OSC 12
Ohio Safety Congress & Expo

WELL AT HOME. SAFE AT WORK.

# Machine Safeguarding

Thursday 3/29/12

## New Standards and Products

Roger Harrison - Director of Training - Rockford Systems Inc.
(800) 922-7533 extension 604 harrison@rockfordsystems.com

Part 1 #103 11:15am-12:15pm
Part 2 #104 1:15pm-2:15pm

Ohio Bureau of Workers' Compensation

---

## In most countries around the world:

### Regulations:
legally mandatory - like OSHA Regulations

### Standards:
voluntary - like ANSI Standards are often used to obtain more current Best Safety Practices

www.rockfordsystems.com

New ANSI Safety Standards since 2008:

ANSI GSR-2008 General Safety Requirements Common to ANSI B11 Machines
ANSI B11.1-2009 Mechanical Power Press Safety
ANSI B11.0-2010 Safety of Machinery and General Risk Assessment
ANSI B11.9-2010 Safety Requirements for Grinding Machines
ANSI B11.19-2010 Performance Criteria for Safeguarding (Methods)
ANSI/NFPA79-2012 Electrical Standard for Industrial Machinery

---

## ANSI B11 Safety Standards for Machine Tools

ANSI GSR - 2008 General Safety for ANSI B11 Machines
ANSI/NFPA 79 - 2012 Electrical Std. for Ind. Machinery
B11.0 - 2010 Safety of Machinery - Risk Assessment
B11.1 - 2009 Mechanical Power Press Safety
B11.2 Hydraulic Power Presses
B11.3 Power Press Brakes
B11.4 Shears
B11.5 Iron Workers
B11.6 Lathes
B11.7 Cold Headers and Formers
B11.8 Drilling, Milling, and Boring
B11.9 - 2010 Grinders - Abrasive Wheels
B11.10 Sawing
B11.11 Gear Cutting
B11.12 Roll Forming and Roll Bending
B11.13 Automatic Screw/Bar and Chucking

www.rockfordsystems.com

---

(continued)

B11.14 Slitters (Now combined with B11.18)
B11.15 Pipe, Tube, and Shape Bending
B11.16 Metal Powder Compacting
B11.17 Horizontal Hydraulic Extrusion Presses
B11.18 Coil Processing (Slitting and Cut-to-Length)
B11.19 - 2010 Safeguarding Criteria (Methods)
B11.20 Integrated Manufacturing Systems
B11.21 Machine Tools using Lasers
B11.22 CNC Turning
B11.23 Machining Centers
B11.24 Transfer Machines

TR 1 - 2004 Ergonomics
TR 2 - 1997 Mist Control
TR 3 - 2000 Risk Assessment
TR 4 - 2004 PLC/PES
TR 5 - 2006 Noise Measurement
TR 7 - 2007 Lean Manufacturing

www.rockfordsystems.com

---

## The American National Standards Institute (ANSI) does not write any Standards

ANSI establishes procedures and accredits Standards development organizations (like RIA)

If the written Standard meets their requirements, ANSI will then approve and publish the Standard

Newer Standards / Regulations tend to be
**Performance Based**
give end result - how to get there is up to you

Older Standards / Regulations tend to be
**Specification Based**
give very specific parameters of how to do

www.rockfordsystems.com

---

ANSI B11.0 – 2010

*American National Standard*
*Safety of Machinery – General Requirements and Risk Assessment*

Secretariat and Accredited Standards Developer:
B11 Standards, Inc.,
42265 Young Lane
Leesburg, VA 20176, USA

APPROVED: 3 DECEMBER 2010

American National Standards Institute

ANSI

COPYRIGHT PROTECTED DOCUMENT
Copyright © 2010 by B11 Standards, Inc.
All rights reserved. Printed in the United States of America
No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of B11 Standards, Inc.

### Type A Standards:
aspects applicable to all types of machines

### Type B Standards:
B1 - ergonomics
B2 - components and protective devices

### Type C Standards:
specific types or groups of machines

www.rockfordsystems.com

## ANSI B11 Standards Instruct Employer:

left side:
shall . . . must . . . will . .

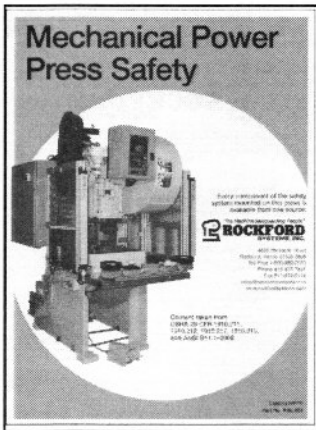
right side:
should . . . may . . .

ANSI B11.19 - 2010
"Safeguarding Methods"

- Guards
- Devices
- Distance
- Location
- Opening

www.rockfordsystems.com

## Mechanical Power Press Safety



## MPPS booklet

1910.211 pages 4-6
Glossary of Terms for Machine Guarding

1910.212 page 7
General Requirements for All Machines

1910.217 pages 8-35
Mechanical Power Presses

1910.219 pages 36-39
Mechanical Power-Transmission Apparatus

www.rockfordsystems.com

## Public Law 91 - 596
## 91st Congress, S. 2193
## December 29, 1970

**5 (a) (1) OSHA's General Duty Clause**

EMPLOYERS to furnish a place of employment free from recognized hazards likely to cause death or serious physical harm to employees

5 (b) EMPLOYEES shall comply with OSHA standards, rules, regulations, and orders applicable to his own actions and conduct

www.rockfordsystems.com

SUBPART P – HAND AND PORTABLE POWERED TOOLS AND OTHER HAND-HELD EQUIPMENT

1910.242 Hand and portable powered tools and equipment, general
1910.243 Guarding of portable powered tools
1910.244 Other portable tools and equipment

SUBPART Q – WELDING, CUTTING, AND BRAZING

1910.252 Welding, cutting and brazing

SUBPART R – SPECIAL INDUSTRIES

1910.261 Pulp, paper, and paperboard mills
1910.262 Textiles
1910.263 Bakery equipment
1910.264 Laundry machinery and operations
1910.265 Saw mills
1910.266 Pulpwood logging
1910.267 Agricultural operations
1910.268 Telecommunications

www.rockfordsystems.com

## Code of Federal Regulations OSHA Sub-Part O
## Machinery and Machine Safeguarding

1910.211 Definitions www.rockfordsystems.com
1910.212 General requirements for all machines

Vertical = specific

1910.213 Woodworking machinery (ANSI 01.1)
1910.214 Cooperage machinery (barrel making)
1910.215 Abrasive wheel machinery ANSI B11.9 ANSI B7.1
1910.216 Mills and calendars (rubber and plastics)
1910.217 Mechanical Power Presses (ANSI B11.1)
1910.218 Forging machines (presses and hammers)

Horizontal = general

1910.219 Mechanical power transmission apparatus

## OSHA 1910.212 General requirements (a) (1)

protect operator & other employees in the machine area from hazards

- point of operation
- ingoing nip points
- rotating parts
- flying chips & sparks

examples of safeguarding methods: barrier guards, two-hand actuators, electronic safety devices, etc.

www.rockfordsystems.com

www.rockfordsystems.com

# 4.6 Safeguarding

ANSI B11.0 - 2010

6.1 General . . . Suppliers and users are required to perform risk assessment

4.2 Collaborative efforts . . . the supplier shall advise the user of residual risk . . .

4.6 Safeguarding . . .The supplier shall provide safeguarding determined by risk assessment.

4.6 Safeguarding . . . The user shall ensure that additional safeguarding is provided and installed as determined by risk assessment.

www.rockfordsystems.com

during a

**Risk Assessment / Hazard Analysis**

look for

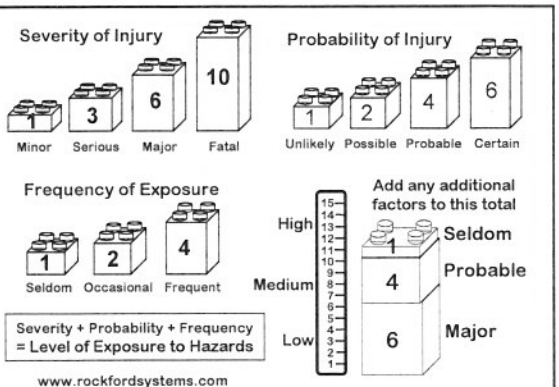
**EXPOSURE to a Recognized Hazard**

(Immediate or impending exposure requires Guard-Device-Method)

and ways to

**Reduce or Eliminate that Exposure**

ANSI B11.TR3-2000

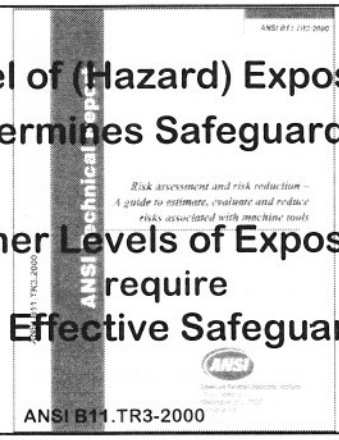



www.rockfordsystems.com

ANSI B11.TR3-2000 Risk Assessment/Risk Reduction

**Level of (Hazard) Exposure Determines Safeguarding**

**Higher Levels of Exposure require More Effective Safeguarding**




www.rockfordsystems.com

ANSI B11.TR3-2000

# Residual Risk

**remaining** risk after protective measures have been taken

# Acceptable Risk

additional expenditure of resources will not result in significant advantages of increased safety.

