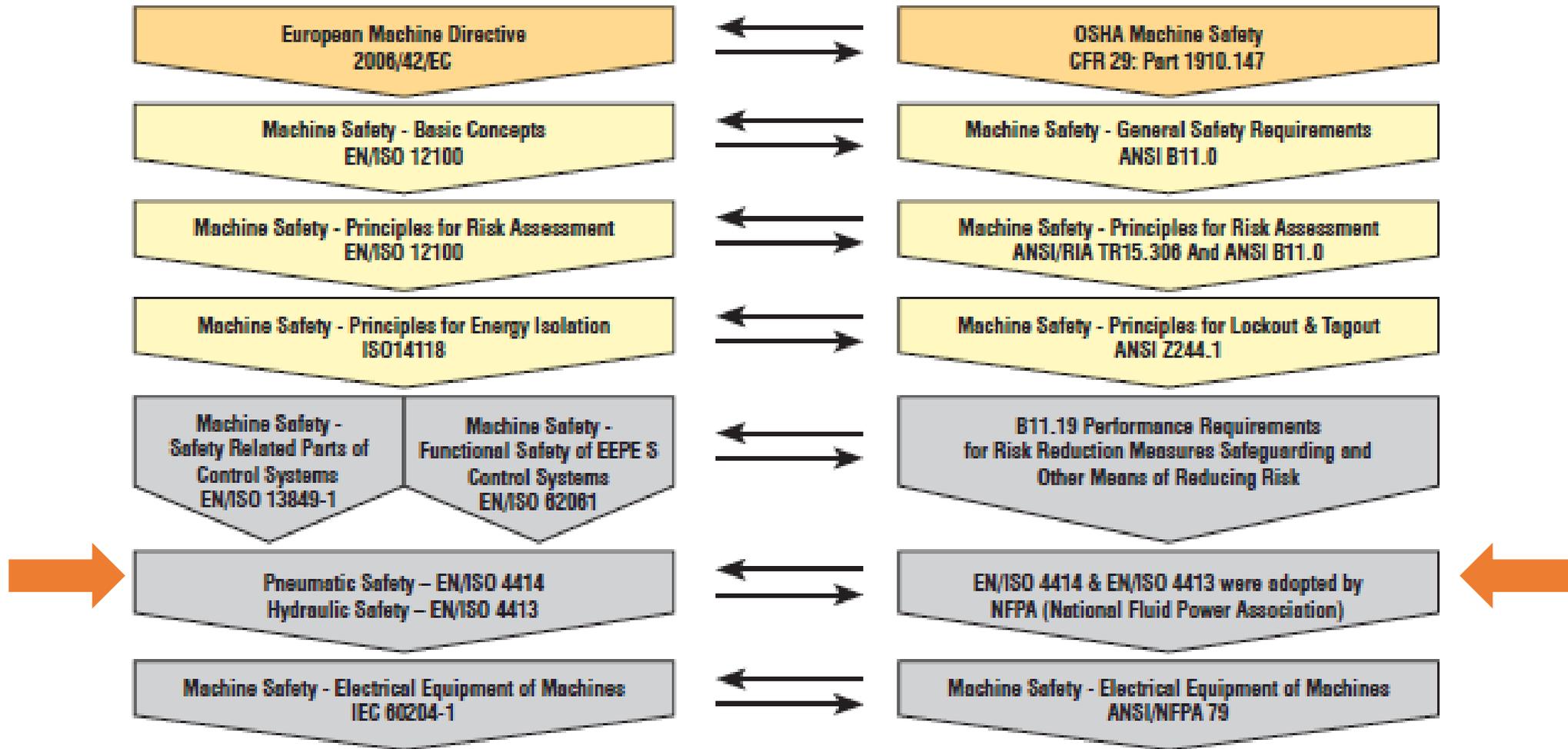
ANSI B11 Machine Safety Standards and Technical Reports

The **ANSI B11** series of American National Standards and Technical Reports consists of nearly three dozen different documents that deal with machine / machinery / machine tool safety, and they specify requirements for both the manufacturers (suppliers) and users of the machines.

- ANSI-ISO 12100 (ISO 12100 IDT) – Safety of Machinery — General principles for design, risk assessment and risk reduction
- ANSI B11.1 – Safety Requirements for Mechanical Power Presses
- ANSI B11.2 – Safety Requirements for Hydraulic and Pneumatic Power Presses
- ANSI B11.3 – Safety Requirements for Power Press Brakes
- ANSI B11.4 – Safety Requirements for Shears
- ANSI B11.5 – Iron Workers – Safety Requirements for Construction, Care and Use
- ANSI B11.6 – Safety Requirements for Manual Turning Machines
- ANSI B11.7 – Safety Requirements for Cold Headers and Cold Formers
- ANSI B11.8 – Safety Requirements for Manual Milling, Drilling, and Boring Machines
- ANSI B11.9 – Safety Requirements for Grinding Machines
- ANSI B11.10 – Safety Requirements for Metal Sawing Machines
- ANSI B11.11 – Safety Requirements for Gear & Spline Cutting Machines
- ANSI B11.12 – Safety Requirements for Roll Forming and Roll Bending Machines
- ANSI B11.13 – Safety Requirements for Single or Multiple Spindle Automatic Bar and Chucking Machines
- ANSI B11.15 – Safety Requirements for Pipe, Tube and Shape Bending Machines
- ANSI B11.16 – Safety Requirements for Metal Powder Compacting Presses
- ANSI B11.17 – Safety Requirements for Horizontal Hydraulic Extrusion Presses
- ANSI B11.18 – Safety Requirements for Machines Processing or Slitting Coiled or Non-Coiled Metal
- ANSI B11.19 – Safeguarding Design, Construction, Installation, Operation, Maintenance
- ANSI B11.20 – Safety Requirements for Integrated Manufacturing Systems
- ANSI B11.21 – Safety Requirements for Machine Tools Using a Laser for Processing Materials
- ANSI B11.22 – Safety Requirements for Numerically Controlled Turning Machines
- ANSI B11.23 – Safety Requirements for Machining Centers
- ANSI B11.24 – Safety Requirements for Transfer Machines
- ANSI B11.25 – Safety Requirements for Large Machines
- ANSI B11.26-2018 Machines - Functional Safety for Equipment: General Principles for the Design of Safety Control Systems Using ISO 13849-1
- ANSI B11.TR1 – Ergonomic Guidelines for the Design, Installation and Use of Machine Tools
- ANSI B11.TR2 – Mist Control Considerations for the Design, Installation and Use of Machine Tools Using Metalworking Fluids
- ANSI B11.TR4- Selection of Programmable Electronic Systems (PES/PLC) for Machine Tools
- ANSI B11.TR5 – Sound Level Measurement Guidelines: A Guide for Measuring, Evaluating and Documenting Sound Levels Emitted by Machinery
- ANSI B11.TR7 – Designing for Safety and Lean Manufacturing — A guide on integrating safety and lean manufacturing principles in the use of machinery
- ANSI B11.TR9 – Guidance to Machinery Manufacturers for Consideration of Related IT-Security (Cyber Security) Aspects
- ANSI / NFPA 79 – Electrical Standard for Industrial Machinery



The reason that I showed you both is so that you could see that the standards are becoming harmonized!



This means that companies can have global designs and global company requirements.

Safety Standards have 3 Levels – Type A, Type B & Type C standards

Two examples we will discuss are:

North America – OSHA Requirements

European – Machinery Directive Requirements

There are three types of Standards

“A” Standards (Basic Standards)

basic concepts
principles for design
general aspects

“B” Standards (Application Standards)

B1 - safety distances, surface temps,
noise

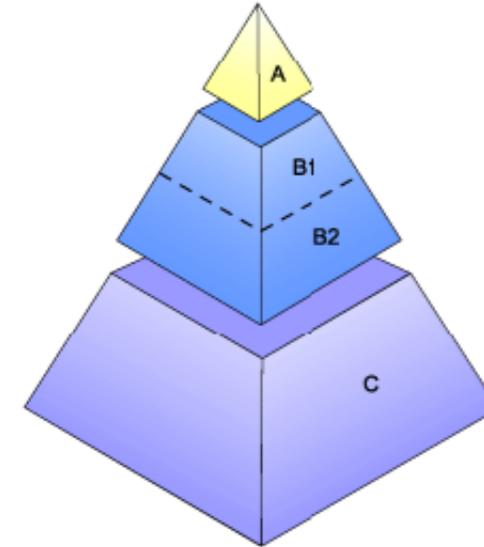
B2 - components or devices

“C” Standards (Specific Machine Standards)

Vertical standards covering a single
type of machine or group of
machines.

Use A and B standards to create C
standards.

Three-tier Structure of International Safety Standards



Type A Fundamental safety standards applicable to all machinery. Type A standards deal with basic concepts, principles for design, and general aspects.

Type B Standards applicable to a wide range of machinery. Type B is divided into two categories:

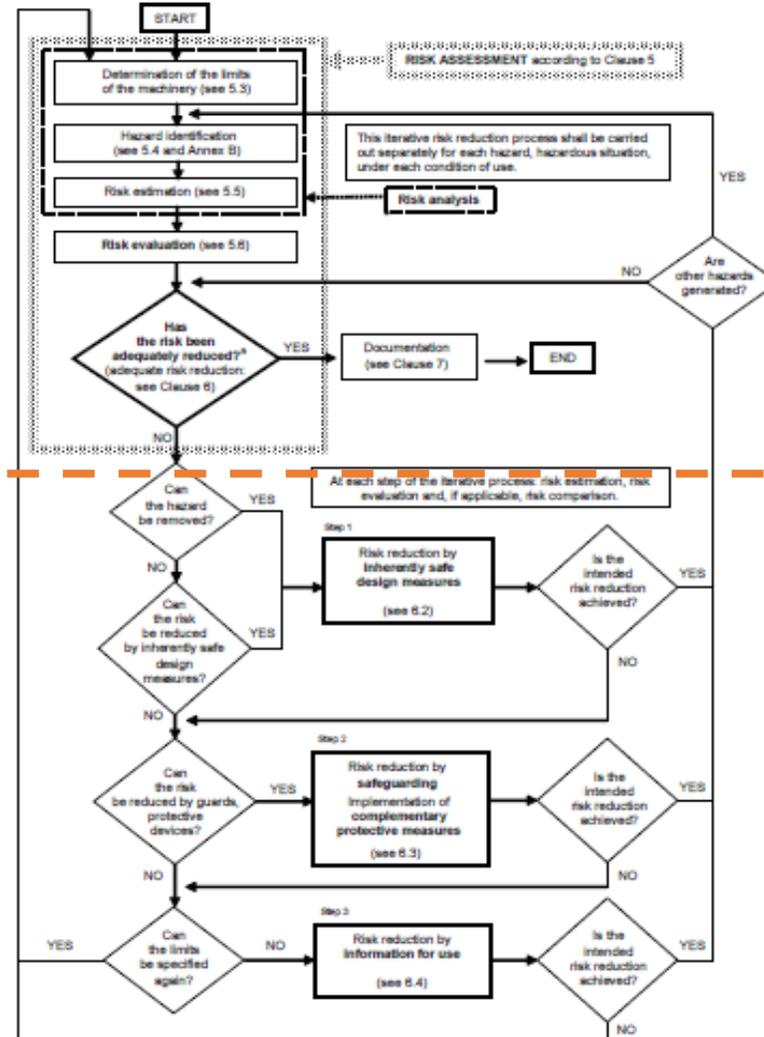
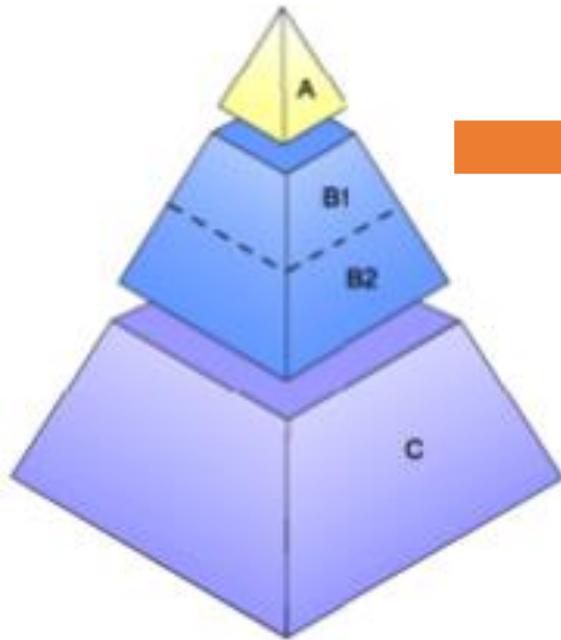
B1: Specific safety aspects (ie., safety distance, surface temperature, and noise)

B2: Safety related devices (ie., two-hand controls, interlocking devices, pressure sensitive devices, and guards)

Type C Detailed standards applicable to a specific machine or a particular group of machines.

A type standards the define the basic techniques risk assessment & risk reduction.

BS EN ISO 12100:2010
ISO 12100:2010(E)



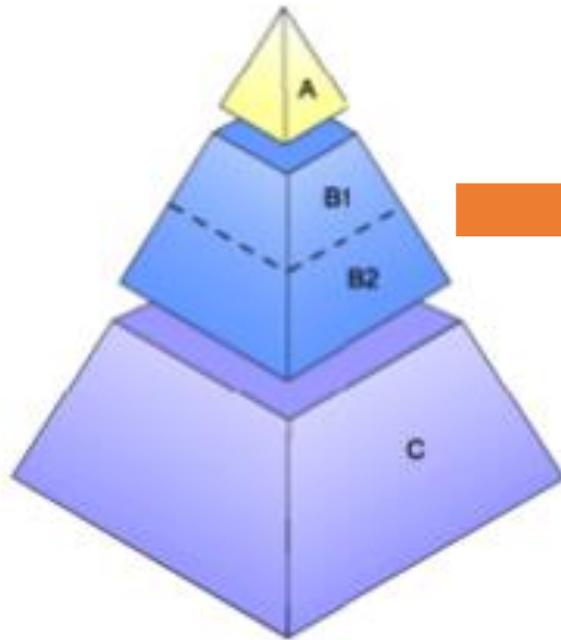
Risk Assessment

Risk Reduction

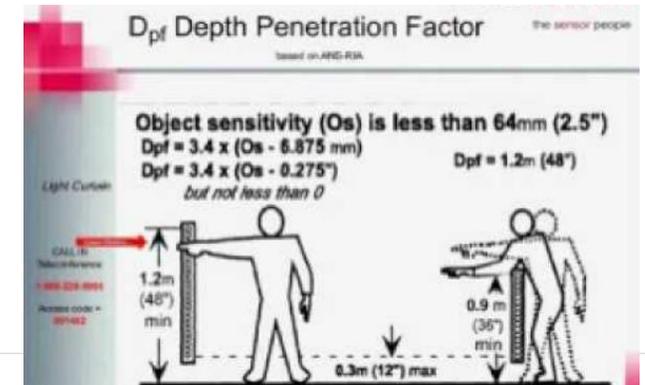
* The first time the question is asked, it is answered by the result of the initial risk assessment.

Figure 1 — Schematic representation of risk reduction process including iterative three-step method

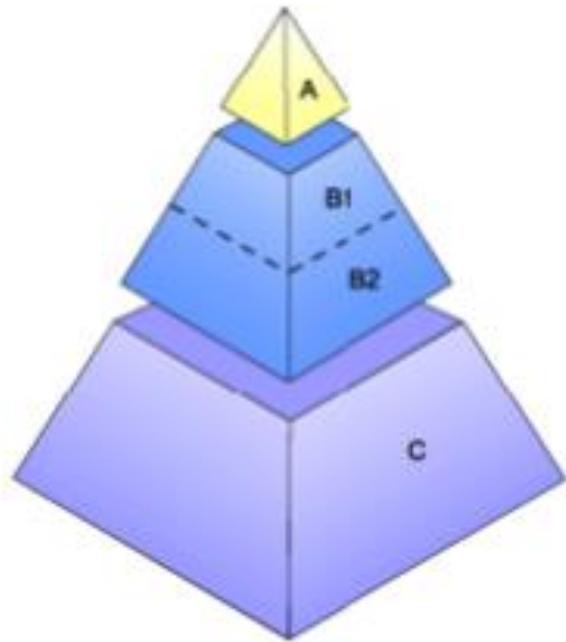
B Type standard tell users how to utilize specific types of technologies



B Type standard are devices & device utilization standard.



C Type standards are for specific machine types

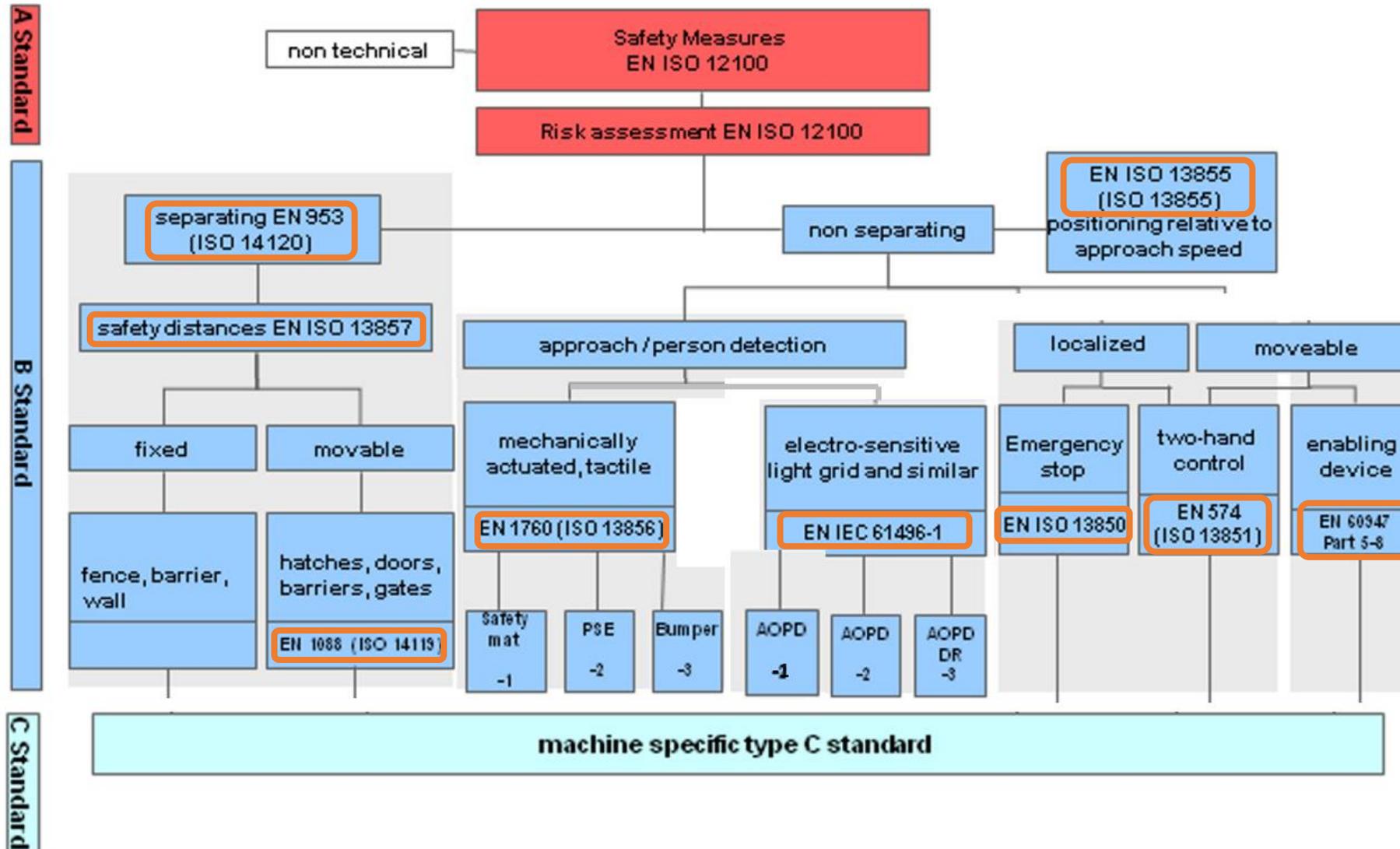


C Type standards are for specific machine types.



Common A & B Type standards

■ Safety Equipment / Overview Standards



ISO 12100:2010

Safety of machinery — General principles for design — Risk assessment and risk reduction

1 Scope

This International Standard specifies basic terminology, principles and a methodology for achieving safety in the design of machinery. It specifies principles of risk assessment and risk reduction to help designers in achieving this objective. These principles are based on knowledge and experience of the design, use, incidents, accidents and risks associated with machinery. Procedures are described for identifying hazards and estimating and evaluating risks during relevant phases of the machine life cycle, and for the elimination of hazards or the provision of sufficient risk reduction. Guidance is given on the documentation and verification of the risk assessment and risk reduction process.

This International Standard is also intended to be used as a basis for the preparation of type-B or type-C safety standards.

It does not deal with risk and/or damage to domestic animals, property or the environment.

ISO12100 is closely harmonized with ANSI B11.0 and covers almost the same content.

ISO 14120:2015

Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards

Abstract

ISO 14120:2015 specifies general requirements for the design, construction, and selection of guards provided to protect persons from mechanical hazards.

ISO 14120:2015 indicates other hazards that can influence the design and construction of guards.

ISO 14120:2015 applies to guards for machinery which will be manufactured after it is published.

The requirements are applicable if fixed and movable guards are used. This International Standard does not cover interlocking devices. These are covered in ISO 14119.

guard

physical barrier, designed as part of the machine, to provide protection

Note 1 to entry: A guard may act either

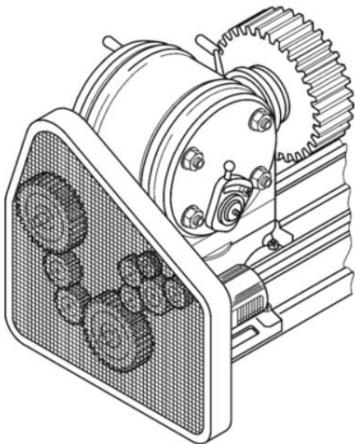
- alone, in which case it is only effective when “closed” (for a movable guard) or “securely held in place” (for a fixed guard), or
- in conjunction with an interlocking device with or without guard locking, in which case protection is ensured whatever the position of the guard.

fixed guard

guard affixed in such a manner (for example, by screws, nuts, and welding) that it can only be opened or removed by the use of tools or by destruction of the means by which the guard is affixed

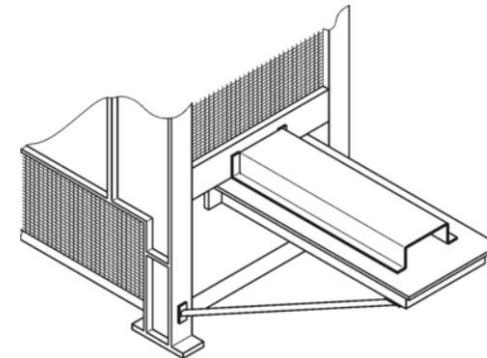
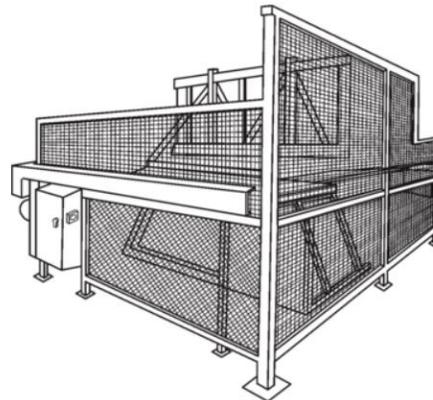
enclosing guard

guard which prevents access to the hazard zone from all sides



distance guard

guard which does not completely enclose a hazard zone, but which prevents or reduces access by virtue of its dimensions and its distance from the hazard zone, for example perimeter fence or tunnel guard



ISO 14119:2013

Safety of machinery — Interlocking devices associated with guards — Principles for design and selection

Abstract

ISO 14119:2013 specifies principles for the design and selection ? independent of the nature of the energy source ? of interlocking devices associated with guards. It covers the parts of guards which actuate interlocking devices. It does not necessarily provide all the specific requirements for trapped key systems.

ISO 14119:2013 provides measures to minimize defeat of interlocking devices in a reasonably foreseeable manner.

interlocking device

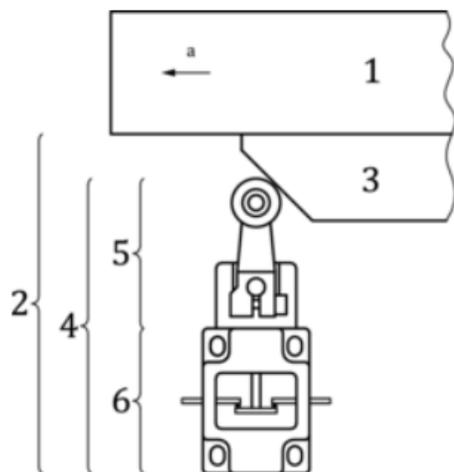
interlock

mechanical, electrical or other type of device, the purpose of which is to prevent the operation of hazardous machine functions under specified conditions (generally as long as a guard is not closed)

Note 1 to entry: See Figure 1 and Table 1.

[SOURCE: ISO 12100:2010, 3.28.1.]

Figure 1 — Example of an interlocking device



Type 1 interlocking device

interlocking device with mechanically actuated position switch with uncoded actuator

Type 2 interlocking device

interlocking device with mechanically actuated position switch with coded actuator

Type 3 interlocking device

interlocking device with non-contact actuated position switch with uncoded actuator

Type 4 interlocking device

interlocking device with non-contact actuated position switch with coded actuator

access time

time taken by a person to reach the hazard zone after initiation of the stop command by the interlocking device, as calculated on the basis of an approach speed of the body or part of the body

ISO 13857:2019

Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs

Abstract

This document establishes values for safety distances in both industrial and non-industrial environments to prevent machinery hazard zones being reached. The safety distances are appropriate for protective structures. It also gives information about distances to impede free access by the lower limbs (see Annex B).

This document covers people of 14 years and older (the 5th percentile stature of 14-year-olds is approximately 1 400 mm). In addition, for upper limbs only, it provides information for children older than 3 years (5th percentile stature of 3-year-olds is approximately 900 mm) where reaching through openings needs to be addressed.

NOTE 1 It is not practical to specify safety distances for all persons. Therefore, the values presented are intended to cover the 95th percentile of the population.

NOTE 2 This document is not intended to provide measures against reaching a hazard zone by climbing over (see ISO 14120:2015, 5.18).

IEC 61496-1

Safety of machinery – Electro-sensitive protective equipment – Part 1: General requirements and tests

Scope:

This part of IEC 61496 specifies general requirements for the design, construction and testing of non-contact electro-sensitive protective equipment (ESPE) designed specifically to detect persons or part of a person as part of a safety-related system. Special attention is directed to functional and design requirements that ensure an appropriate safety-related performance is achieved. An ESPE can include optional safety-related functions, the requirements for which are given in Annex A.

IEC 61496-2:2020 specifies requirements for the design, construction and testing of **electro-sensitive protective equipment** (ESPE) designed specifically to detect persons as part of a safety-related system, employing active opto-electronic protective devices (AOPDs) for the sensing function.

IEC 61496-3:2018 specifies additional requirements for the design, construction and testing of **electro-sensitive protective equipment** (ESPE) designed specifically to detect persons or parts of persons as part of a safety-related system, employing active opto-electronic protective devices responsive to diffuse reflection (AOPDDR) for the sensing function.

US Emergency Stop Requirements

Emergency Stop (E-Stop) buttons are arguably the most identifiable element on a piece of machinery and serve a specific function which is universally known. This is not by chance, but instead a requirement as called out by governing bodies such as OSHA and in consensus standards. NFPA 79 defines an Emergency Stop as “a device designed to be used in reaction to an incident or hazardous situation.”

I call it the “Oh Crap” button. It is meant to interrupt all modes of operation and activities in order to control hazardous energy.

International Emergency Stop Requirements

ISO 13850:2015

Safety of machinery — Emergency stop function — Principles for design

4.1.1 The emergency stop function shall be available and operational at all times and override all other functions and operations in all operating modes of the machine without impairing any facilities designed to release trapped persons. It shall not be possible for any start command (intended, unintended or unexpected) to be effective on those operations stopped by the initiation of the emergency stop function until the emergency stop function is manually reset.

Examples of the removal of power include

- switching off the electrical power to the electric motor(s) of the machine,
- declutching the movable elements of the machine from the source of mechanical energy, and
- blocking the fluid power supply to the hydraulic/pneumatic machine actuators of the machine.

ISO 13850:2015

Safety Of Machinery - Emergency Stop Function - Principles For Design

ISO 13850:2015 Standard specifies functional requirements and design principles for the emergency stop function on machinery, independent of the type of energy used.

This means that all energy sources must be considered.

ISO 13851:2019(en) Safety of machinery — Two-hand control devices — Principles for design and selection

This document specifies the safety requirements of a two-hand control device (THCD) and the dependency of the output signal from the actuation by hand of the control actuating devices.

This document describes the main characteristics of THCDs for the achievement of safety and sets out combinations of functional characteristics for three types. It does not apply to devices intended to be used as enabling devices, as hold-to-run devices or as special control devices.

This document does not specify with which machines THCDs shall be used. It also does not specify which types of two-hand-control device shall be used for a specific application. Moreover, while guidance is given, it does not specify the required distance between the THCD and the danger zone (see 8.8).

This document provides requirements for design and guidance on the selection (based on a risk assessment) of THCDs including the prevention of defeat, the avoidance of faults and verification of compliance.

NOTE 1 A THCD only offers protection for the person using it.

NOTE 2 For specific machines, the suitability of a two-hand control as a suitable protective device can be defined in a type-C standard. If such a standard does not exist or is not appropriate, the risk assessment and determination of suitable protective measures is the responsibility of the manufacturer of the machine.

Type I, which requires provision of two **control** devices requiring the concurrent actuation by both hands,

Type II, which requires the release of both **control** devices before machine operation may be reinitiated

Type III which requires concurrent actuation of the control devices within a certain time limit.

The most misunderstood information in two hand control is how the types are combined.

Type 1 is the basic requirement!

Type 2 requires Type 1 + Type 2 requirements!

Type 3 requires Type 1 + Type 2 + Type 3 requirements.

ISO/DIS 13855(en) Safety of machinery – Positioning of safeguards with respect to the approach of the human body

Abstract

This International Standard specifies the safety requirements of a two-hand control device and the dependency of the output signal from the input signals.

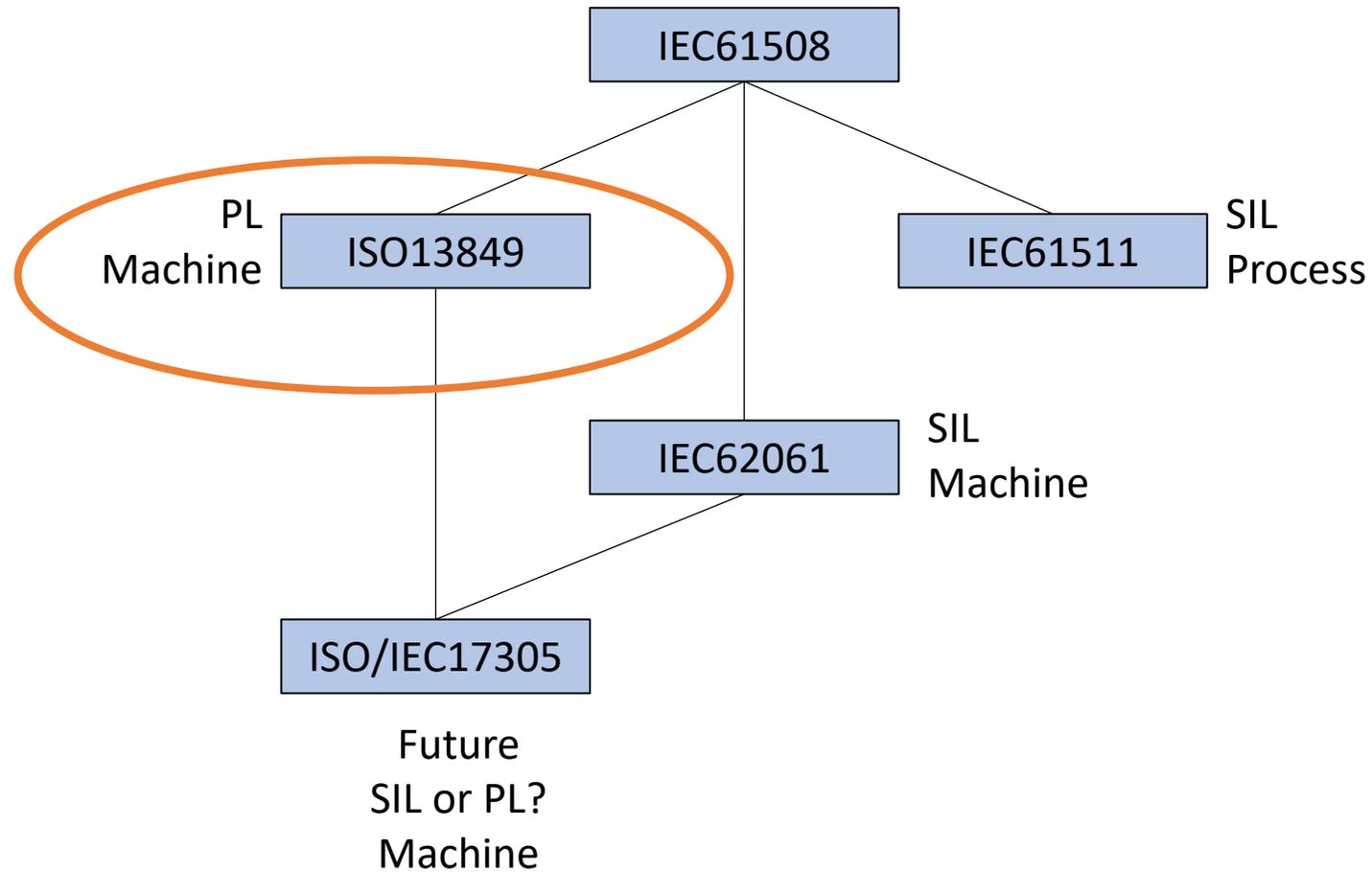
It describes the main characteristics of two-hand control devices for the achievement of safety and sets out combinations of functional characteristics for three types. It does not apply to devices intended to be used as enabling devices, as hold-to-run devices or as special control devices.

This International Standard does not specify with which machines two-hand control devices shall be used. It also does not specify which types of two-hand-control device shall be used. Moreover, it does not specify the distance between the two-hand control device and the danger zone.

This International Standard provides requirements and guidance on the design and selection (based on a risk assessment) of two-hand control devices including their assessment, the prevention of defeat and the avoidance of faults. It also provides requirements and guidance for two-hand control devices containing a programmable electronic system.

This International Standard applies to all two-hand control devices, independent of the energy used, including:

Safety Design Standards Structure



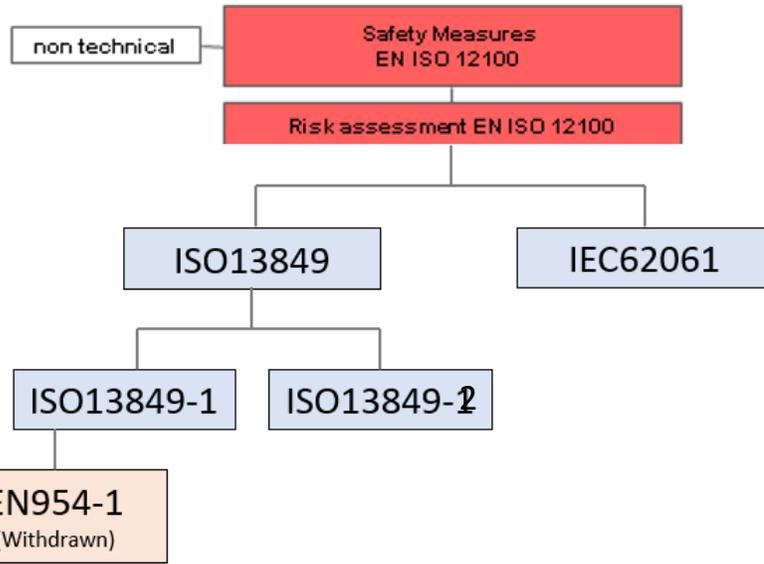
Safety Logic/Design standards

European Safety System Design Standards

The US Equivalents

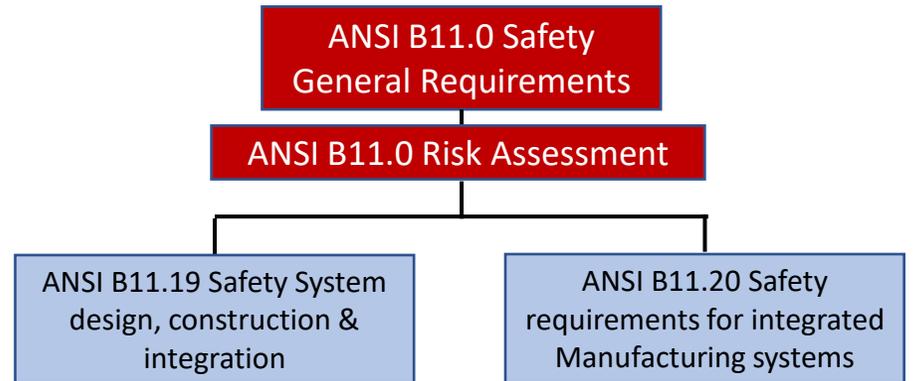
■ Safety Equipment / Overview Standards

A Standard



B Standard

A Standard



B Standard

C Standard

Note: EN954-1 was withdrawn in 2011 but the category concept is now included in ISO13849-1

machine specific type C standard

machine specific type C standard

In the past there were multiple design standards, but now there are only 2.