Acceptable (tolerable) risk to one company may not be to another

www.rockfordsystems.com

ANSI B11.TR3-2000

www.rockfordsystems.com

## B11-2008 6.7 Achieving Acceptable Risk

- High Risk - only acceptable when all reasonable alternatives/ options (protective measures) have been reviewed and deemed impracticable or infeasible
- Medium Risk - undesirable but permissible when all reasonable alternatives/options (protective measures) have been formally reviewed and accepted by relevant stakeholders
- Low Risk - usually acceptable
- Negligible Risk - acceptable

*Informative Note 2: Acceptable risk is fundamentally a business decision made by each supplier or user in the context of their own unique circumstances. The following structure is one example of a practical application of acceptable risk:*

# 6.6 Assess Residual Risk

## Incentives to defeat or circumvent protective measures may include:

- protective measures prevent the task from being performed
- task was not identified and assessed for all hazards and risks
- protective measure slows down production
- protective measure interferes with user preferences
- protective measure is difficult or awkward to use
- additional personnel are needed to perform the task; operator resets safeguard while maintenance man inside the hazard area safeguards intended to protect only one person are used for more than one
- protective measure or its hazard not recognized as such by personnel
- protective measure not accepted as suitable, necessary, or appropriate

ANSI B11.0 - 2010



Annex A - Guide for the Risk Assessment Process

## Forming a Risk Assessment Team

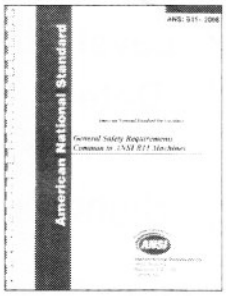
Assessing risk requires the reasoned judgment and expertise of a team of individuals with a variety of experience. Team size should be proportional to system complexity and the degree of risk. Members should be people who:

- can answer technical questions about machinery design and function
- have actual experience of how machinery is setup, operated, maintained
- have knowledge of machine processes and hardware and their limits
- have knowledge of incident history of this type of machinery
- have a good understanding of relevant safety regulations and standards
- are aware of specific safety issues associated with this type of machinery
- understand human factors and ergonomic issues regarding machinery



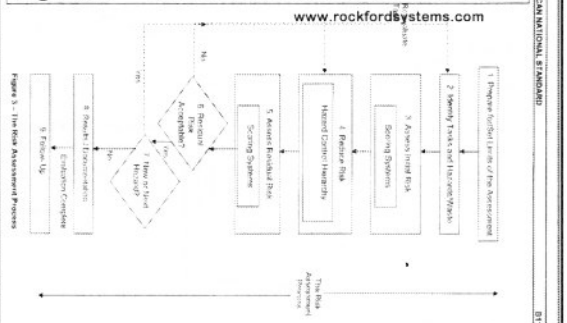
## General

"Safe" is the state of being protected from recognized hazards that are likely to cause serious physical harm. There is no such thing as being absolutely safe, that is, a complete absence of risk. In turn, there is no machine tool that is absolutely safe. All machines contain hazards, and some level of residual risk. However, the risk associated with those hazards should be reduced to an acceptable level.

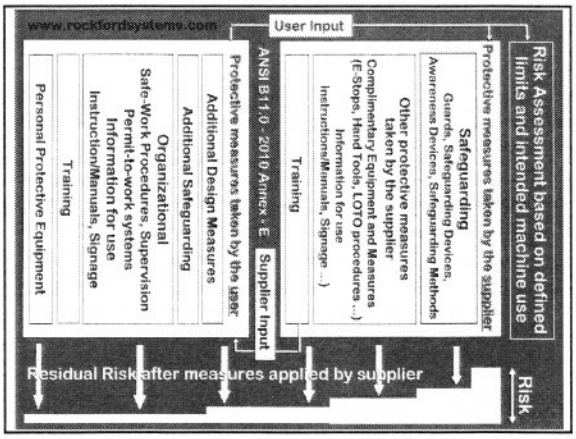





## Figure 3 – The Risk Assessment Process




B11-2008 GSR (General Safety Requirements)




## 5 concerns on any machine

**Safeguarding** - guard, device, method

**Controls** - control reliability

**Disconnect** and other LOTO devices

**Starter** - magnetic (drop-out protection)

**Covers** - rotating components covered to (7 feet - OSHA) from floor/working platform (8 feet - ANSI) (10 feet – European Stds.)

# Light Curtain
## Presence Sensing Devices

**Prevent initiation** — if sensing field is obstructed prior to cycle initiation

and

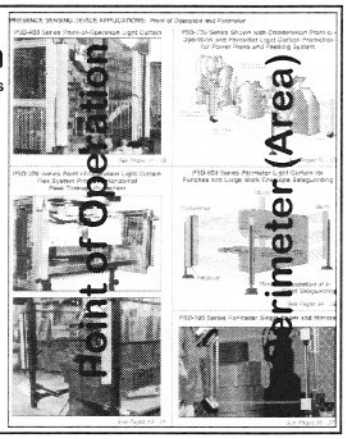
**Stop hazardous motion** — if sensing field is obstructed after cycle initiation

www.rockfordsystems.com

## Light Curtain
Presence Sensing Devices

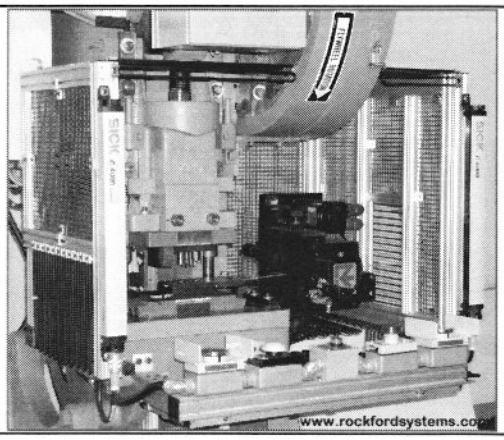
can only be used on machines that can stop consistently and immediately anywhere in their stroke or cycle

without damaging: machine - tooling – work or creating another hazard




www.rockfordsystems.com

Light Curtain-Single or Continuous



Two-hand Control for Cycle Actuation / Safeguarding

www.rockfordsystems.com

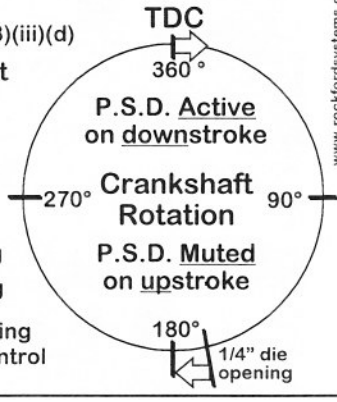
## Light Curtain
## Muting (c)(3)(iii)(d)

Bypasses output signal of P.S.D. on upstroke

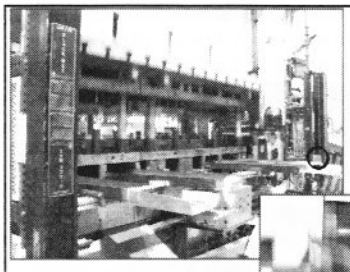
Muting used for:

1) parts ejection
2) circuit checking
3) material feeding

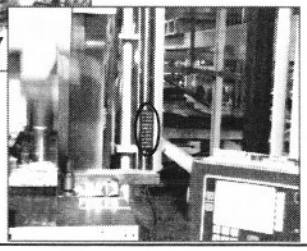
Muting done in timing circuit of press control




www.rockfordsystems.com



## Light Curtain Blanking



www.rockfordsystems.com

Blankers increase Safety Distance

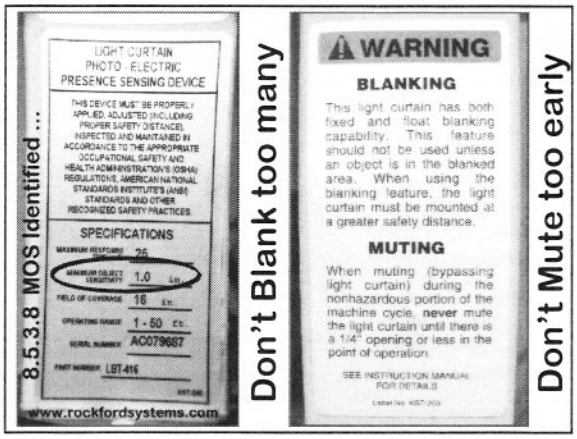
One Example

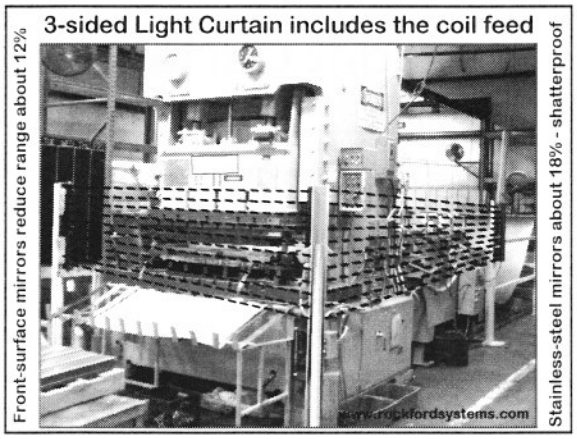
Red: obstructed

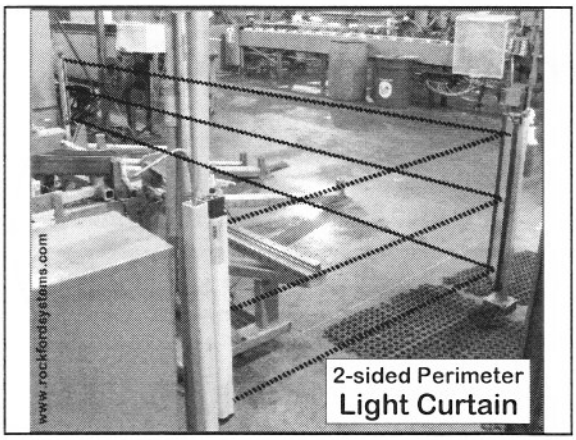
Amber: blanking

Green: clear

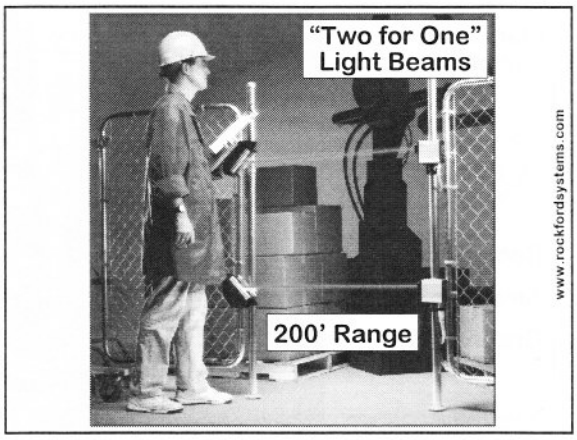
www.rockfordsystems.com


8.5.3.8 MOS Identified ...
LIGHT CURTAIN
PHOTO - ELECTRIC
PRESENCE SENSING DEVICE
THIS DEVICE MUST BE PROPERLY APPLIED, ADJUSTED (INCLUDING PROPER SAFETY DISTANCE), INSPECTED AND MAINTAINED IN ACCORDANCE TO THE APPROPRIATE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION'S (OSHA) REGULATIONS, AMERICAN NATIONAL STANDARDS INSTITUTE'S (ANSI) STANDARDS AND OTHER RECOGNIZED SAFETY PRACTICES.
SPECIFICATIONS
MINIMUM OBJECT SENSITIVITY 1.0
FIELD OF COVERAGE 16
OPERATING RANGE 1 - 50
SERIAL NUMBER AC079687
PART NUMBER LBT-416
www.rockfordsystems.com
Don't Blank too many
WARNING
BLANKING
This light curtain has both fixed and float blanking capability. This feature should not be used unless an object is in the blanked area. When using the blanking feature, the light curtain must be mounted at a greater safety distance.
MUTING
When muting (bypassing light curtain) during the nonhazardous portion of the machine cycle, never mute the light curtain until there is a 1/4" opening or less in the point of operation.
SEE INSTRUCTION MANUAL FOR DETAILS
Don't Mute too early

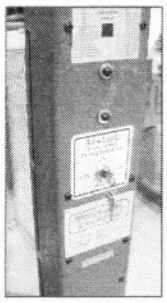

3-sided Light Curtain includes the coil feed
Front-surface mirrors reduce range about 12%
Stainless-steel mirrors about 18% - shatterproof
www.rockfordsystems.com

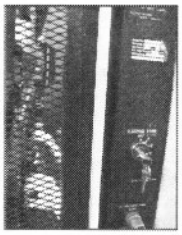

www.rockfordsystems.com
2-sided Perimeter
Light Curtain

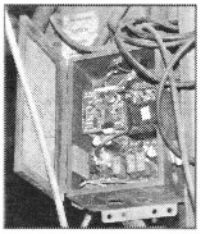
www.rockfordsystems.com
Two Light Beams with corner mirrors for three-sided protection
Railings protect the Light Beams and Mirrors


"Two for One"
Light Beams
200' Range
www.rockfordsystems.com

Bottom rails prevent a hand from reaching under LC's "effective zone"
No protection below this line
www.rockfordsystems.com







Don't leave Blanking keys in Light Curtain selectors

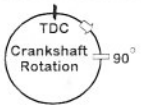
Unless all the key does is Reset the Light Curtain after being interrupted

www.rockfordsystems.com

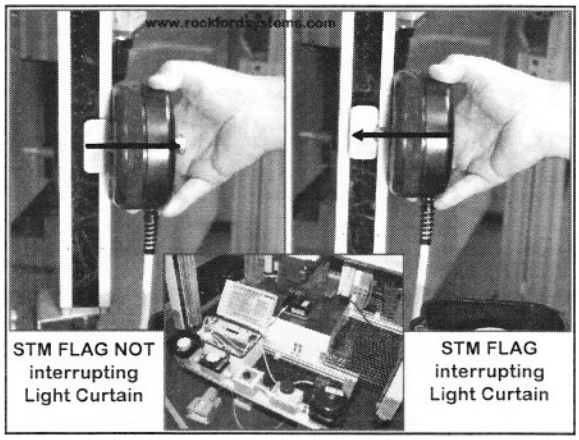
## OSHA Safety Distance Formula
### Light Curtains or 2 Hand Controls

Stopping Time in seconds at 90° crankshaft position
x 63 inches per second (hand speed constant)
= minimum safety distance in inches

**.200 x 63 = 12.6" Safety Distance**




www.rockfordsystems.com




## ANSI B11.1 - 2009 E6.5.3 (16) Safety Distance for a Light Curtain Presence Sensing Device

**(.200 + .020 + .020) x 63 + 2.5 = 17.62"**

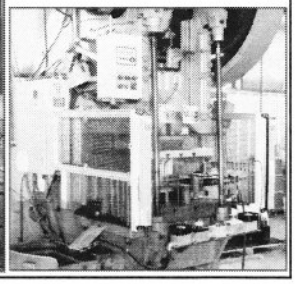
$T_s$ press and $T_c$ press control
$T_r$ light curtain (tag or flag)
$T_{bm}$ added for brake monitor
K hand speed constant
$D_{pf}$ penetration depth factor
$D_s$ Minimum Safety Distance

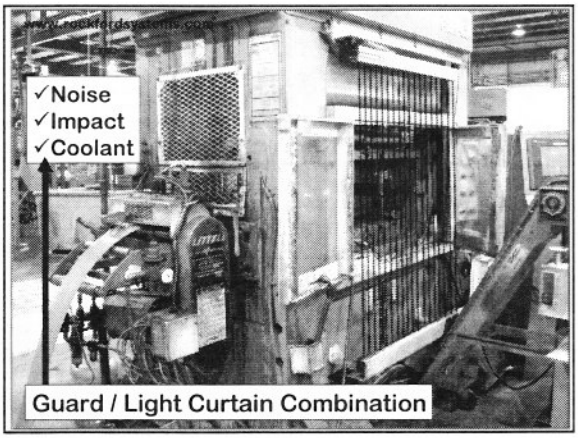
$$D_S = K\,(T_S + T_C + T_r + T_{bm}) + D_{pf}$$

www.rockfordsystems.com

## Light Curtain for Safeguarding in Continuous Mode

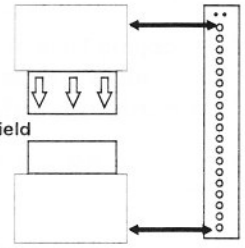
no protection from flying objects





## Light Curtain Pass-through Protection

If Operator can get in between LC sensing field and machine, more safeguarding is required:

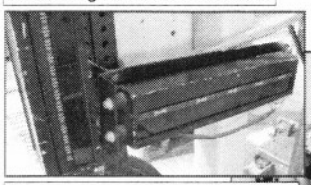


- manual reset outside sensing field
- additional barrier guards
- additional light curtains
- safety mats or other devices
- operator(s) controls outside the sensing field of light curtain

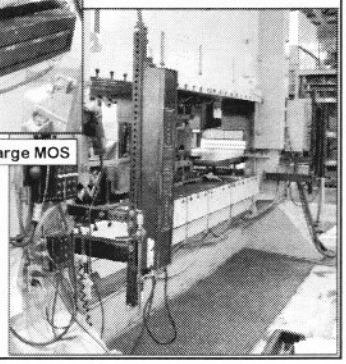
www.rockfordsystems.com

Vertical Light Curtain - Small MOS

www.rockfordsystems.com



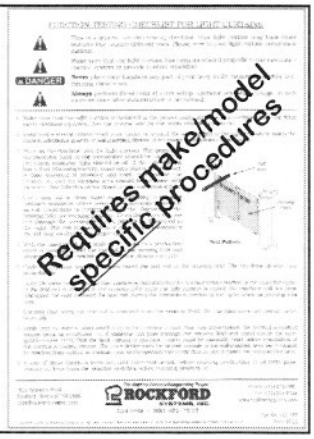
Horizontal Light Curtain - Large MOS



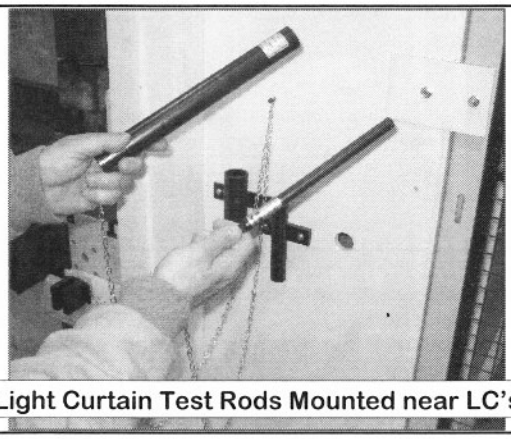
MOS = Minimum Object Sensitivity differs for each make/model of Light Curtain

## Function Testing Light Curtains

Function Test Checklist steps on this plastic-laminated quick-reference guide are generic. Refer to make model specific function test procedures from the manufacturer of your light curtain

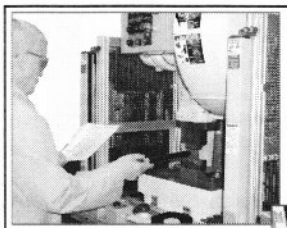



www.rockfordsystems.com



www.rockfordsystems.com

Light Curtain Test Rods Mounted near LC's



Light Curtains should be only be installed, checked out, and maintained by a "Qualified Person"

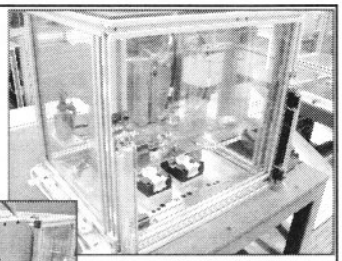
"a person or persons who, by possession of a recognized degree or certificate of professional training, or who, by extensive knowledge, training, or experience, has successfully demonstrated the ability to solve problems relating to the subject matter and work." ANSI B30.2-1983

## Light Curtain "Function Testing" Procedure

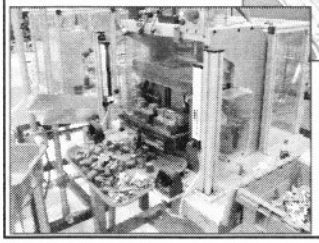
ANSI B11.1-2001 8.3.1 Guards and devices must be checked ...

www.rockfordsystems.com

Light Curtain and Manual Gate protect Operator

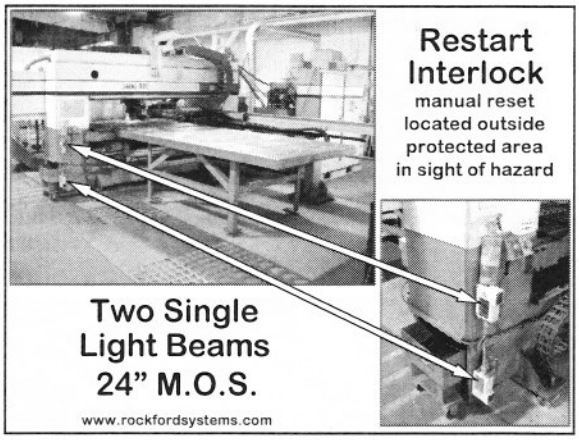


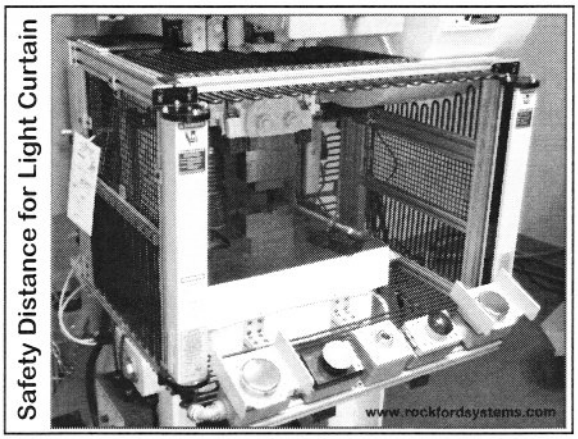
Lexan Guarding keeps other people out of POO

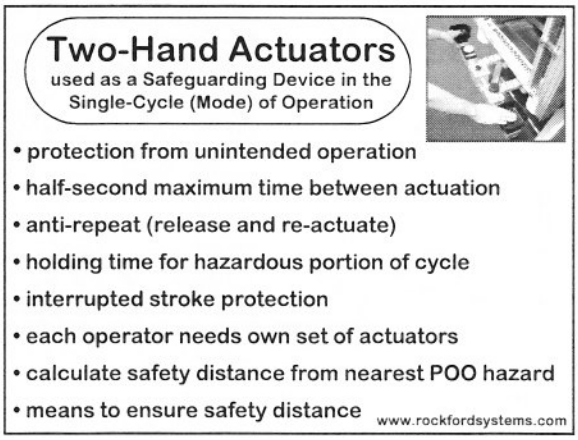


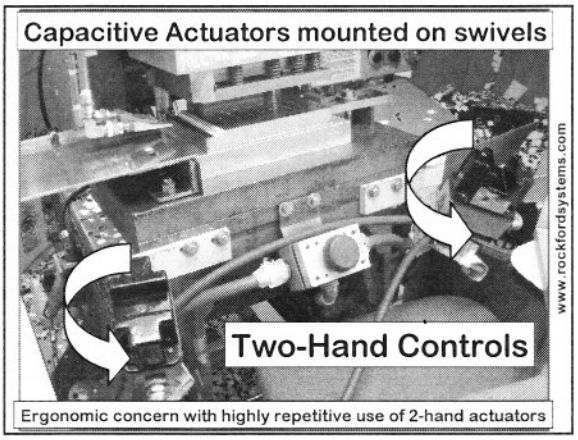
www.rockfordsystems.com

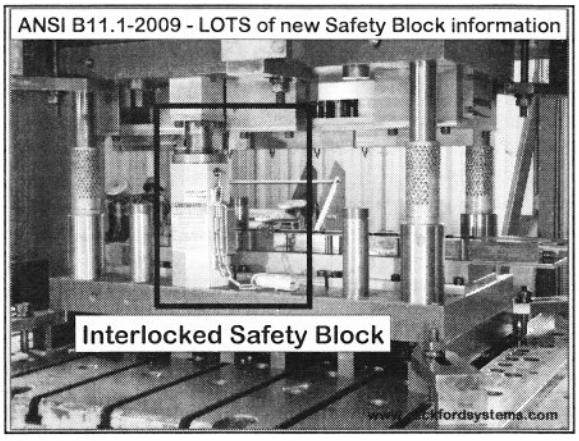
Light Curtain and Two-hand Control protect Operator