EN 954-1	EN ISO 13849-1	IEC62061
Electrical Control Circuits	Control circuits all technologies : <ul style="list-style-type: none"> • Electrical • Electronic • Pneumatic • Fluids • Hydraulic 	Electrical Control Circuits Electronic Control Circuit Programmable Electronic And now Fluid Power
Safety Categories B, 1, 2, 3 & 4	Performance Levels PLa to PLe	Safety Integrity Levels 1, 2, 3, 4
Safety provided by the structure of the control circuit	Safety provided by: <ul style="list-style-type: none"> • The architecture/structure (EN954-1 categories) • The reliability of the system (MTTF_d, B10_d) • The diagnostic coverage of the system (DC) • The preventive measures against common causes of failure (CCF) 	Safety provided by: <ul style="list-style-type: none"> • Structure (HFT) • Reliability (PFHd) • Diagnostics • Beta Factor
Draw a diagram (schematic)	Draw a diagram <u>and</u> verification of PL Does PL(achieved) = PLr (required) ?	Draw a diagram and verify SILcl=SILr

Withdrawn in December of 2011

IOS13849 became the most popular because EN954 was withdrawn and because IEC62061 did not consider fluid power until 2021.

ISO 13849-1

ISO 13849-1 provides safety requirements and guidance on the principles for the design and integration of safety-related parts of control systems (SRP/CS), including the design of software. For these parts of SRP/CS, it specifies characteristics that include the performance level required for carrying out safety functions. It applies to SRP/CS for high demand and continuous mode, regardless of the type of technology and energy used (electrical, hydraulic, pneumatic, mechanical, etc.), for all kinds of machinery. It does not specify the safety functions or performance levels that are to be used in a particular case.

Most people ignored Fluid Power Safety until ISO13849 and other standards started defining requirements

Reference from ISO13849-1 2006

- Pneumatic and hydraulics are part of the SRP/CS
 - Safety related parts of the control system
 - Requires “proven in use” or “well tried components”
 - Requires “well tried safety principles”

	PFH _D (1/h)	Cat. B	Cat. 1	Cat. 2	Cat. 3	Cat. 4
PL a	2*10 ⁻⁵	•	0	0	0	0
PL b	5*10 ⁻⁶	•	0	0	0	0
PL c	1,7*10 ⁻⁶	-	•2*	•1*	0	0
PL d	2,9*10 ⁻⁷	-	-	-	•1*	0
PL e	4,7*10 ⁻⁸	-	-	-	-	•1*

• Applied category is recommended.

0 Applied category is optional.

- Category is not allowed.

1* Proven in use (see 3.1.39) or well-tries (confirmed by the component manufacturer to be suitable for the particular application) components and well-tries safety principles must be used.

2* Well-tries components and well-tries safety principles must be used.

For safety-related components that are not monitored in the process, the T10d value can be determined based on proven in use data by the machine manufacturer.



ROSS proves that our product is “Well tried” and “Proven in Use” by doing 3rd party certifications and we apply a CE Mark to all safety compliant products.



ANSI B11:19 directly references ISO13849 & IEC62061 as best practices for design of safety control systems.



ANSI B11.19-2019: Safeguarding and Machinery Risk Reduction

Harmonization

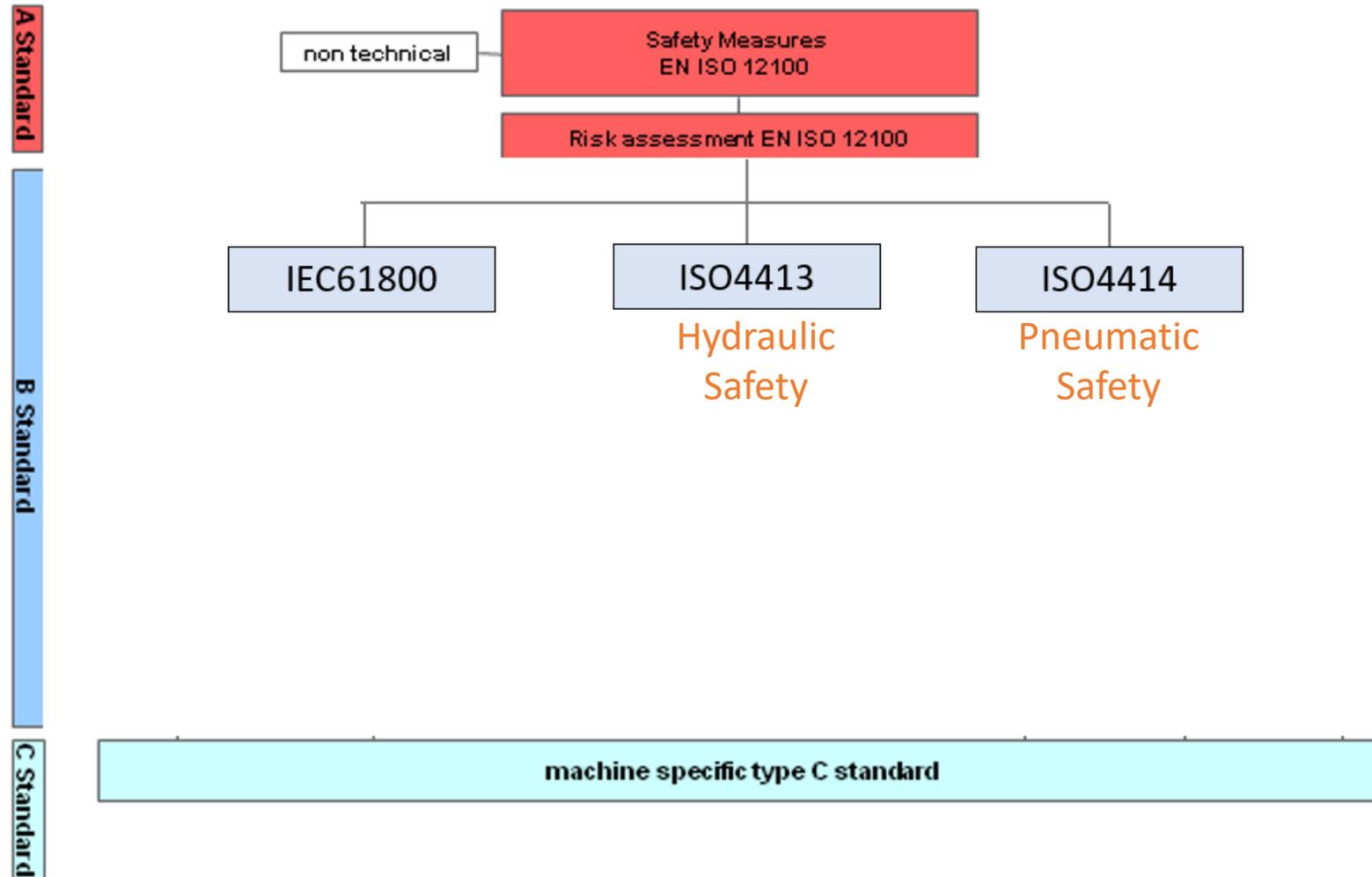
The requirements of this standard have been harmonized with similar requirements in several international (ISO and IEC) and European (EN) standards. Harmonization means that the requirements have been aligned in essence to achieve a similar level of risk reduction. Harmonization does not mean duplication of exact requirements.

While the requirements of control reliability are not directly comparable to the requirements of ISO 13849-1, for the purposes of this standard, complying with either of the following, at a minimum, will satisfy the requirements of control reliability:

- Category 3 or 4 according to ISO 13849-1; or
- Performance Level “d” or “e”, according to ISO 13849-1 (2015).

Other Categories and Performance Levels per ISO 13849-1, and Safety Integrity Levels (SILs) per IEC 61508 and IEC 62061 can also satisfy the requirements of this subclause depending on the design, construction, fault exclusions, installation, and maintenance of the safety function and a documented risk assessment. For further information on the performance of safety functions, see [Annex C](#).

■ Safety Equipment / Overview Standards



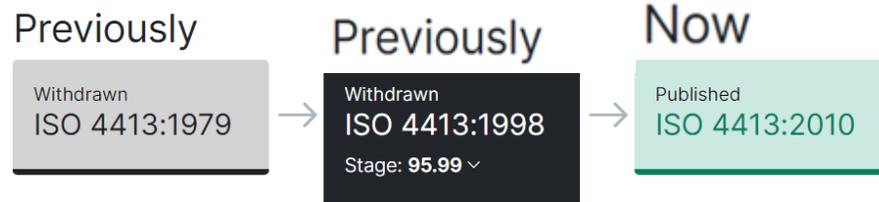
Fluid Power Specific Standards

The two basic standards for fluid power safety design are:

- **ISO 4413 Hydraulic fluid power** — General rules and safety requirements for systems and their components
- **ISO 4414 Pneumatic fluid power** — General rules and safety requirements for systems and their components

INTERNATIONAL STANDARD	ISO 4413
	Third edition 2010-2-15
<hr/> <hr/> Hydraulic fluid power — General rules relating to systems	

INTERNATIONAL STANDARD	ISO 4414
	Third edition 2010-11-15
<hr/> <hr/> Pneumatic fluid power — General rules and safety requirements for systems and their components	



ISO 4413:2010

Hydraulic fluid power — General rules and safety requirements for systems and their components

ISO 4413:2010 specifies general rules and safety requirements for hydraulic fluid power systems and components used on machinery as defined by ISO 12100. ISO 4413:2010 deals with all significant hazards associated with hydraulic fluid power systems and specifies the principles to apply in order to avoid those hazards when the systems are put to their intended use.

ISO 4413:2010 applies to the design, construction and modification of systems and their components, also taking into account the following aspects: assembly, installation, adjustment, uninterrupted system operation, ease and economy of maintenance and cleaning, reliable operation in all intended uses, energy efficiency and environment.

ISO 4414:2010

Pneumatic fluid power — General rules and safety requirements for systems and their components

This International Standard specifies general rules and safety requirements for pneumatic fluid power systems and components used on machinery as defined by ISO 12100:2010, 3.1. It deals with all significant hazards associated with pneumatic fluid power systems and specifies principles to apply in order to avoid those hazards when the systems are put to their intended use.

ISO 4414:2010 and ISO 4413:2010 have the same general requirements

5 General rules and safety requirements

5.1 General

5.1.1 When designing pneumatic or hydraulic systems for machinery, all intended operations and use of systems shall be considered. Risk assessment, e.g., in accordance with ISO 14121-1 (replaced by ISO 12100:2010), shall be carried out to determine the foreseeable risks associated with systems when they are used as intended. Reasonably foreseeable misuse shall not cause hazards. The risks identified shall be eliminated by design and, where this is not practicable, safeguards (first preference) or warnings (second preference) against such risks shall be incorporated, in accordance with the hierarchy established in ISO 12100.

NOTE: This International Standard provides requirements for components of fluid power systems; some of these requirements are dependent on the hazards associated with the machine in which the system is installed. Therefore, the final specification and construction of the pneumatic or hydraulic system could need to be based on risk assessment and agreement between purchaser and supplier.

5.1.2 The control systems shall be designed in accordance with the risk assessment. This requirement is met when ISO 13849-1 is used.

This will change in the future since IEC62061 now includes fluid power safety!

ANSI B11.26-2018

Machines - Functional Safety For Equipment: General Principles For The Design Of Safety Control Systems Using ISO 13849-1

Provides both requirements and guidance for the implementation of safety-related control functions (functional safety) as they relate to electrical, electronic, pneumatic, hydraulic, and mechanical components of control systems.

2.2 Informative References

ANSI B11.TR3 – 2000 (R16), Risk Assessment and Risk Reduction – A guide to estimate, evaluate and reduce risks associated with machine tools (see ANSI B11.0)

ANSI B11.TR4 – 2004 (R16), Selection of Programmable Electronic Systems (PES/PLC) for Machine Tools

ANSI / ISO 12100:2012 (ISO 12100:2010 IDT), Safety of machinery – General principles for design – Risk assessment and risk reduction

ASME Boiler and Pressure Vessel Code Section VIII Division 1.

ISO 13849-1:2015, Safety of machinery – Safety-related part of control systems – Part 1: General Principles for Design

ISO 13849-2:2012, Safety of machinery – Safety-related part of control systems – Part 2: Validation

ISO 4413 – 2010, Hydraulic fluid power – General rules and safety requirements for systems and their components

ISO 4414 – 2010, Pneumatic fluid power – General rules and safety requirements for systems and their components

There are also 2 other standards that are important but often overlooked

Lockout/Energy Isolation Standards



ISO 14118:2017
Safety of machinery — Prevention of unexpected start-up

Every machine needs to have lockout devices for every energy source and every machine must have a emergency stop!

ISO 14118: Safety of machinery — Prevention of unexpected start-up

ISO 14118:2017 specifies requirements for designed-in means aimed at preventing unexpected machine start-up (see 3.2) to allow safe human interventions in danger zones (see Annex A).

ISO 14118:2017 applies to unexpected start-up from all types of energy source, i.e.:

- power supply, e.g. electrical, hydraulic, pneumatic;
- stored energy due to, e.g. gravity, compressed springs;
- external influences, e.g. from wind.

Notice the requirements are for the control of all hazardous energy including Pneumatic & Hydraulic energy.



ANSI/ASSP Z244.1-2016: Control of Hazardous Energy: Lockout

The [ANSI/ASSP Z244.1-2016](#) standard establishes guidelines for the control for hazardous energy associated with machinery, equipment, or processes that could do harm to the personnel. Specifically, it does this by establishing lockout, tagout, or alternative methods to control the hazardous energy. It is applicable to many activities, including erecting, installing, constructing, repairing, adjusting, inspecting, unjamming, set up, testing, troubleshooting, cleaning, dismantling, servicing, and maintaining machines, equipment, or processes.

Notice the requirements are for the control of all hazardous energy including Pneumatic & Hydraulic energy.

How does this affect us?

Companies should implement safety solutions using proper standards in a systematic process to reduce risk.

Machinery Safety Development : A Systematic Development Process		
Step 1	Risk Assessment	<ul style="list-style-type: none"> • Risk Assessment for all task and hazard pairs • Pressure and Force Analysis for fluid power risks • Identifying the system Performance Level required (PLr) for each hazard
Step 2	Functional Specification Development	<ul style="list-style-type: none"> • Determination of job task types for each hazard • Determination of functionality needs • Determination of mitigation techniques • Determination of required safety functions
Step 3	Selection of Mitigation Devices	<ul style="list-style-type: none"> • For electrical power, mechanical power, fluid power, and all sources of hazardous energy
Step 4	Safe Design	<ul style="list-style-type: none"> • For electrical power, mechanical power, and fluid power design • Design verification calculations to ensure that the Performance Level achieved (PLa) exceeds or meets the Performance Level required (PLr)
Step 5	Installation & Validation	<ul style="list-style-type: none"> • Installation process & procedures according to manufacturer • Validation that each safety function operates as intended • Validation should include fault injection and functional testing
Step 6	Periodic Testing and Maintenance of the Safety Components	<ul style="list-style-type: none"> • Maintenance according to manufacturer requirements • Annual testing of each safety function

This means that we need to follow a defined process!

All of the safety standards say the risk assessment is the starting point.

ISO13849-1, ISO4413, ISO4414, and ANSI B11.19 and NPFA all say that **a Risk Assessment shall be done** to identify risks that are associated with operating the machine/system and that identified risks must be reduced to an acceptable level.

ISO 13849-1:2015(E)

4.3 Determination of required performance level (PL_r)

For each selected safety function to be carried out by a SRP/CS, a required performance level (PL_r) shall be determined and documented (see [Annex A](#) for guidance on determining PL_r). The determination of the required performance level is the result of the risk assessment and refers to the amount of the risk reduction to be carried out by the safety-related parts of the control system (see Figure 2).

The greater the amount shall be.

ISO 4414:2010(E)

5.1.1 When designing pneumatic systems for machinery, all intended operations and use of systems shall be considered. Risk assessment, e.g. in accordance with ISO 14121-1, shall be carried out to determine the foreseeable risks associated with systems when they are used as intended. Reasonably foreseeable misuse shall not cause hazards. The risks identified shall be eliminated by design, by the use of safety devices, or by safeguards (first preference) or warnings (second preference) against misuse. In accordance with the hierarchy established in ISO 12100.

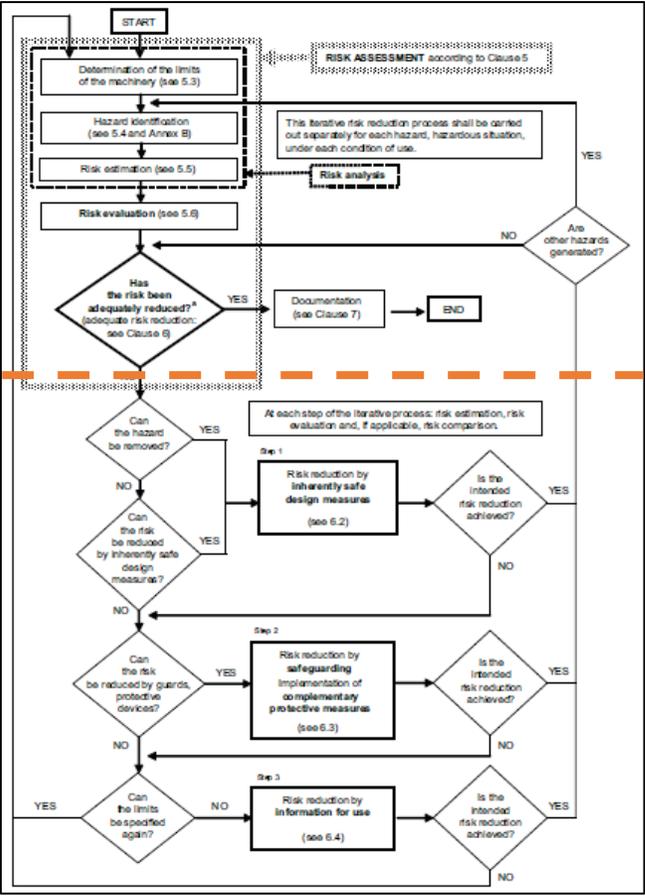
American National Standard

B11.19-2010

See the appropriate ANSI B11 machine-specific standard or other related machinery safety standard(s) for the requirements for the selection of safeguarding based on specific applications. Selection of the safeguarding requires task and hazard identification, and the application of documented risk assessment and risk reduction of the total production system.

ISO12100 and ANSI B11.0 following the same process

ISO12100 and/or ANSI B11.0 outline the requirements for **risk assessment and risk reduction** and ask users to look at all modes of operation and all energy sources.

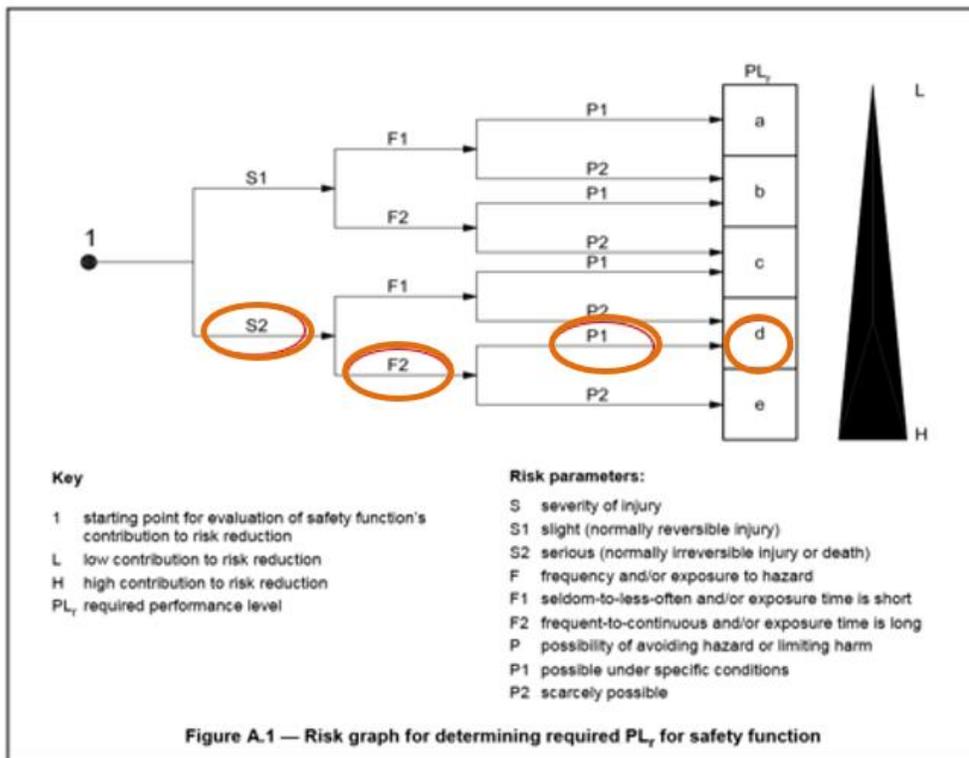


Risk Assessment

Risk Reduction



- Each mode should be evaluated
 - Auto/Manual/Jogging/Threading
- Each type of task should be evaluated
 - Production – Loading/Unloading/Adjusting
 - Set-up – Change-overs/Teaching
 - Maintenance – Service/Repairs/Replacement
 - Material Handling – Loading/Unloading
 - Sanitation – Cleaning/Washing
- Every source of energy should also be evaluated



• Per EN 13736 there is a Risk of injury if:

Force > 150 N (33.8 lbf)

Weight of tooling > 15 kg (33 lbs)

• Per ANSI B11.0 the Risk is:

Moderate	150 N (33.7 lbf) < Force < 400 N (90)	PLc
Serious	400 N (90 lbf) < Force < 2000 N (450)	PLd
Catastrophic	Force > 2000 N (450 lbf)	PLe

ANSI B11.0 Table 8	Units	Catastrophic	Serious	Moderate	Minor
Force	lbf	449.6	89.9	33.7	
	N	2000	400	150	
Pressure	psi	59	59	43	12
	N/cm ²	40	40	29.6	8.3
PL _r	–	e	d	c	b

The risk assessment and pressure & force evaluation identify the hazards and specify required performance levels.

The next step is developing a Functional Specification that determines the correct risk reduction measures for each mode of operation.

- How does the machine need to function in Manual Mode?
- How does the machine need to function in Automatic Mode?
- How does the machine need to operate in Set-up/Teaching Mode?
- How does the machine need to operate in Cleaning Mode?
- How does the machine need to function during Change-over Mode?

Recognized Safety Functions/Solutions are identified in Tables 8 & 9 of ISO13849-1

Table 8 — Some International Standards applicable to typical machine safety functions and certain of their characteristics

Safety function/ characteristic	Requirement(s)		For additional information, see:
	This part of ISO 13849	ISO 12100:2010	
Safety-related stop function initiated by safeguard ^a	5.2.1	3.28.8, 6.2.11.3	IEC 60204-1:2005, 9.2.2, 9.2.5.3, 9.2.5.5 ISO 14119 ISO 13855
Manual reset function	5.2.2	—	IEC 60204-1:2005, 9.2.5.3, 9.2.5.4
Start/restart function	5.2.3	6.2.11.3, 6.2.11.4	IEC 60204-1:2005, 9.2.1, 9.2.5.1, 9.2.5.2, 9.2.6
Local control function	5.2.4	6.2.11.8, 6.2.11.10	IEC 60204-1:2005, 10.1.5
Muting function	5.2.5	—	IEC/TS 62046:2008, 5.5
Hold-to-run function	—	6.2.11.8 b)	IEC 60204-1:2005, 9.2.6.1
Enabling device function	—	—	IEC 60204-1:2005, 9.2.6.3, 10.9
Prevention of unexpected start-up	—	6.2.11.4	ISO 14118 IEC 60204-1:2005, 5.4
Escape and rescue of trapped persons	—	6.3.5.3	
Isolation and energy dissipation function	—	6.3.5.4	ISO 14118 IEC 60204-1:2005, 5.3, 6.3.1
Control modes and mode selection	—	6.2.11.8, 6.2.11.10	IEC 60204-1: 2005, 9.2.3, 9.2.4
Interaction between different safety-related parts of control systems	—	6.2.11.1 (last sentence)	IEC 60204-1:2005, 9.3.4
Monitoring of parameterization of safety-related input values	4.6.4	—	—
Emergency stop function ^b	—	6.3.5.2	ISO 13850 IEC 60204-1:2005, 9.2.5.4

^a Including interlocked guards and limiting devices (e.g. overspeed, overtemperature, overpressure).

^b Complementary protective measure, see ISO 12100:2010.

Table 9 — Some International Standards giving requirements for certain safety functions and safety-related parameters

Safety function/ safety-related parameter	Requirement		For additional information, see:
	This part of ISO 13849	ISO 12100:2010	
Response time	5.2.6	—	ISO 13855:2010, 3.2, A.3, A.4
Safety-related parameter such as speed, temperature or pressure	5.2.7	6.2.11.8 e)	IEC 60204-1:2005, 7.1, 9.3.2, 9.3.4
Fluctuations, loss and restoration of power sources	5.2.8	6.2.11.8 e)	IEC 60204-1:2005, 4.3, 7.1, 7.5
Indications and alarms	—	6.2.8	ISO 7731 ISO 11428 ISO 11429 IEC 61310-1 IEC 60204-1:2005, 10.3, 10.4 IEC 61131 IEC 62061

The functions in Tables 8 & 9 are not just electrical control functions, they are also fluid power functions.

Safety Function Types	Electrical Function	Equivalent Fluid Power Function
Safety Stopping	Stopping/Braking	Stopping/Braking
Safe Holding	Braking/Locking	Load Holding/Checking
Safe Direction	Reversing Contactors/VFD's/Servo's	Safe-return
Isolation & Energy Dissipation	Electrical Isolation	Pneumatic Dump & Hydraulic Bleed
Safe Restart Function	Safety limited start/Ramp to speed	Soft-start & Speed Control
Emergency stop	Energy isolation/power removal	Pneumatic Dump & Hydraulic Bleed
Guardlocking	Electrical lock function	Pneumatic or hydraulic lock function
Safe Parameterization	Electrical Function	Equivalent Fluid Power Function
Safe ramp-up speed	Safe speed control using VFD or Servo	Soft-start
Safe speed	Safe speed control using VFD or Servo	Speed control valve
Safe limited force	Safe limited torque	Safe pressure select valve

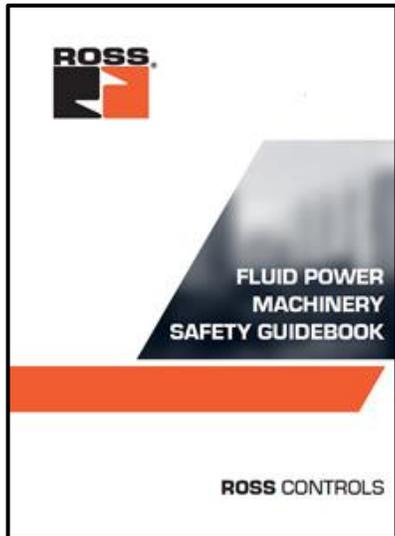
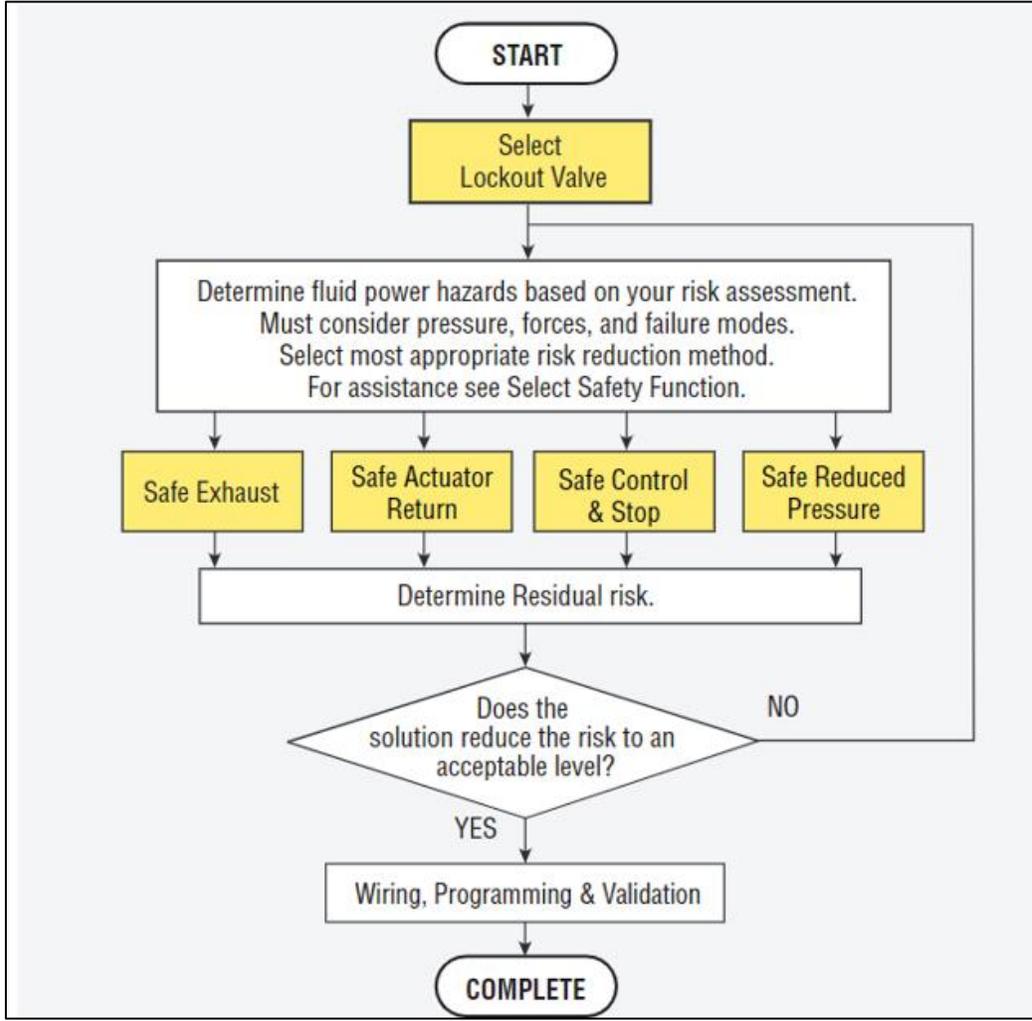
The function is the same, but the terminology & technology is different.

ROSS Recognized Safety Solutions

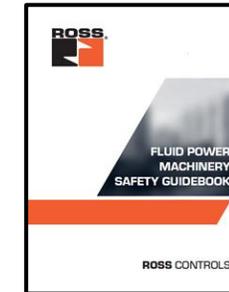
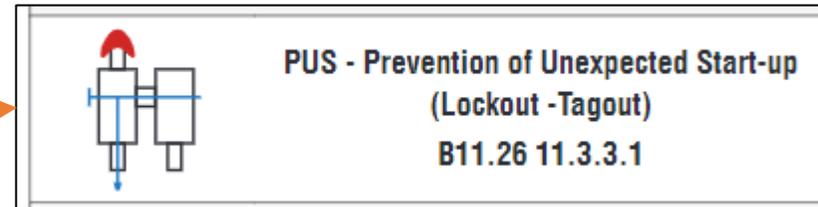
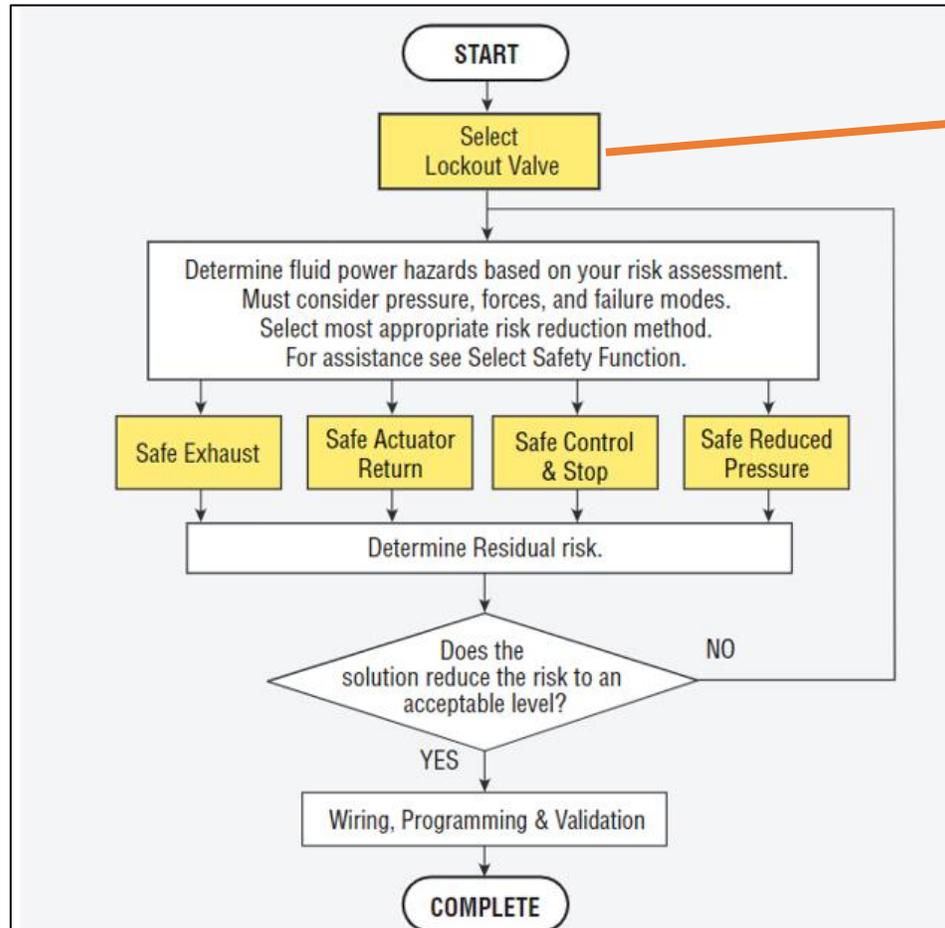
PNEUMATICS						
Safety Function Type	Energy Isolation	Safe Exhaust	Safe Return	Safe Return "Dual Pressure"	Safe Control and Safe Load Holding	Safe Pressure Select
 PUS - Prevention of Unexpected Start-up (Lockout - Tagout) B11.26 11.3.3.1						
 SDE - Safe Deenergization (Safe Exhaust) B11.26 11.3.3.2						
 SEZ - Safe Energization (Safe Exhaust with Soft-Start) B11.26 11.3.3.2						
 STO - Safe Torque Off (Safe Exhaust) B11.26 11.3.3.2						
 SBC - Safe Brake Control B11.26 11.3.3.3 B11.26 11.3.3.2						
 SDI - Safe Direction (Safe Return) B11.26 11.3.3.3						
 SS1 - Safe Stop 1 (Controlled Stop) (Safe Stop with holding) B11.26 11.3.3.4						
 SS2 - Safe Stop with Blocking (Safe-Holding) B11.26 11.3.3.4						
 SLP - Safe Limited Pressure (Torque) B11.26 11.3.3.3						

HYDRAULICS			
Safety Function Type	Energy Isolation	Block & Bleed	Block & Hold/Stop
 SDE - Safe Deenergization (Block & Bleed) B11.26 11.4.3.1			
 SEZ - Safe Energization (Block & Bleed) B11.26 11.4.3.1			
 STO - Safe Torque Off (Block & Bleed) B11.26 11.4.3.1			
 SBC - Safe Brake Control B11.26 11.4.3.1			
 SS1 - Safe Stop 1 (Controlled Stop) (Safe Stop with holding) B11.26 11.4.3.4			
 SS2 - Safe Stop with Blocking (Safe-Holding) B11.26 11.4.3.4			

We will use ROSS Selection Flowcharts to guide us thru the selection process.