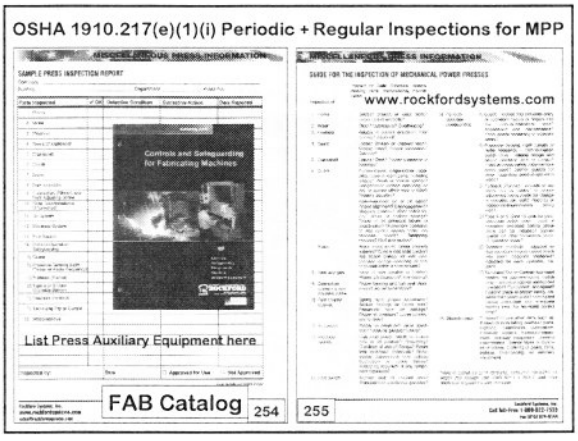

Restart Interlock
manual reset
located outside
protected area
in sight of hazard
Two Single
Light Beams
24" M.O.S.
www.rockfordsystems.com

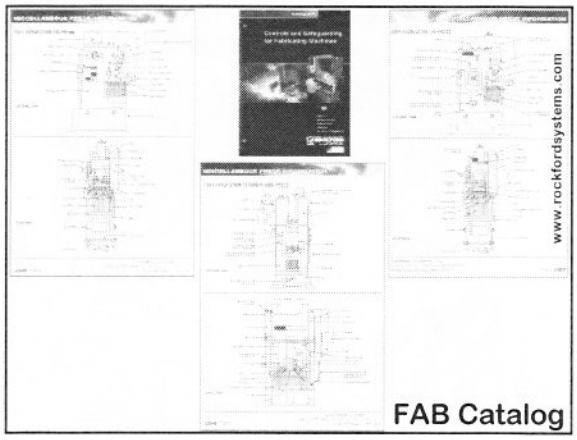

Safety Distance for Light Curtain
www.rockfordsystems.com


Two-Hand Actuators
used as a Safeguarding Device in the
Single-Cycle (Mode) of Operation
• protection from unintended operation
• half-second maximum time between actuation
• anti-repeat (release and re-actuate)
• holding time for hazardous portion of cycle
• interrupted stroke protection
• each operator needs own set of actuators
• calculate safety distance from nearest POO hazard
• means to ensure safety distance
www.rockfordsystems.com

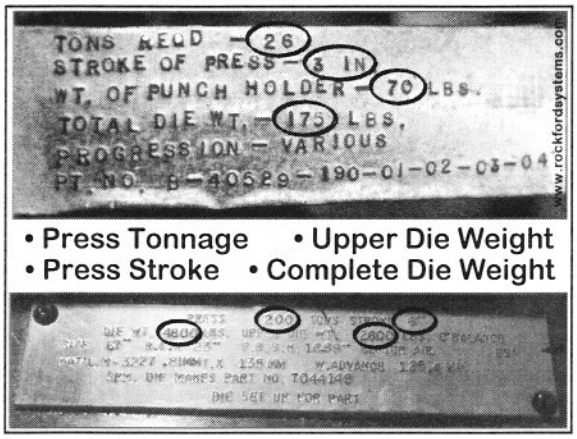

Capacitive Actuators mounted on swivels
Two-Hand Controls
www.rockfordsystems.com
Ergonomic concern with highly repetitive use of 2-hand actuators


ANSI B11.1-2009 - LOTS of new Safety Block information
Interlocked Safety Block


OSHA 1910.217(e)(1)(i) Periodic + Regular Inspections for MPP
www.rockfordsystems.com
Controls and Safeguarding for Fabricating Machines
List Press Auxiliary Equipment here
FAB Catalog
254
255




FAB Catalog




- Press Tonnage
- Upper Die Weight
- Press Stroke
- Complete Die Weight



## Reporting Injuries

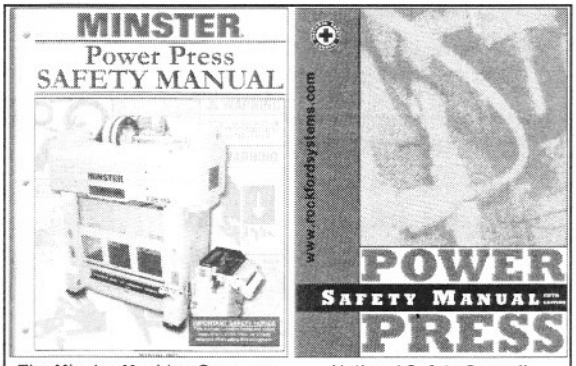
on mechanical power presses
OSHA 1910.217(g)

**POINT OF OPERATION INJURIES**
requiring more than simple first aid

must be reported to
State or Federal OSHA
within 30 days of occurrence

MPPS page 35

www.rockfordsystems.com




The Minster Machine Company
(419) 628-2331 Manual #805D
Minster, OH www.minster.com

National Safety Council
(800) 621-3433 #129760000
Roselle, IL www.nsc.org

## PSDI is allowed on Hydraulic Presses

Follow the guidelines in ANSI B11.2 -1995

www.rockfordsystems.com

## Presence Sensing Device Initiation

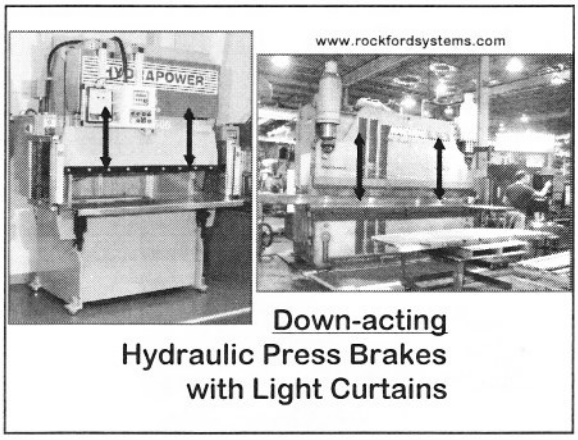
(using a light curtain for press cycle actuation)

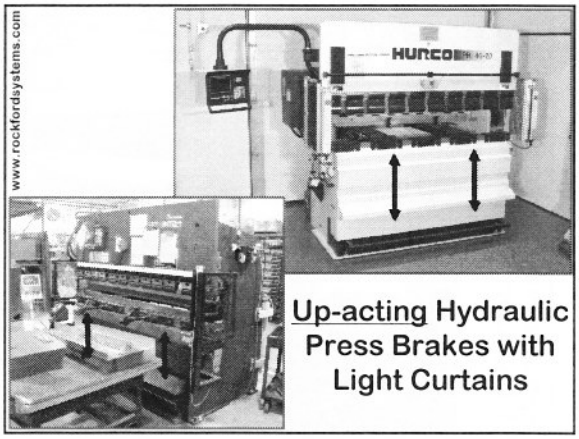
**PSDI IS NOT PERMITTED**
on Mechanical Power Presses because
OSHA 1910.217 (h) requires 3rd Party certification validation (no such 3rd party organization exists)

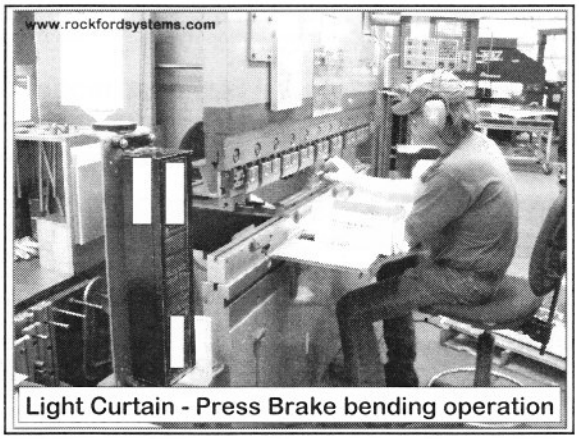
**PSDI PERMITTED on Hydraulic Presses**
because they are excluded from 1910.217 but are covered under ANSI B11.2 - 1995 which allows PSDI providing it is applied correctly