The first safety function that we are going to look at is the Prevention of Unexpected Start-up



• Things to think about:

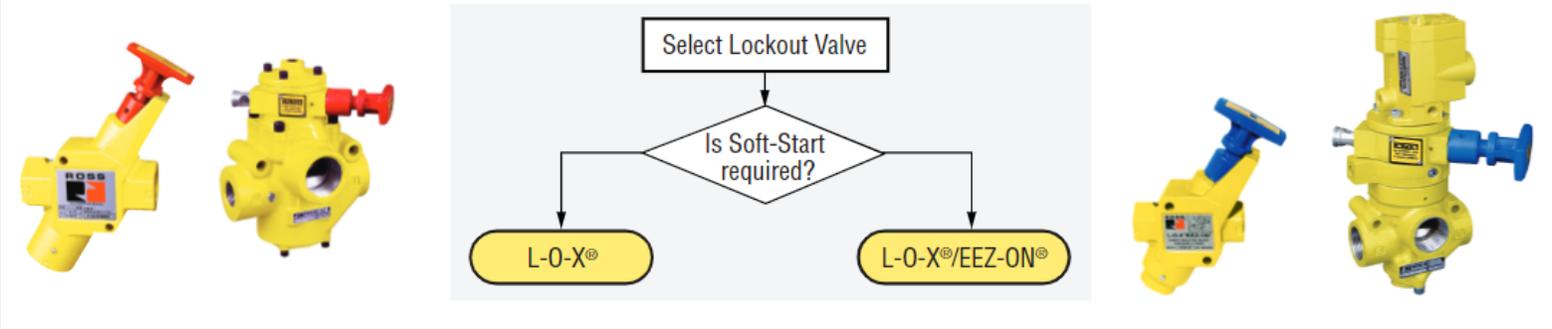
- Will shutting off the supply pressure to the system cause things to move?
- At what speed/rate will they move?
- Is this movement dangerous?
- Could blocking or chaining be included in the process and procedures?
- What happens when I reapply pressure?

Remember the lockout/energy isolation requires specific procedures for each machine.

Lockout/Energy Isolation

The first step is to choose the lockout valve that is needed. Each machine is required to have an energy isolation valve, and, in fact, there may also be other lockout valves for individual machines or zones of a line.

Lockout/Energy Isolation Valve Selection Flow Chart with ROSS Valve Series



Companies are responsible for:

- Creating a Lockout/Energy Isolation Program
- Creating Lockout/Energy Isolation Procedures
- Providing Lockout/Energy Isolation Hardware
- Providing Lockout/Energy Isolation training for employees and contractors
- Inspecting the procedures annually or when a machine change occurs

LOTO Requirements and Best Practices

- Valve not used for any other function
- Located outside of the hazardous area
- Valve should be well marked
- Valve should be differentiated by its appearance
- Easily identified and operated



- Full diameter exhaust (rapid release of stored energy)



- Tamper resistant
- Should only be able to be locked in the off position
- “Positive action” which would indicate only two positions (ON and OFF)

Locked ON



Locked in between



Locked ON/OFF?

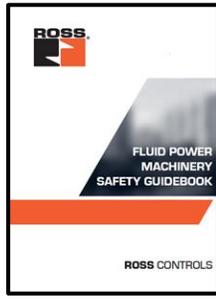
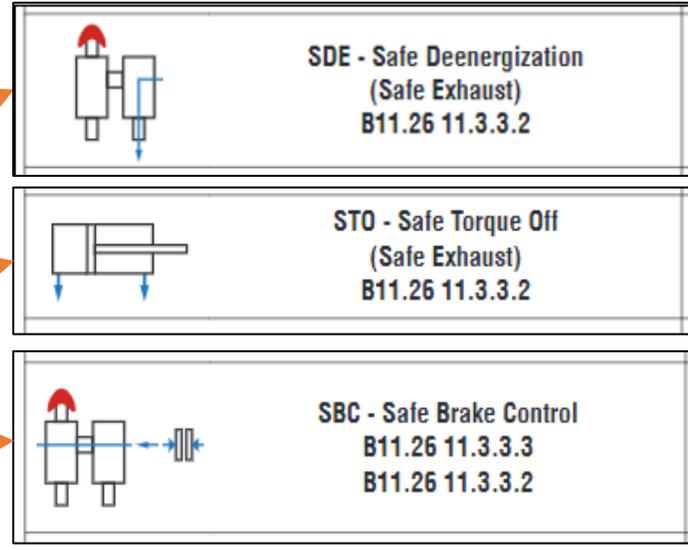
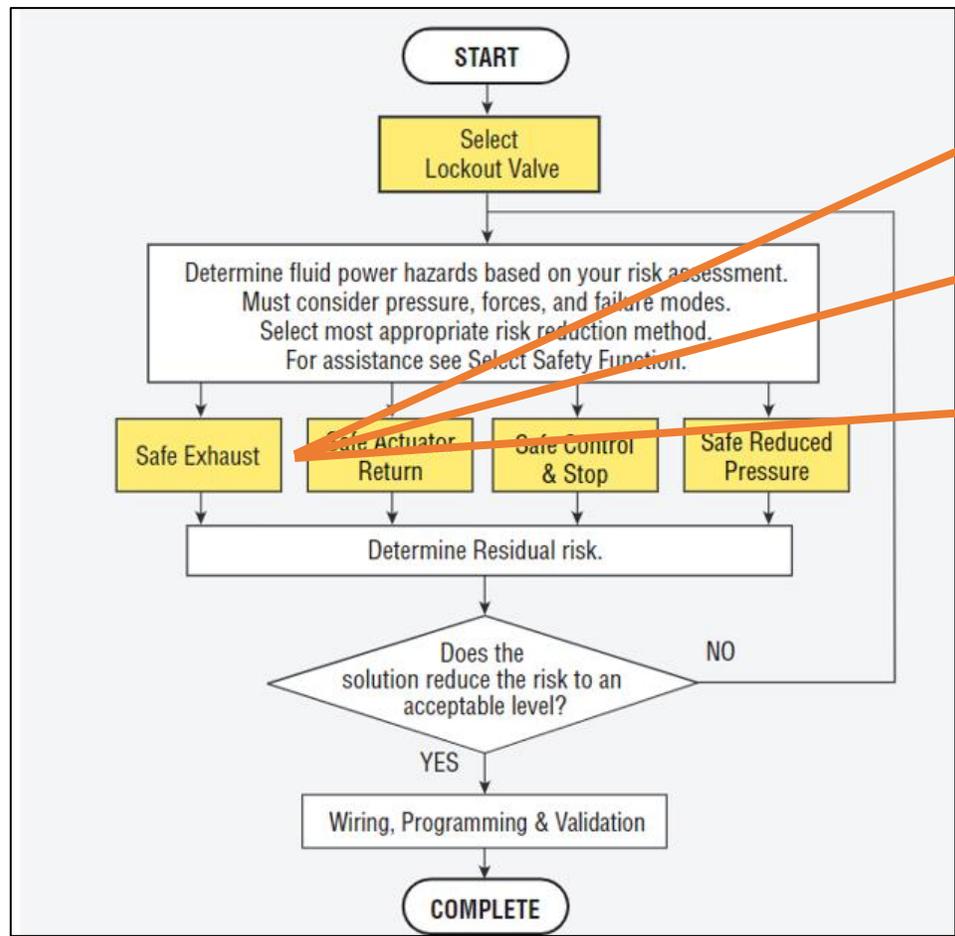


- A method for the employee to verify that the energy has dissipated after initiating lock out process.



Pop-up Pressure Indicator

The second safety function that we are going to look at is Safe-exhaust/Safe-De-energization and is often used with Safe-Energization



• Things to think about:

- Will exhausting system pressure cause things to move?
- At what speed/rate will they move?
- Is this movement dangerous?
- Would an additional safety function be required?
- What happens when I reapply pressure?

Safe-Exhaust Selection Criteria

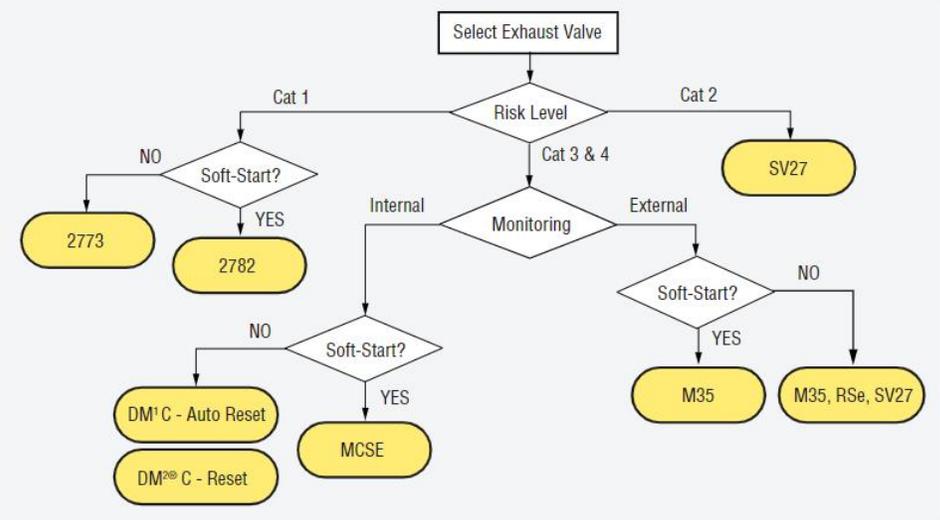
Key things that you need to know:

- What Category & Performance Level does this function need to meet?
- What kind of safety monitoring system does the machine have?
- Is soft-start needed when reapplying pressure?

Safe Exhaust

Safe Exhaust valves are used to block supply pressure and exhaust downstream pressure from an entire machine. Safe exhaust valves can also be used to isolate individual actuators and/or zones depending on requirements of the risk assessment. Safe exhaust valves are available for use in systems that require up to Performance Level e with a variety of voltages and sizes to meet specific customer needs. The safe exhaust valve selection flow chart below is meant to help users select the most appropriate safe exhaust valve.

Safe Exhaust Valve Selection Flow Chart with ROSS Valve Series (Part 1)



Most people think about dumping/exhausting pneumatic and hydraulic pressure without thinking about what happens!

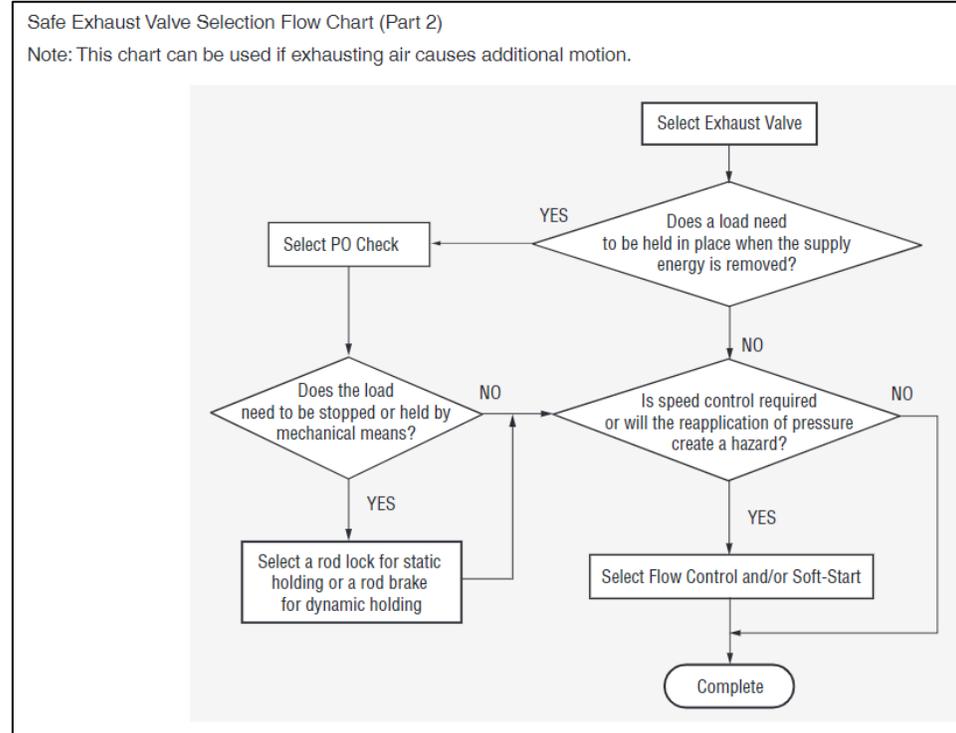
The most commonly utilized Fluid Power safety Solution is Safe-exhaust and/or Safe-block & bleed.

The problem is that this is implemented across a variety of machine types for all fluid power actuators.

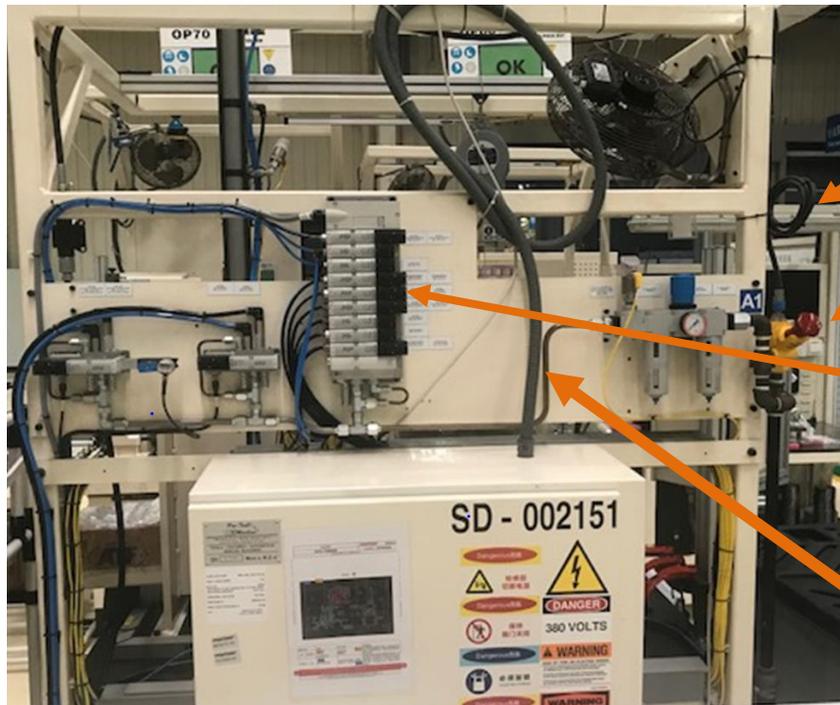
The problem is that shutting off supply pressure to vertical cylinders with loads can cause unsafe drift or the unsafe release of materials.

The standards say that a safeguarding method should not create additional hazards.

The follow sections will look at additional safety functions that might be used alongside Safe-exhaust.



One of the most Common Safe Exhaust Applications is Emergency stops.



Air Supply Line

Lock-out/Tag-out Device

Standard Pneumatic
Control Valves

Guess what's missing?
The Safe-exhaust Valve!

Emergency stops are required to control the sources of hazardous energy in the event of a dangerous situation or an emergency.

Safe-exhaust valves are also used in safe brake control applications.

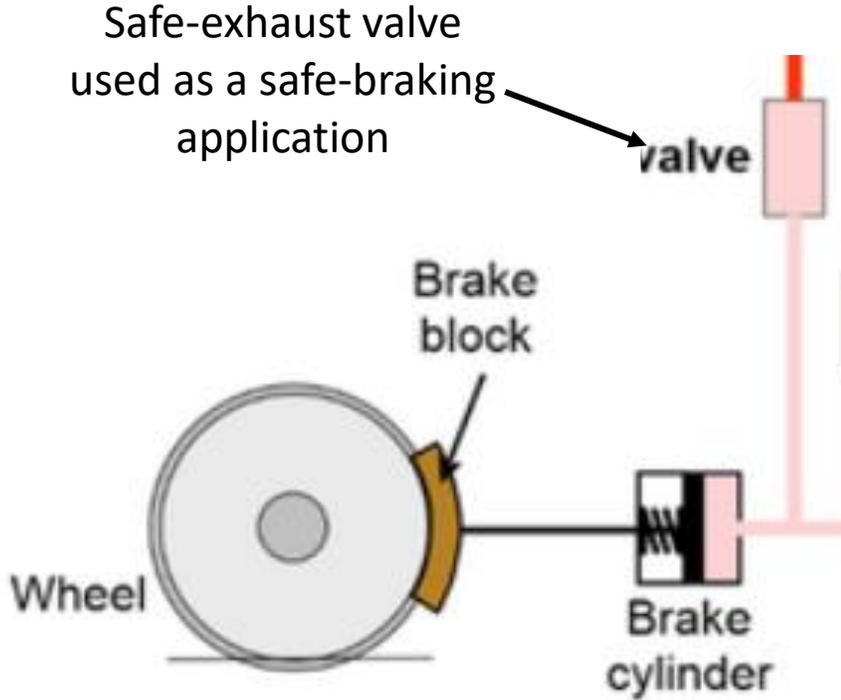
Pneumatic Clamp Brake



Typical pneumatic brakes require safe control of air pressure to open the brake to allow movement. This is then fail-safe because:

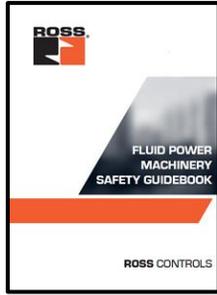
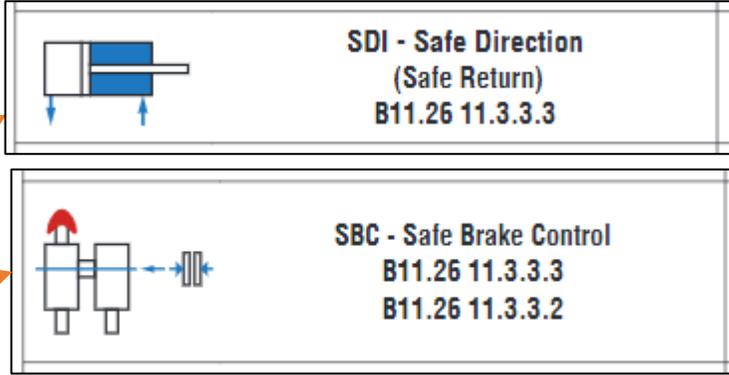
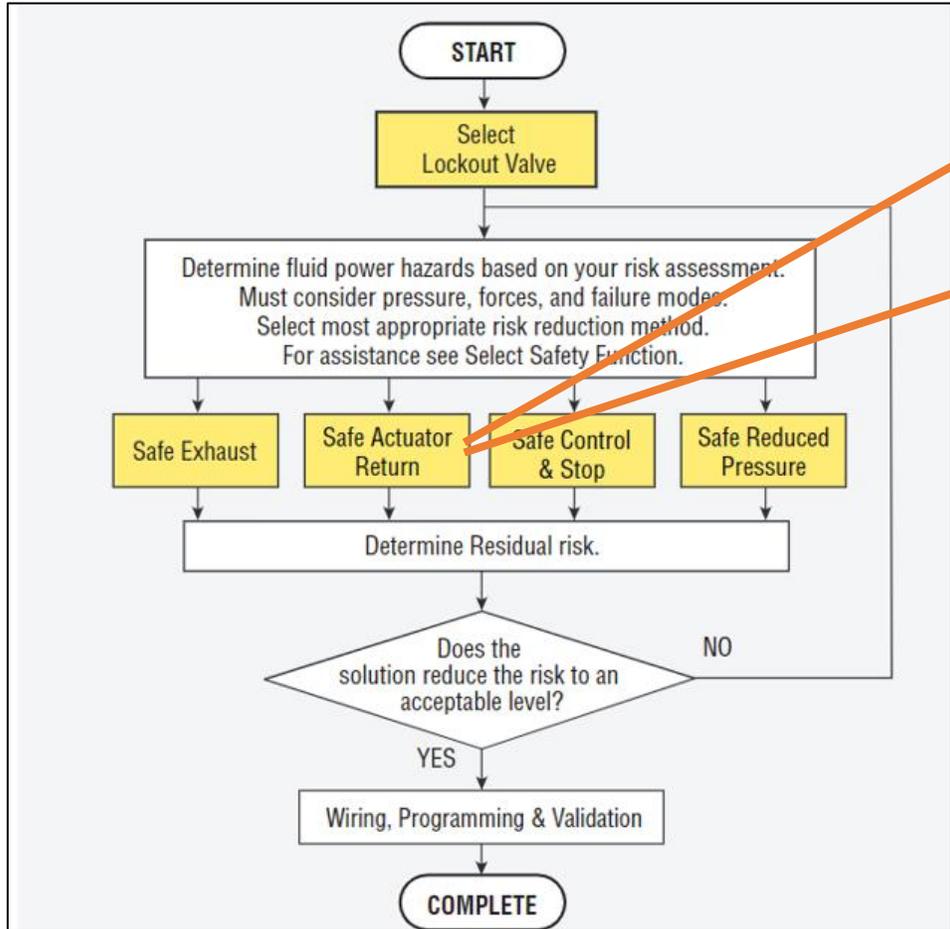
- Safely and redundantly removing air pressure results in the brake closing.
- The loss of supply pressure results in the brake closing.

Pneumatic Rod Brake



The braking system is only as good as the valve that is controlling it!

The third safety function that we are going to look at is Safe-return



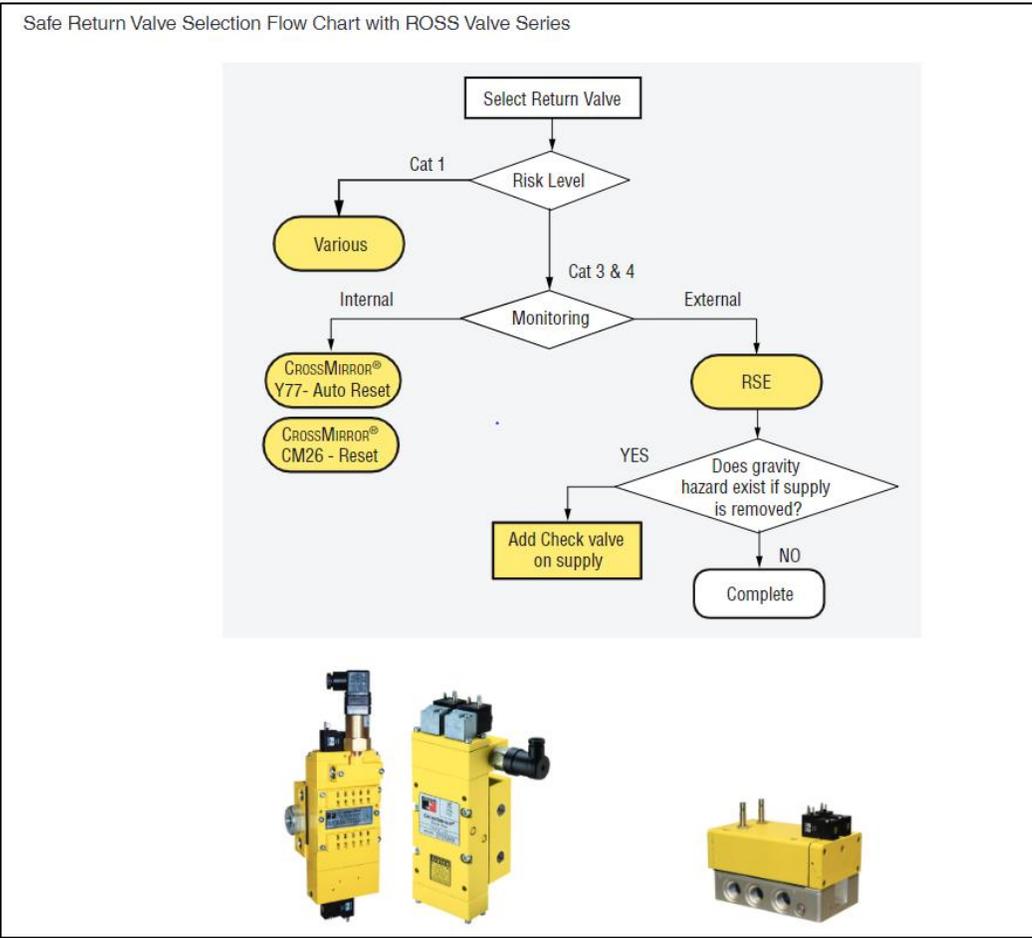
• Things to think about:

- Can you move the hazardous activity away from personnel?
- Can move the hazardous activity away from personnel without creating an additional hazard?
- Safe-return could also be moving a guard to prevent access.

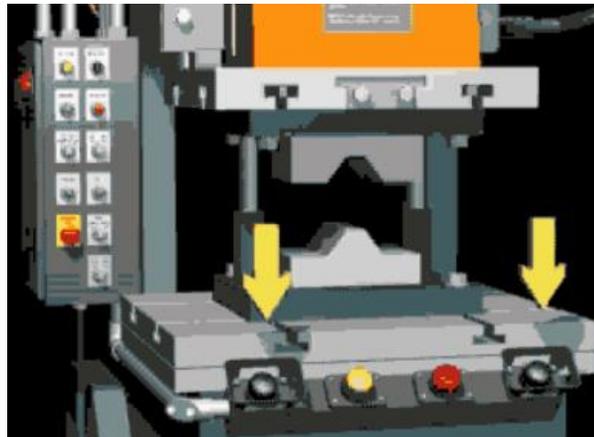
Safe-return Selection Criteria

Key things that you need to know:

- What Category & Performance Level does this function need to meet?
- What kind of safety monitoring system does the machine have?
- Can we safely move the hazard away from the operator without creating an additional hazard?



Cylinder presses use Two Hand Control (THC) systems with Safe-return valves to change the direction of the cylinder motion to prevent forward press motion.

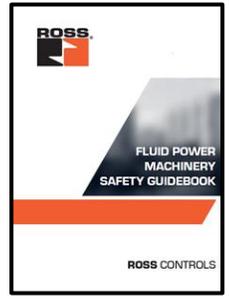
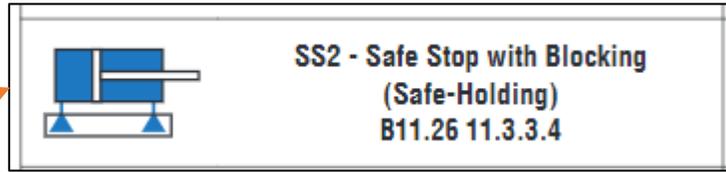
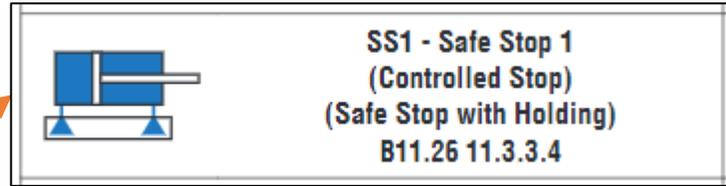
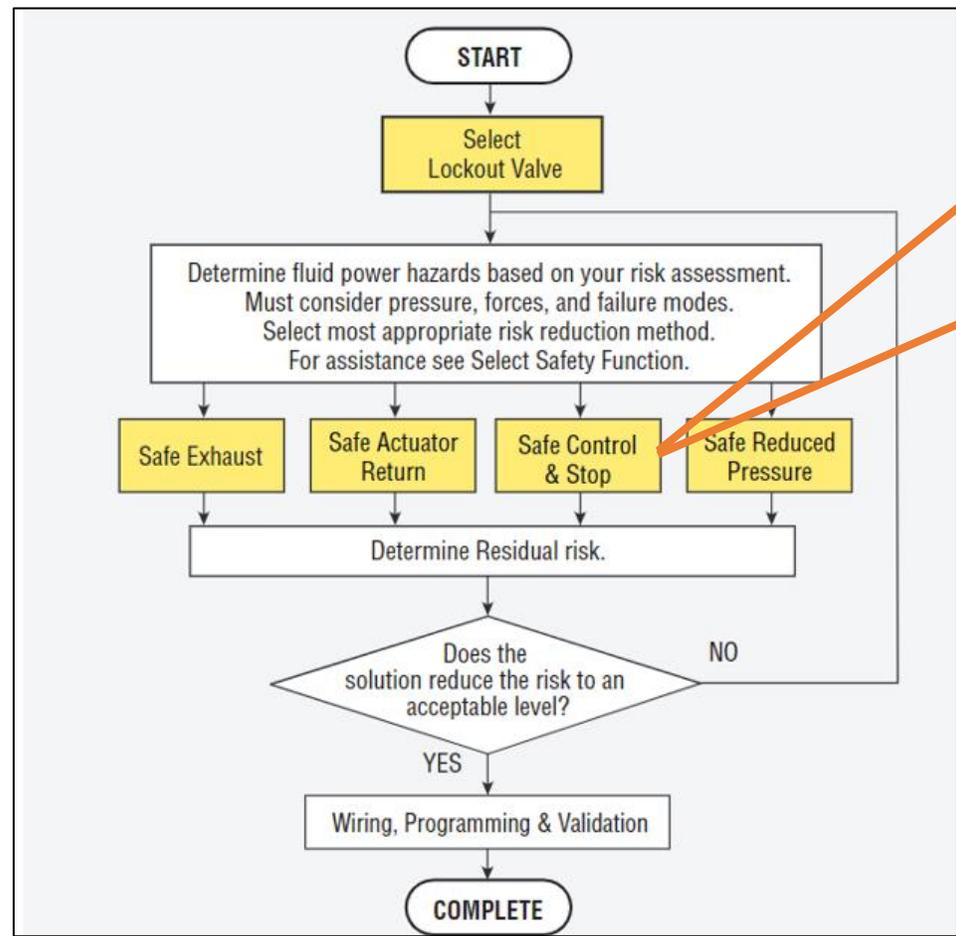


Automated shearing machines use light curtains or other detection devices to detect operator presence and uses safe return type valves to retract the sheering cylinder to prevent injuries.



More people are using standard valves to do safe return functions!

The fourth type safety function that we are going to look at is Safe-Control & Stop and can accomplished 2 different ways.



- Things to think about:
 - Can you stop and hold the hazardous motion/activity?
 - What is the size & speed of the actuator?
 - How fast does the actuator move?
 - What is the flow and/or speed that required for the actuator being controlled?

Safe-Stop & Hold (Safe-stop with blocking) Selection Criteria



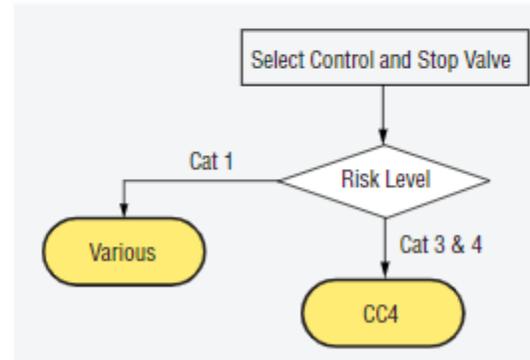
Key things that you need to know:

- What Category & Performance Level does this function need to meet?
- What kind of safety monitoring system does the machine have?
- What is the flow/speed that is needed by the actuator/cylinder?

Safe Control and Stop

There is only one available valve choice that can perform the combined functions of safe control and stop at Cat 2, 3, or 4 without the use of multiple valves. Otherwise, it would require a safe exhaust valve, an open-center control valve, and multiple monitorable PO checks to achieve this function. Sometimes, a mechanical holding device may be required as well.

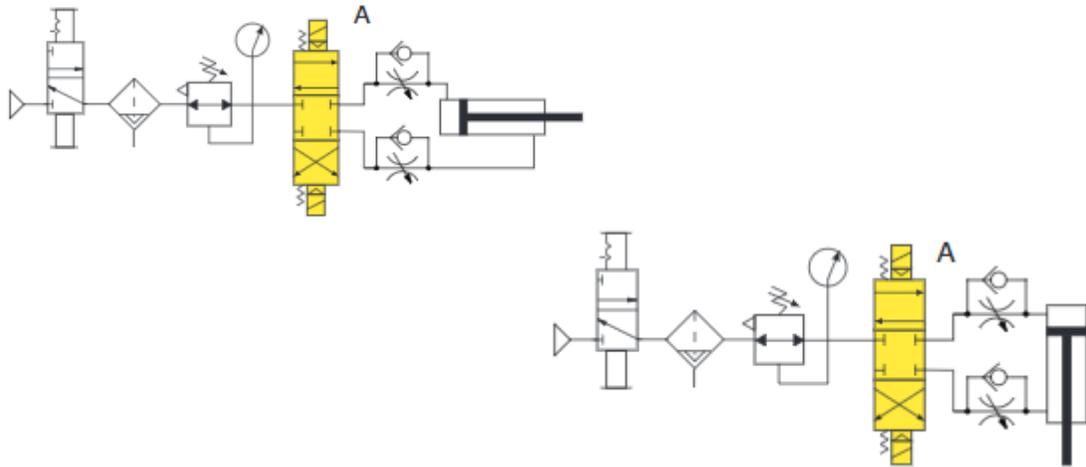
Safe Control and Stop Selection Flow Chart with ROSS Valve Series



Most pneumatic companies struggle with Safe-stop and hold applications because they only have Safe-exhaust valves and non-monitored PO checks which feedback monitoring. This results in a low Cat & PL.

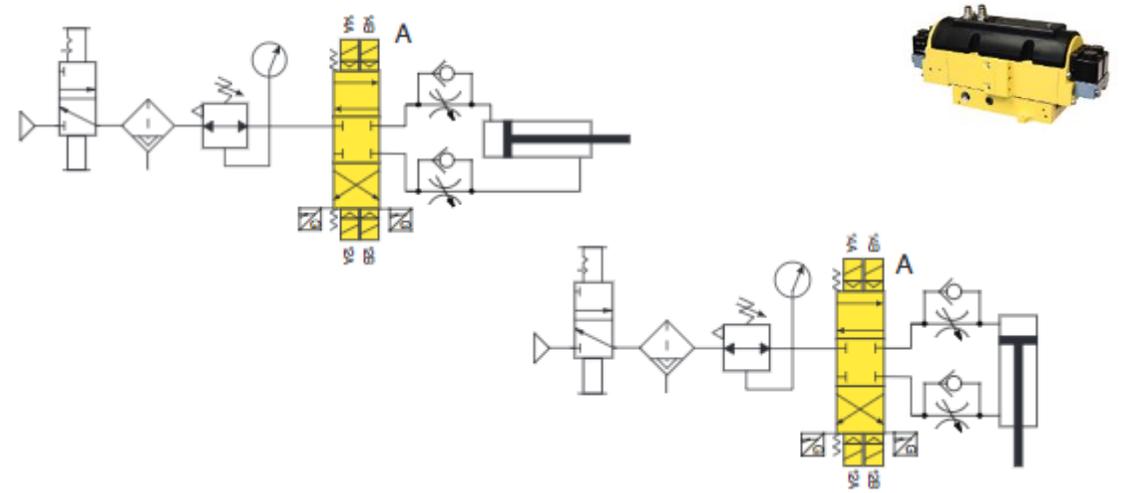
Safe-control & hold considerations

Most companies use 3-position directional control valves for load holding applications.



These problem is that these are non-monitored valves that can fail and lead to the loss of the control/hold function and is not detected and are rated CatB/PlA or Cat1/PLb at best.

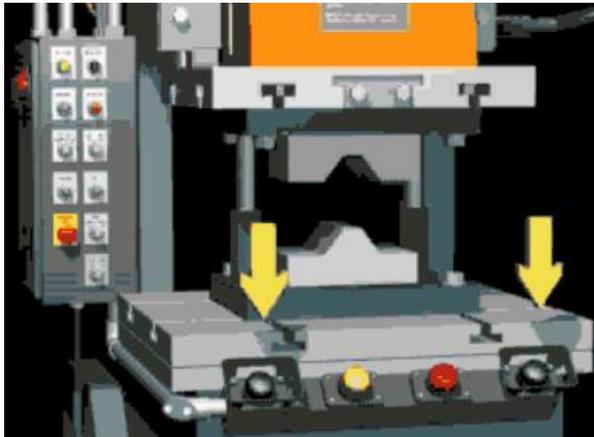
The ROSS CC4 solution us a redundant 3-position directional control valve that is monitored to provide a Safe-control and hold function.



The CC4 is the only valve in the industry that can accomplish Safe-control and holding in 1 valve and is rated to Cat4/PLe.

Common Safe-control & hold Applications

Cylinder presses use Two hand control systems with Safe-control & hold valves to stop motion of the cylinder motion to prevent forward press motion.



A user might use the Safe-control & hold valve instead of a Safe-return valve because there might be a pinch point on the retract stroke.

Forming Machines (TBM's use Safe-control & hold valves to stop motion of the cylinder motion to prevent pinch points caused by moving actuators



See the ROSS application note that describes how Safe-control & hold cylinders protect operators for injury by stopping motion.