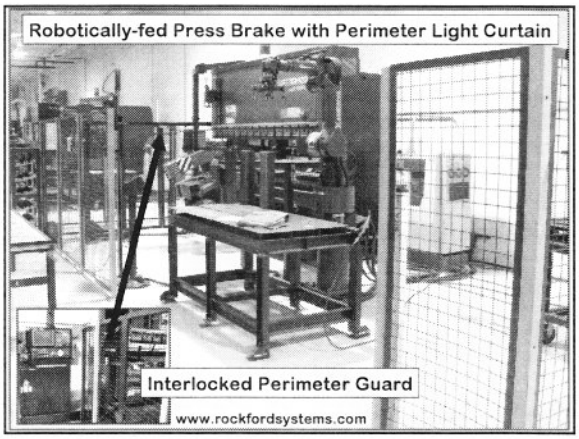
www.rockfordsystems.com

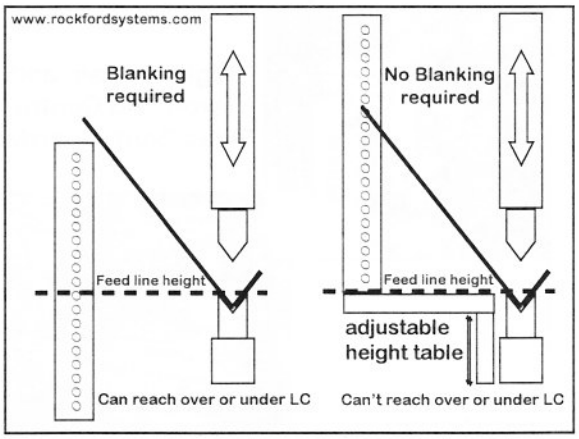
Light Curtains
can be applied to any type of press Brake:
• Air Clutch
• Hydraulic
• Hydra-Mechanical
• Servo-Drive
• Mechanical Friction
(requires new control system)
ANSI B11.3 – 2002 8.6.2
www.rockfordsystems.com


www.rockfordsystems.com
Down-acting
Hydraulic Press Brakes
with Light Curtains


www.rockfordsystems.com
Up-acting Hydraulic
Press Brakes with
Light Curtains

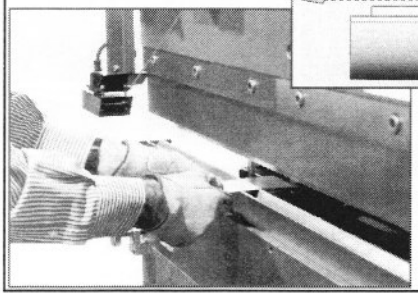

www.rockfordsystems.com
Light Curtain - Press Brake bending operation

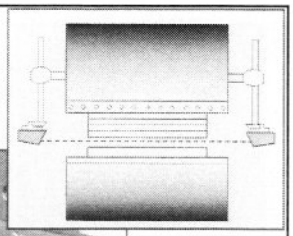

Robotically-fed Press Brake with Perimeter Light Curtain
Interlocked Perimeter Guard
www.rockfordsystems.com


www.rockfordsystems.com
Blanking
required
Feed line height
Can reach over or under LC
No Blanking
required
Feed line height
adjustable
height table
Can't reach over or under LC

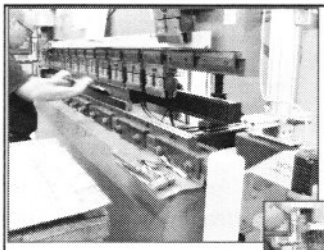
## LazerSafe

Safeguarding System
ONLY FOR HYDRAULIC
PRESS BRAKES





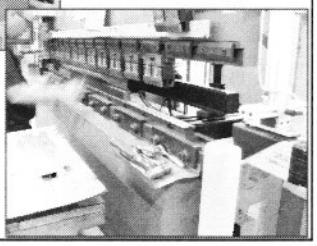
www.rockfordsystems.com

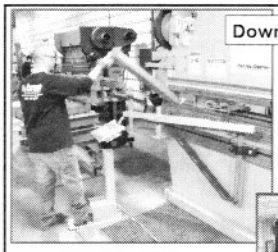


SICK V-4000
Laser Device
allows for
hand-holding
small parts on
HYDRAULIC PB's

Light Curtain
would require
EXCESSIVE
BLANKING

www.rockfordsystems.com



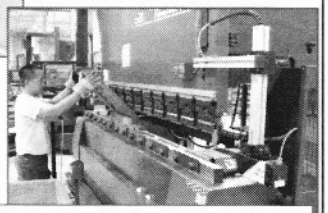


Down-acting Hydraulic Press Brake

- Standard mode
- Box mode
- Back-gauge mode

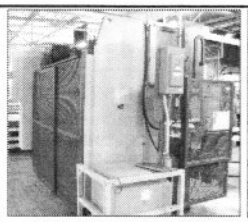
"Box Mode"
for parts
with tall
side-legs

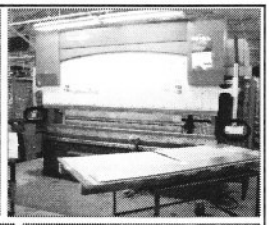
www.rockfordsystems.com

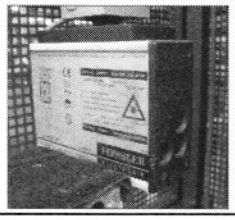


Up-Acting Hydraulic Press Brake

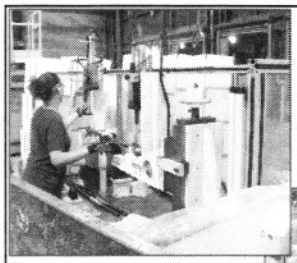
Hydraulic Press Brake with Fiessler
P.O.O. Laser Safeguarding Device



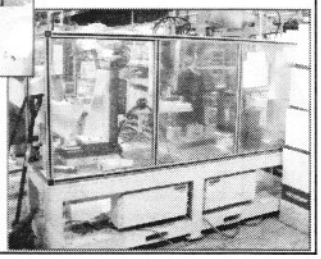




www.rockfordsystems.com



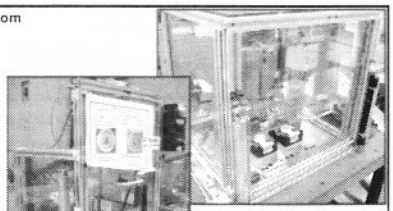
Light Curtain and
Two-hand Control
Sides/Back Guarded

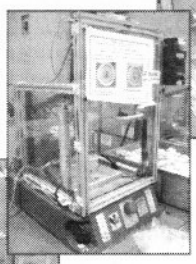


www.rockfordsystems.com

www.rockfordsystems.com

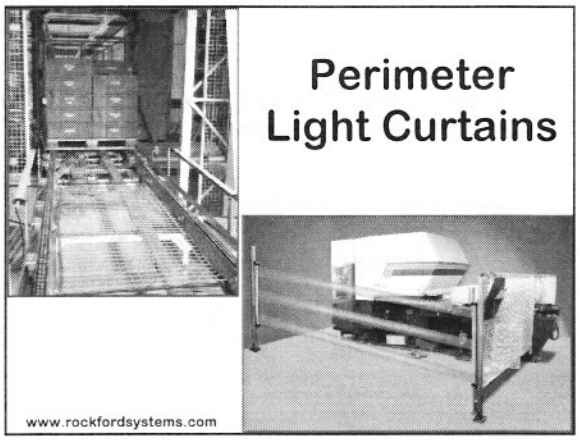
Manual Gate and
Two-hand Control

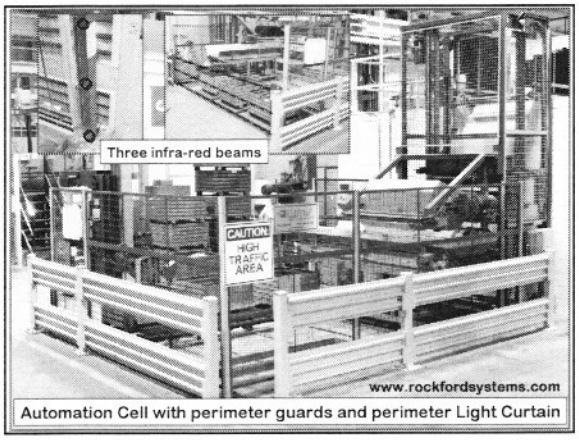


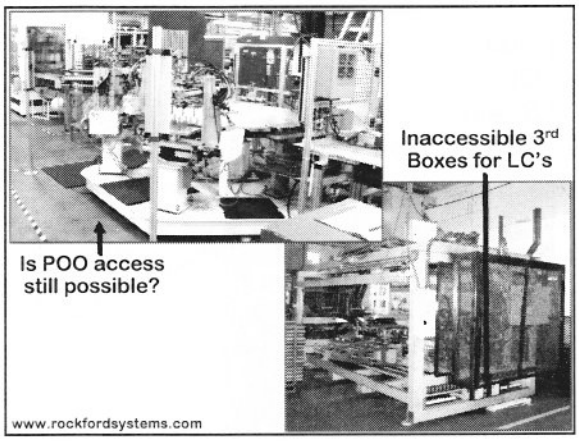


Light Curtain and
a Manual Gate

Light Curtain and
Two-hand Control






## Presence Sensing Safeguarding Devices

PSSD's

- ❑ Safety Light Curtains / Screens
- ❑ Single and Multiple Safety Beams
- ❑ Safety Mat Systems
- ❑ Area Scanning Systems — Area Laser Scanners
- ❑ Radio Frequency (capacitance)
- ❑ Drop Probe (Ring Drop) devices