Common Safe-Load holding/blocking Applications

Large Cylinder presses that are stopped during the process to do some assembly function might use PO Checks cylinder motion to prevent forward press motion.

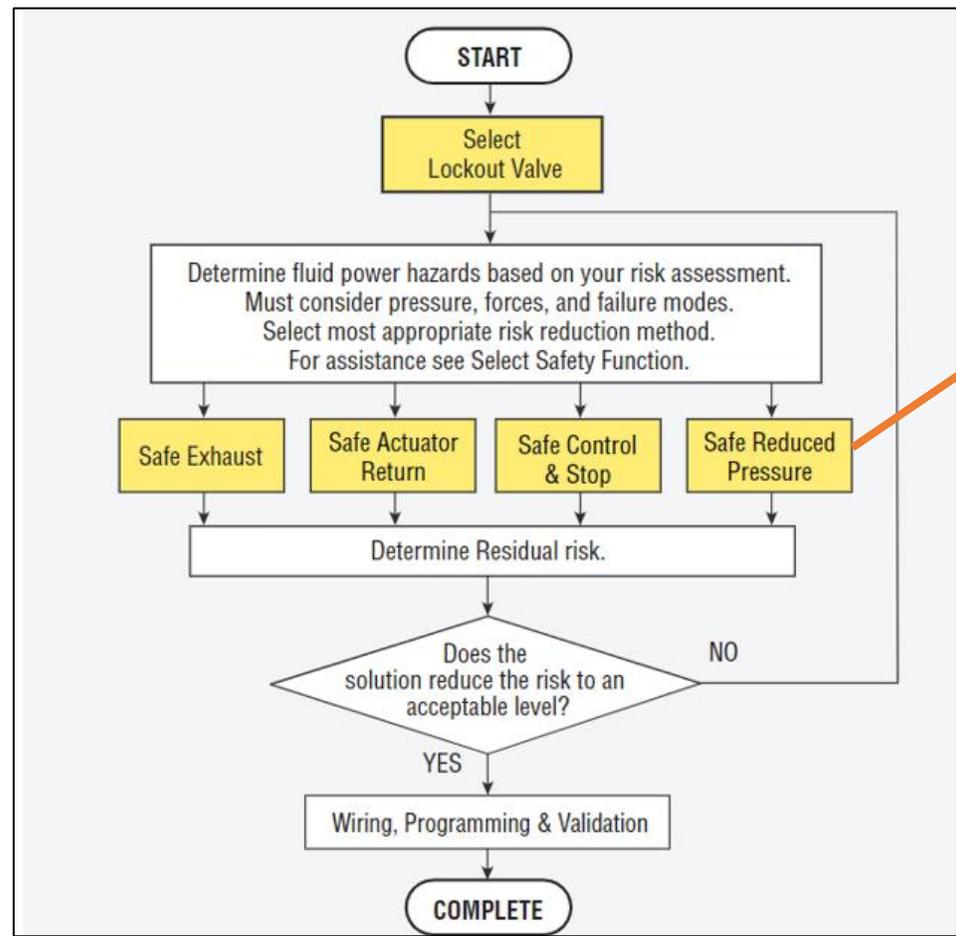


Packaging & material handling machines are another large user of PO Check to stop individual actuators to prevent unwanted motion during operator interaction.

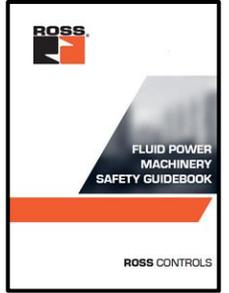


A user might use the Safe-load holding valve because the Safe-control & hold valve is too small or because a Safe-return valve might meet the functionality need.

The fifth type safety function that we are going to look at is Safe-Reduced Pressure and can accomplished 2 different ways.

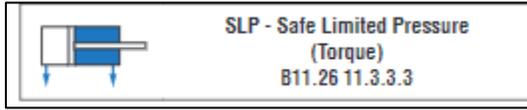


System Data	Imperial		Metric		
Bore	1.25	in	31.75	mm	
Tooling contact area	0.5	in ²	12.7	mm ²	
High pressure	100	psi	0.6895	mpa	
Low pressure	30	psi	0.2068	mpa	
Bore Area	1.227	in ²	792	mm ²	
					PL
High Pressure Calc					
Force in pounds	122.7	lbf	545.9	N	d
Actual pressure at too	245.4	psi	4298.3	N/cm ²	
Low Pressure Calc					
Force in pounds	36.8	lbf	163.8	N	c
Actual pressure at too	73.6	psi	1289.5	N/cm ²	



- Things to think about:
 - Can you reduce pressure but still allow activities to occur?
 - What is the size & speed of the actuator?
 - What is the surface area of the tooling?
 - What is the maximum and minimum pressures that the system can still function with?

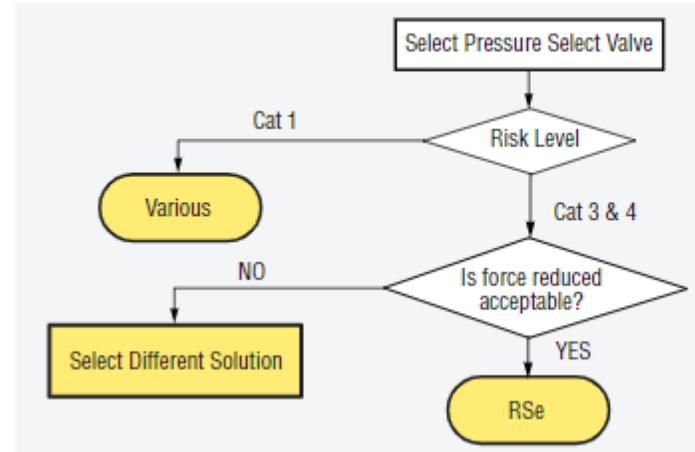
Safe-Pressure Select Selection Criteria



Key things that you need to know:

- What Category & Performance Level does this function need to meet?
- What kind of safety monitoring system does the machine have?
- What is the safe limited pressure threshold for your machine?

Safe Pressure Select Valve Selection Flow Chart with ROSS Valve Series



Most pneumatic companies do not have a solution for safe pressure select. Most consider safe-limited-pressure to be anything less than 150N.

Common Safe-pressure select Applications

Safe pressure select is often used in application that have operators interacting with machine movements & actions.

Collaborative Robots



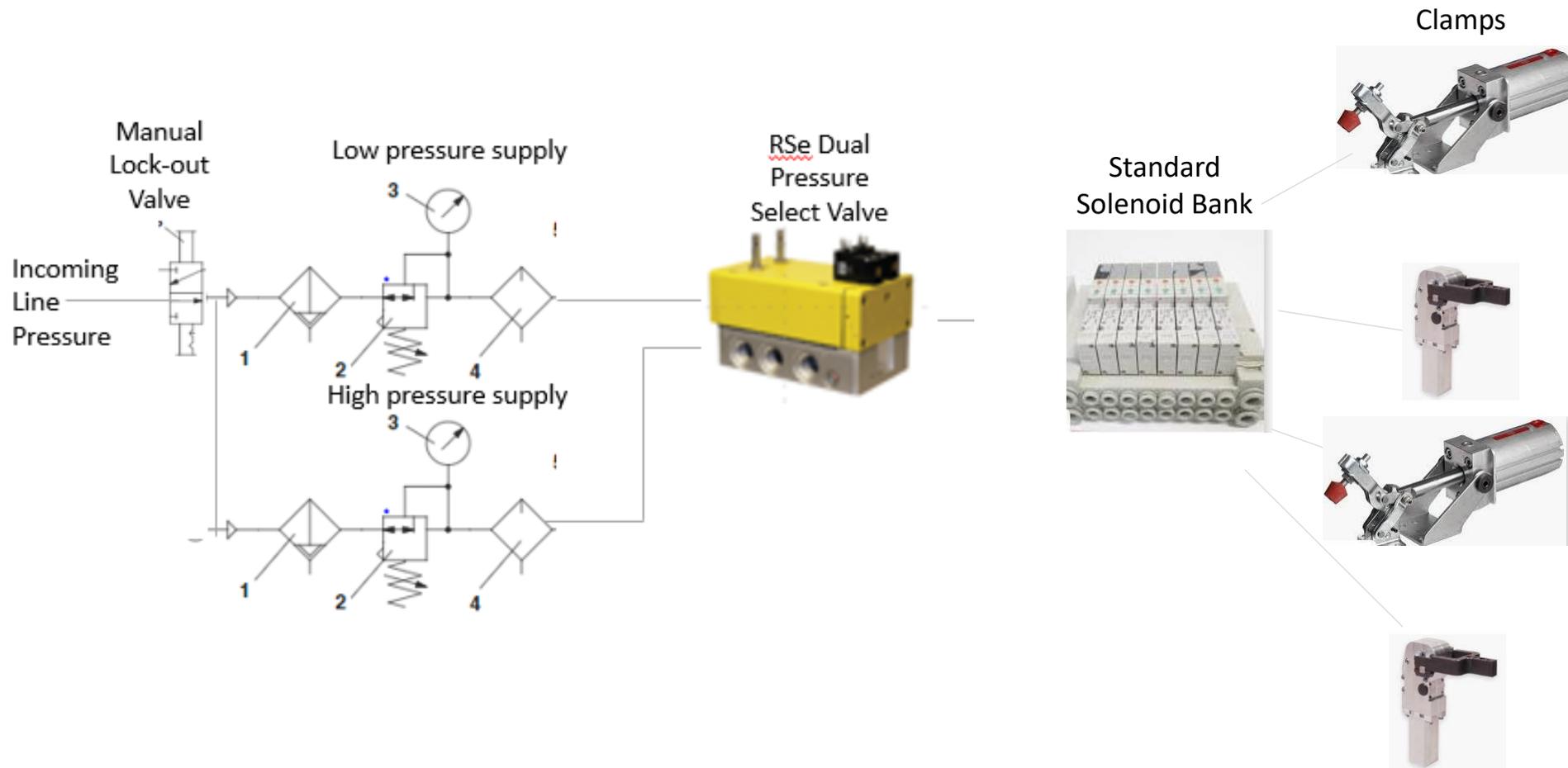
You are controlling the robots' ability to generate pressure and force by limiting, torque, speed and range. Should we do the same for the tooling attached to it?

Welding work cells



Most people are using Safe-exhaust valve to dump air when someone is loading and loading parts. This creates a lot of inefficiency. What is we could allow action to continue but at a safe pressure?

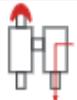
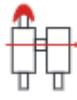
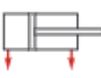
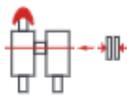
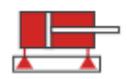
Let's look at how we can accomplish a Safe-pressure select function



Hydraulics has nearly the same Safety functions but uses slightly different terminology and the selection process is a bit different.

Potential safety functions for hydraulics include:

- Energy Isolation - This is the same as "Prevention of unexpected start-up" from Table 8
- Block and Bleed - This is the same as "Isolation and energy dissipation function from Table 8 but is also tied to the 3 top safety functions. Safety related stop initiated by a safeguard, manual reset, and start/restart functions.
- Block and Stop - This is a local control function per Table 8 and is also tied to other safety functions from Table 8. Safety related stop initiated by a safeguard, manual reset, start/restart and control modes, and mode selection functions.

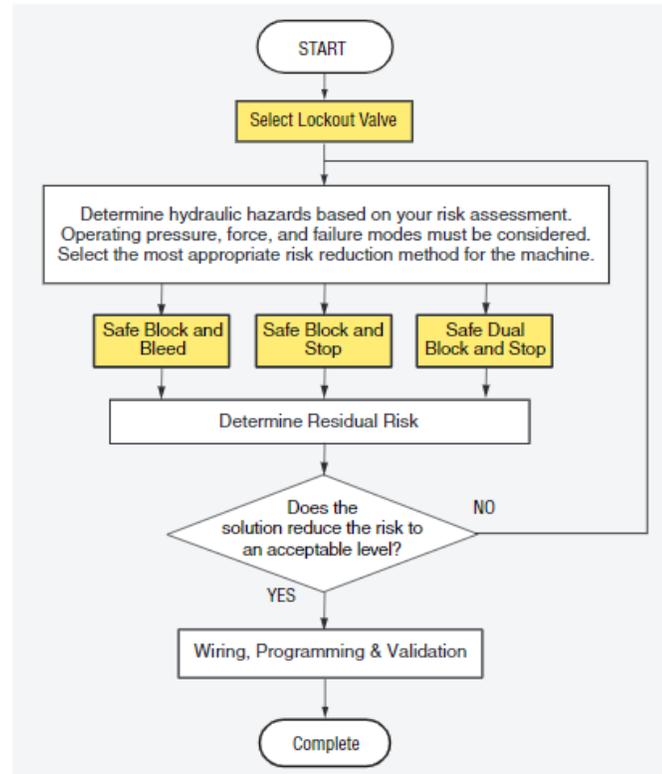
HYDRAULICS			
Safety Function Type	Energy Isolation	Block & Bleed	Block & Stop
 <p>SDE - Safe Deenergization (Block & Bleed) B11.26 11.4.3.1</p>		✓	
 <p>SEZ - Safe Energization (Block & Bleed) B11.26 11.4.3.1</p>		✓	
 <p>STO - Safe Torque Off (Block & Bleed) B11.26 11.4.3.1</p>		✓	
 <p>SBC - Safe Brake Control B11.26 11.4.3.1</p>		✓	
 <p>SS1 - Safe Stop 1 (Controlled Stop) (Safe Stop with holding) B11.26 11.4.3.4</p>			✓
 <p>SS2 - Safe Stop with Blocking (Safe-Holding) B11.26 11.4.3.4</p>			✓

Hydraulics uses slightly different terminology, and the safety functions are a bit different.

HYDRAULIC SAFETY VALVE SELECTION

When choosing specific valves to address primary and residual risk, the choice will be dependent on a number of factors including desired safety function, flow rate, pipe size, voltage, and pressure range.

The flowchart below guides users through the selection process to determine the type of valve that is needed for a machine or hazard. Available hydraulic valve types are Safe Block and Bleed as well as Safe Block and Stop.



Where would you use hydraulic safety valve?

Hydraulic Safety Valves are often used to isolate and control hazardous energy feeders, palletizers, tilt stands and dumping stations in multiple industries.

Hydraulic Safety Valve Uses

Roll de-coiling and straightening



Presses



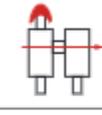
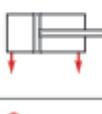
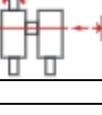
Palletizers

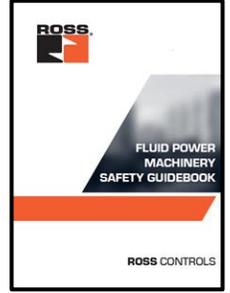


Safe-Block & Bleed Select Selection Criteria

Key things that you need to know:

- What Category & Performance Level does this function need to meet?
- What kind of safety monitoring system does the machine have?
- What is the flow rate of the actuator/machine/system that you want to isolate?

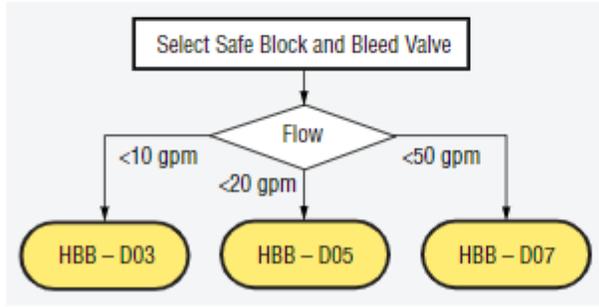
	SDE - Safe Deenergization (Block & Bleed) B11.26 11.4.3.1
	SEZ - Safe Energization (Block & Bleed) B11.26 11.4.3.1
	STO - Safe Torque Off (Block & Bleed) B11.26 11.4.3.1
	SBC - Safe Brake Control B11.26 11.4.3.1



Safe Block and Bleed

When machine access is required for production-related tasks it may be necessary to block the supply of hydraulic energy and also to bleed residual energy from downstream, especially from accumulators, in order to prevent further movement. The devices used to block and bleed hydraulic energy must meet the required Performance Level as determined by the risk assessment. Actuators could move as a result of releasing residual energy from the system. Therefore, an additional load-holding device may be needed to ensure no movement as a result of blocking & bleeding.