www.rockfordsystems.com

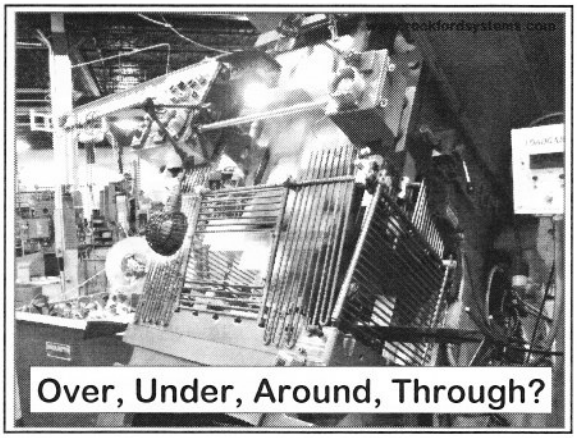
## Point of Operation Guard Requirements

OSHA 1910.217(c)(2) and ANSI B11.1-2009(8)(5)

- can't reach through, over, under, around
- meets Table 0-10 for openings and distances
- no pinch points between guard & moving parts
- good visibility into the point of operation
- fasteners not readily removable (tool required)
- *materials strong enough to protect people
- *free from sharp edges that could injure people

MPPS pages 26-28

www.rockfordsystems.com




## OSHA Guard Opening Scale – 1948

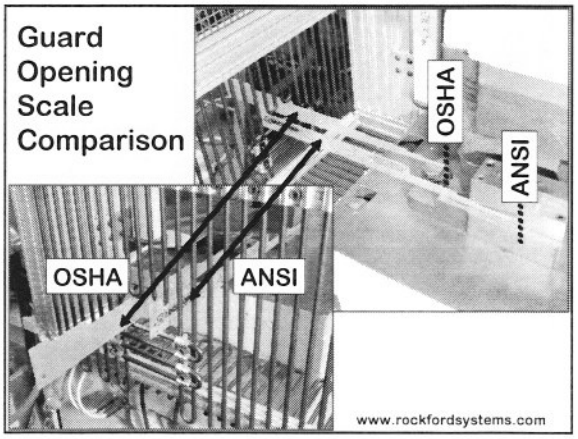
Liberty Mutual and ANSI Standard writing committee

## ANSI Guard Opening Scale – 1996

Liberty Mutual and ANSI Standard writing committee

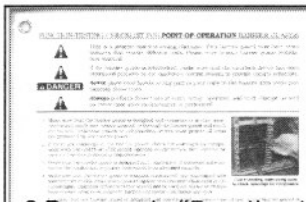
www.rockfordsystems.com

## Guard Opening Scale Comparison




## Function Testing

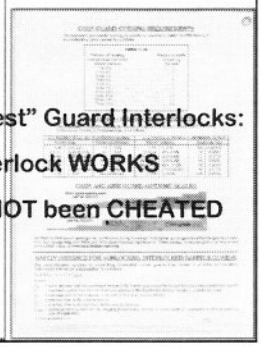
Point of operation Guard



2 Reasons to "Function-test" Guard Interlocks:

1) to make sure the interlock WORKS

2) to make sure it has NOT been CHEATED



www.rockfordsystems.com

7.9.2.1 When tasks such as start-up, set-up, repair, adjustment or maintenance require removing, disabling, bypassing, suspending one or more safeguards, alternative protective measures shall be required. Only properly trained and authorized personnel shall be allowed access to a hazard area. The bypass process shall be documented and shall include specific procedures and appropriate training of personnel . . . safeguards shall be restored . . . prior to resumption of normal operation.

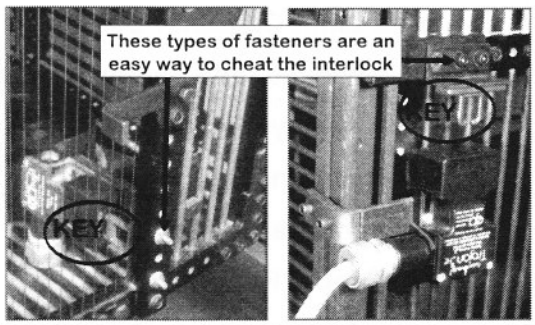
www.rockfordsystems.com

ANSI B11.0 - 2010

## Newer Guard Interlock Switches

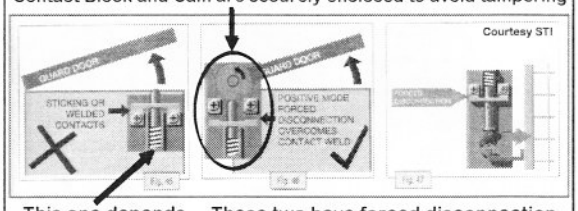
KEY geometry makes it difficult to defeat

KEY forces a make/break of electrical contacts




www.rockfordsystems.com

Contact Block and Cam are securely enclosed to avoid tampering




This one depends only upon a spring

These two have forced disconnection (if spring breaks – fails to safe condition)

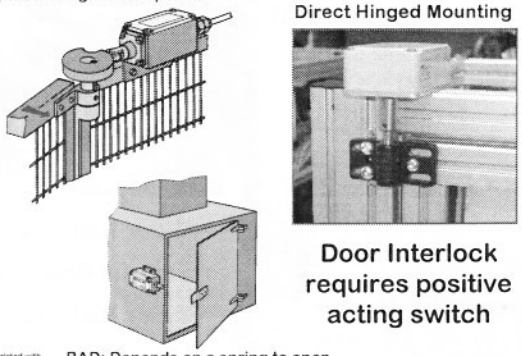
"Positive Mode Guarding" ensures that the interlock switch contacts are physically pulled apart or "Force Disconnected" by the movement of the guard

www.rockfordsystems.com

GOOD: Forces contacts apart when guard is opened

www.rockfordsystems.com

Direct Hinged Mounting



Door Interlock requires positive acting switch

reprinted with permission SICK Inc.

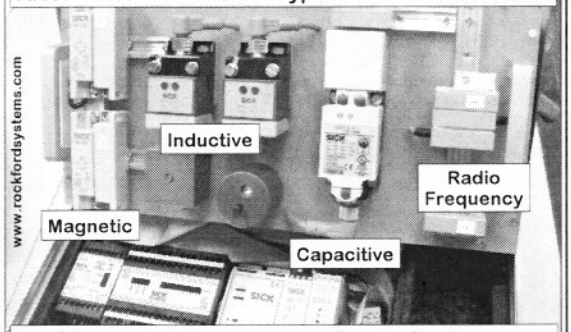
BAD: Depends on a spring to open contacts when guard is opened

SICK Incorporated

www.rockfordsystems.com

ANSI B11.1-2009 8.5.5.8 Types of Interlock Devices

www.rockfordsystems.com




ANSI B11.1-2009 8.5.5.7 d) interlocks must be tamper resistant . . . not easily bypassed

## Guard Interlock Safety Switches:

Tongue: tongue (key-shaped) actuator must be inserted and removed for switch operation

Hinge: mounted on hinge pin of guard door and uses opening motion of door to actuate

Latching: locks guard door closed and delays it's opening until hazardous machine motion is complete (run-down) before interlock opens

Non-contact: no physical contact required to actuate these capacitive or magnetic switches; sometimes "coded" to decrease tampering

Position (limit switch): linear or rotary cam operated in a positive mode often used on sliding guards