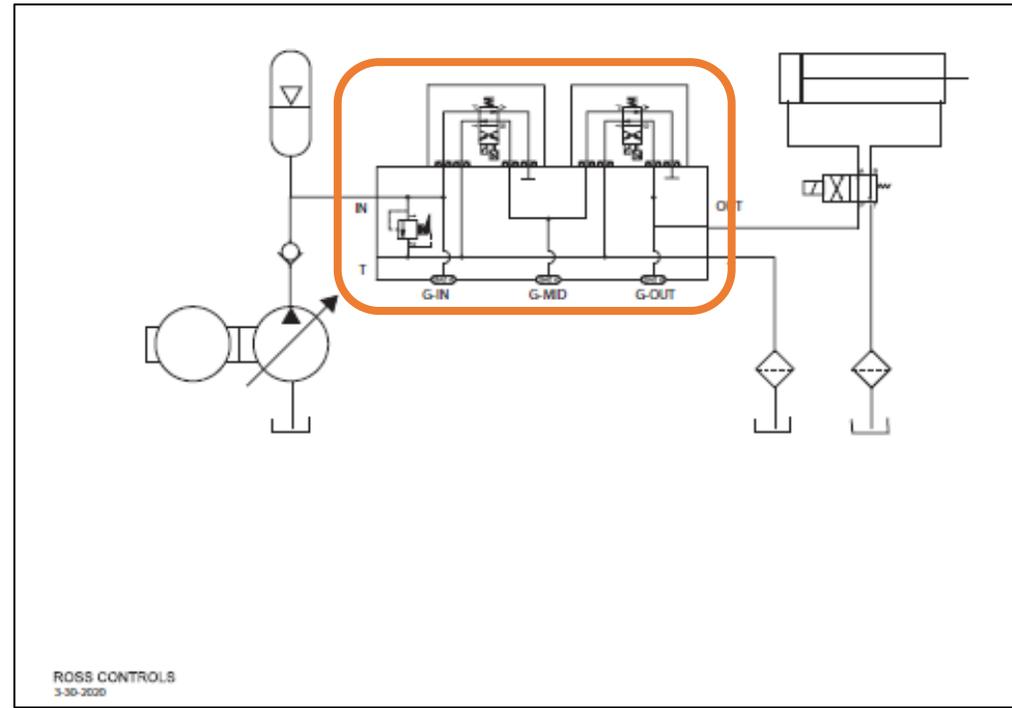
Hydraulic Safe Block and Bleed Valve Selection Flow Chart with ROSS Valve Series



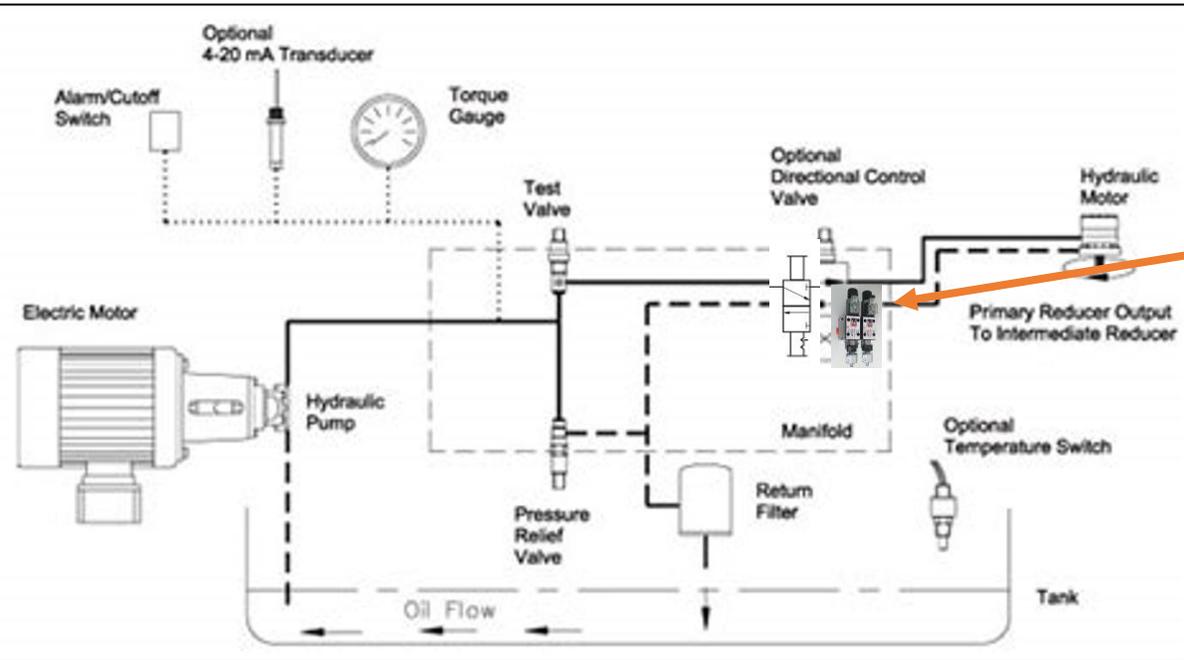
Typical Application for the Block & Bleed valve

Block & Bleed

When machine access is required for production-related tasks it may be necessary to block the supply of hydraulic energy and also to bleed residual energy from downstream, especially from accumulators, in order to prevent further movement. The devices used to block, and bleed hydraulic energy must meet the required Performance Level as determined by the risk assessment. Actuators might move as a result of releasing residual energy from the system. Therefore, additional load-holding devices might be needed to ensure no movement as a result of blocking & bleeding.



The Hydraulic Block and Bleed Safety should go after the Lock out valve and before any control valves to eliminate supply pressure from the system in the event of a requirement from the safety system.



The block and bleed valve blocks supply pressure and bleeds all upstream pressure back to tank.

Things to know:

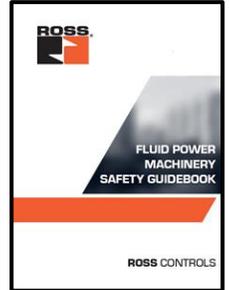
1. Standard hydraulic control valves have no safety rating, so they are only CatB or Cat1.
2. A single failure in the standard control valve will lead to the loss of safety control.
3. ROSS offers a redundant valve solution with monitoring. This means that we can meet Cat4/PLe if properly implemented.
4. These valves carry a third-party validation to Cat4/PLe. Others do not!

Safe-Block & Stop/Hold Select Selection Criteria

Key things that you need to know:

- What Category & Performance Level does this function need to meet?
- What kind of safety monitoring system does the machine have?
- What is the flow rate of the actuator/machine/system that you want to stop & hold?

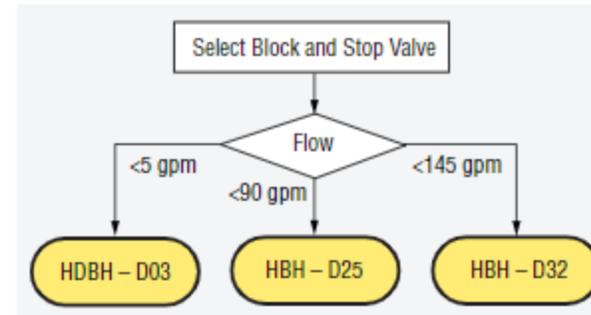
	SS1 - Safe Stop 1 (Controlled Stop) (Safe Stop with holding) B11.26 11.4.3.4			✓
	SS2 - Safe Stop with Blocking (Safe-Holding) B11.26 11.4.3.4			✓



Safe Block and Stop

Block and Stop valves are used to block flow in order to prevent unwanted motion, and are typically integrated into individual actuator circuits to prevent movement of a particular component or components. The risk assessment should indicate the required block and stop needs and should indicate the required performance level and category of valves to complete the safety circuit. ROSS offers two series of Block & Stop valves – HDBH and HBH.

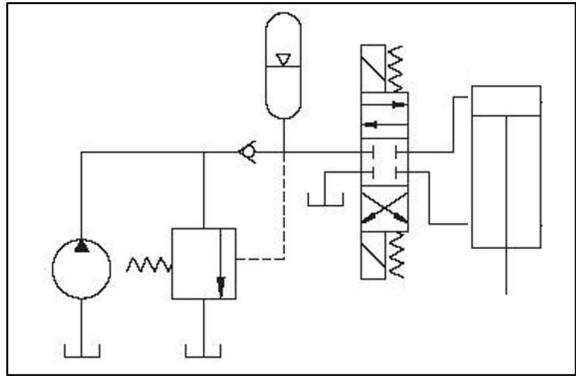
Hydraulic Safe Block and Stop Valve Selection Flow Chart with ROSS Valve Series



The Hydraulic Block and Hold Safety Valves would be used in vertical applications to prevent downward movement.

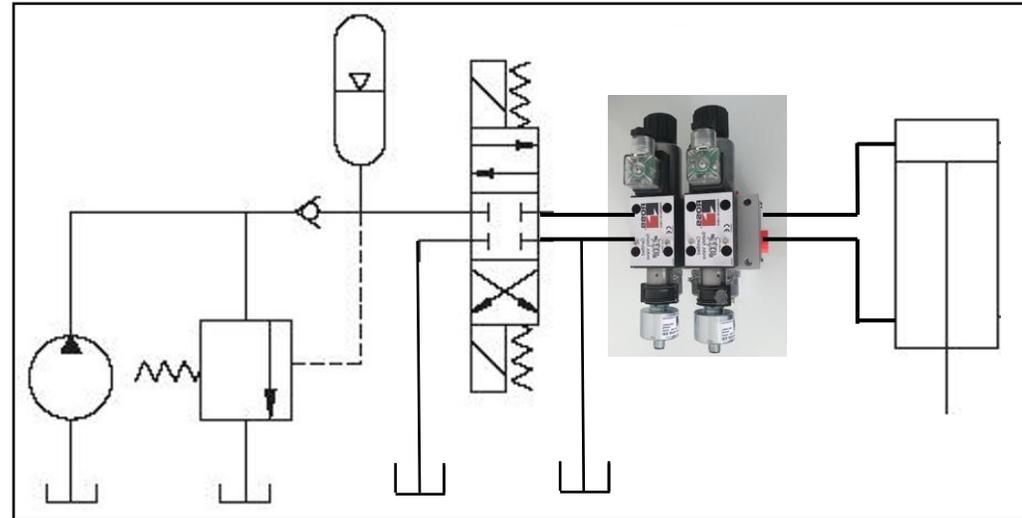
CatB/PLa

Standard Load Holding Hydraulic Control Solution



Up to Cat3/PLd

ROSS Load Holding Hydraulic Control Solution
using the HBH series Valves

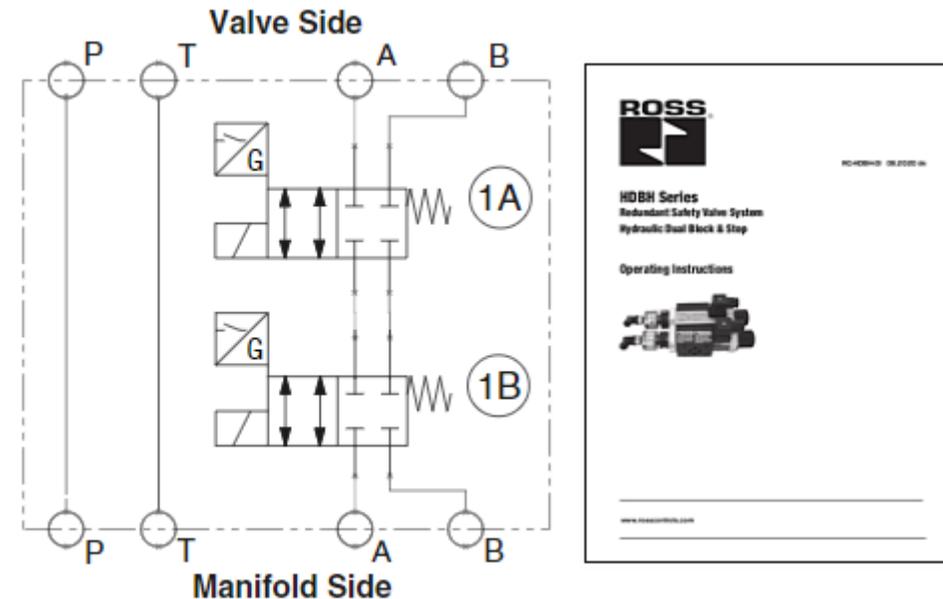


Things to know:

1. Standard hydraulic control valves have no safety rating, so they are only CatB or Cat1.
2. A single failure in the standard control valve will lead to the loss of safety control.
3. ROSS offers a redundant valve solution with monitoring. This means that we can meet Cat3/PLd if properly implemented.
4. These valves will carry a third-party validation. Others do not!

Hydraulic Double Block & Hold (HDBH)

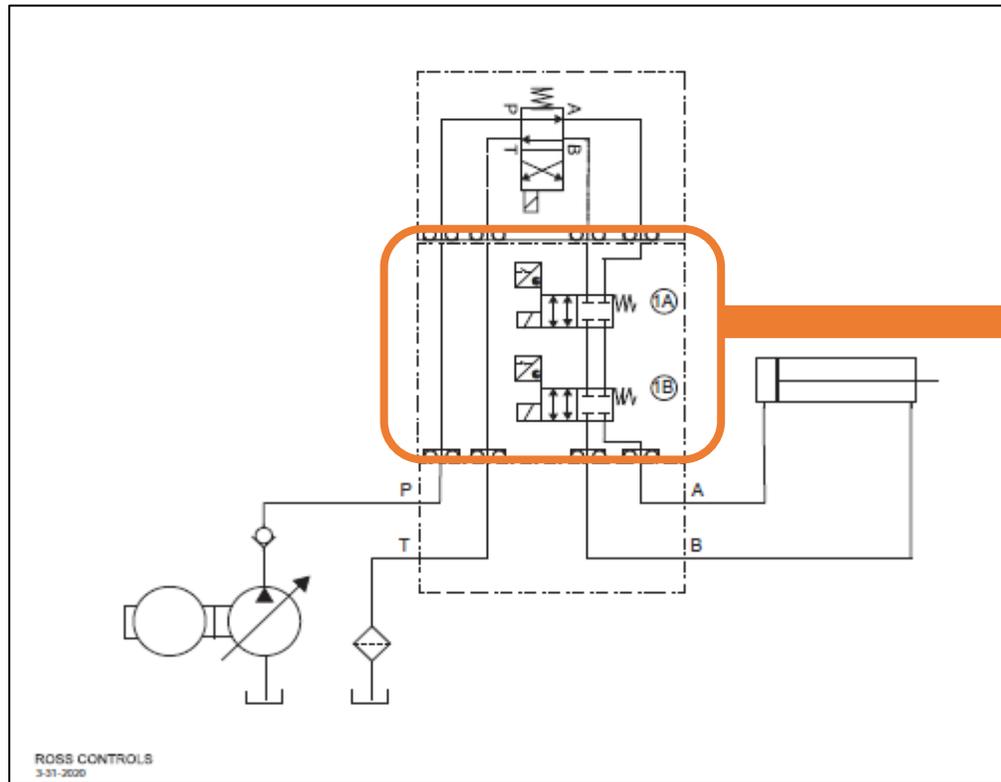
- Redundant Cat1 certified valves
 - Atos standard product
 - Third party certified
 - Factory calibrated sensors
 - Tamper resistant sensor collars
- Anti-tamper Assembly
- Standard Din Connectors for the solenoids
- Standard 5 pin M12 sensor connectors
- Replaceable Coils
- Replacement Solenoid kits with tamper resistant tool & test checklist
- Sandwich or flange mounted
- 3rd Party Certified to Cat4/PLe
- Program Blocks



Hydraulic Double Block & Hold (HDBH) Circuits

Cylinder Load Holding/Stopping

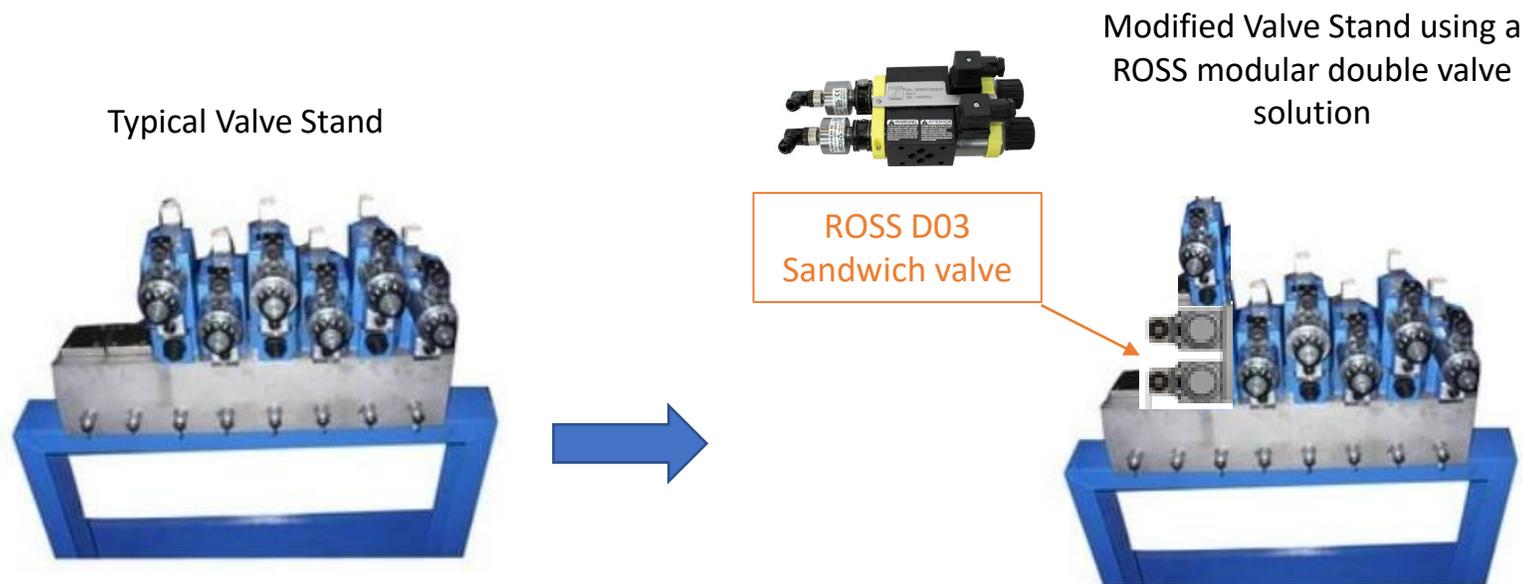
When machine access is required for production-related tasks it may be necessary to stop and/or prevent fluid power actuator motion by blocking flow in or out of an actuator. Trapping pressure on one or both sides of the actuator can be a viable method to stop and prevent further movement due to gravity or applied force. The devices used to block the flow in and/or out of the actuator(s) must meet the required Performance Level as determined by the risk assessment.



In-line Mounting Kit	
Kit Number	2790B77
<p>In applications where installation on a manifold is not practical, the in-line mounting kit can be used to facilitate installation in-line between a directional valve and actuator (typically a cylinder). The 2790B77 kit provides 2 mounting plates with multiple SAE 06 ports for the A, B, and T ports in order to provide for flexibility in piping. At least one of the T ports must be piped back to the tank. Through holes (0.422" dia.) for mounting the assembly are included in the plates. All assembly hardware and plugs are included, but mounting hardware for the assembly must be provided by the customer.</p>	
<p>Dimensions – inches (mm)</p> <p>4.0 (101.6)</p> <p>2.0 (50.8)</p> <p>~7.9 (201.67)</p>	

Typical Hydraulic Dual Block and Bleed applications are blocking individual actuators on hydraulic manifolds.

If the customer needs to control for one actuator, we could accomplish this with a modular approach by using a Dual Block & Stop valve solutions. The customer could remove the standard control solenoid that is driving the associated actuator and could insert our modular HDBH in it's place and would then bolt their existing valve to the top of our valve for standard control of the actuator.



Just remember that safety solutions for fluid power are similar to the functions in electrical safety but work together to make complete safety solution.

Safety Functions

Complete safety functions are made of input devices, logic devices, and output devices. The safety input device is the trigger for the safety function. The safety logic device monitors the input device and makes a decision on how to control the output devices. The safety logic device also monitors the feedback signals from the output device/devices. For specific design requirements, see section 10 of this document.



If you need help addressing fluid power safety needs, please visit the ROSS Controls website or contact your local ROSS distributor.

ROSS is the Global Leader of Fluid Power Safety with more than 100 years in the metals industry.

Please let us know how we can assist you in future safety products and solutions.