Trapped Key: control or power interlocks which require a specific sequence of de-energization

www.rockfordsystems.com Rockwell Automation - Allen Bradley Safebook 3 - 2009

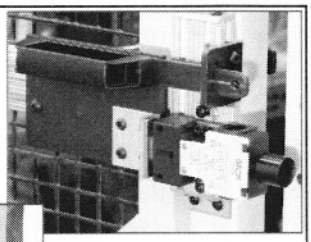
www.rockfordsystems.com

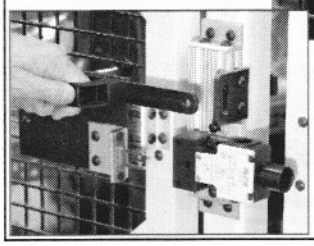
EN 954-1 Safety Related Parts of Control Systems

| | | | |
|---|---|---|---|
| | **Category B** Prevention of faults | safety-related parts of machine and safeguards – components withstand environment | PREVENTION of faults |
| | **Category 1** Prevention of faults | well tried safety components and principles | PREVENTION of faults |
| Mats | **Category 2** Detection of faults | components monitored before machine start-up and periodically | DETECTION of faults |
| Grd Int | **Category 3** Detection of faults | dual/monitored system of critical components – single fault does not lead to loss of safety function | DETECTION of faults |
| IR-LC | **Category 4** Detection of faults | dual/monitored system with all foreseeable faults detected | DETECTION of faults |

www.rockfordsystems.com

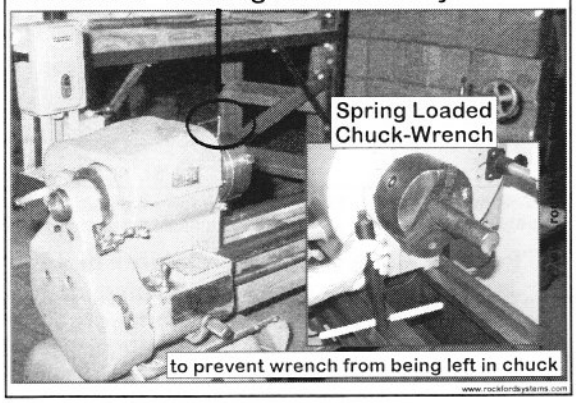
## Risk Assessment for Interlock Reliability

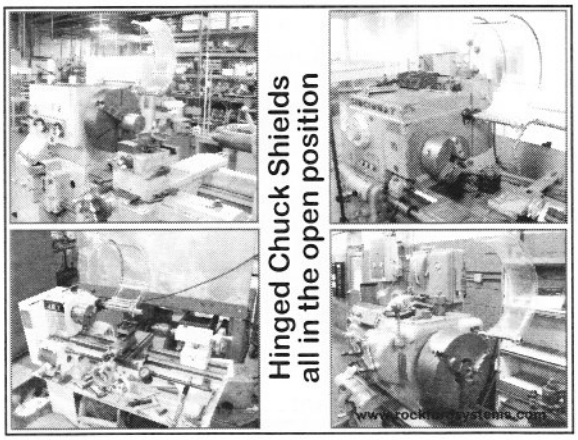


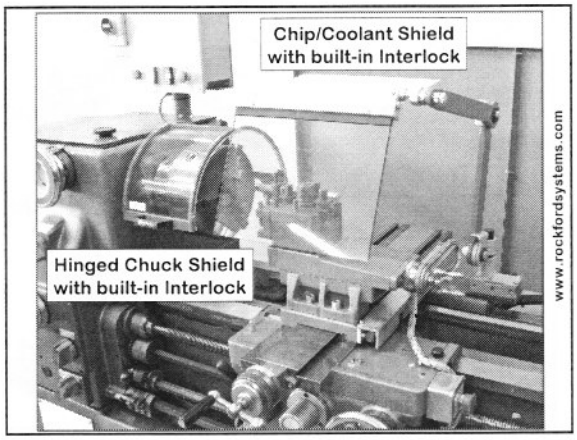


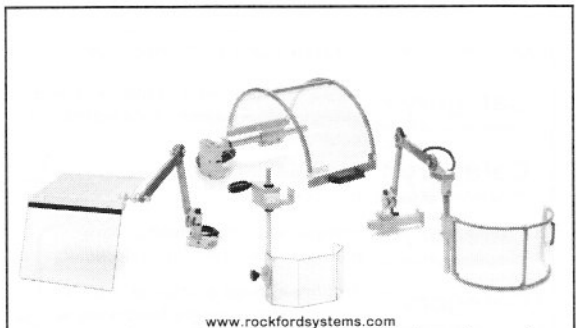
- Minor Risk – Cat. 1
- Serious Risk – Cat. 2
- Major Risk – Cat. 3
- Fatal Risk – Cat. 3

## #1 Hazard - starting lathe with key in chuck



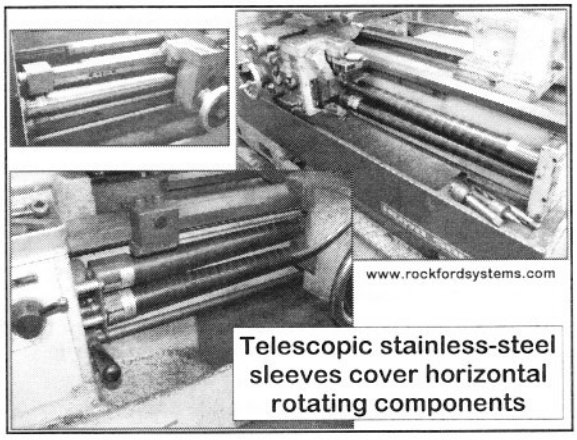



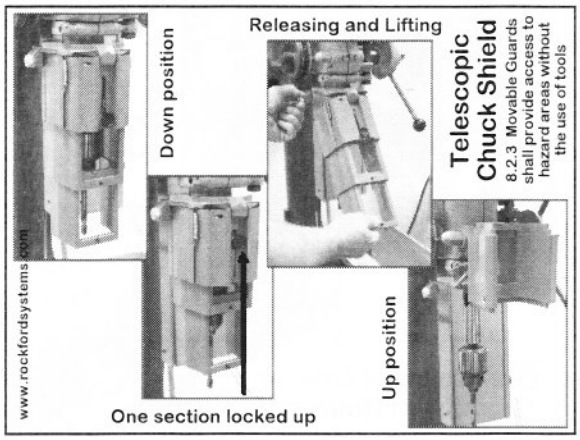



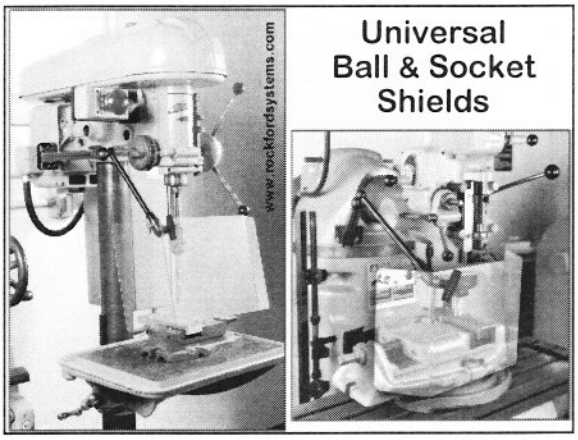



www.rockfordsystems.com

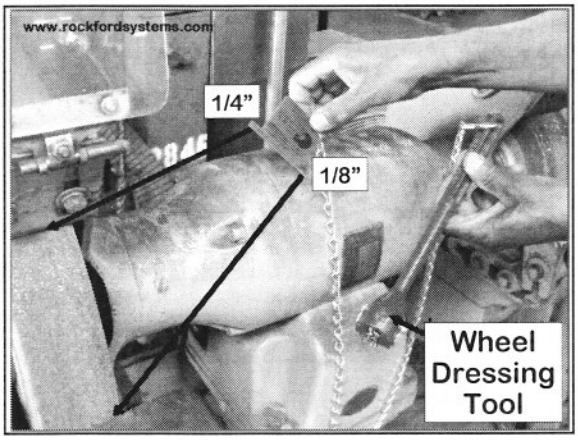
## Shields with built-in Interlocks

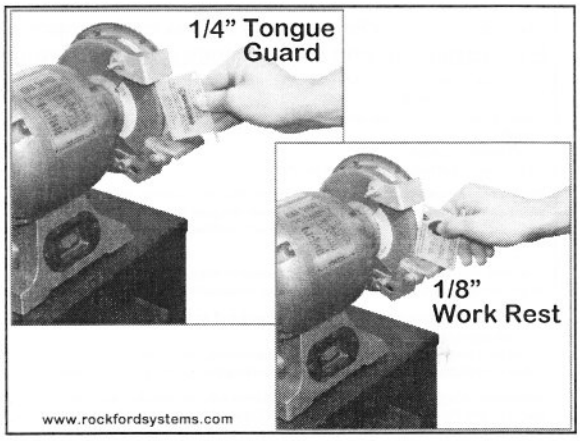


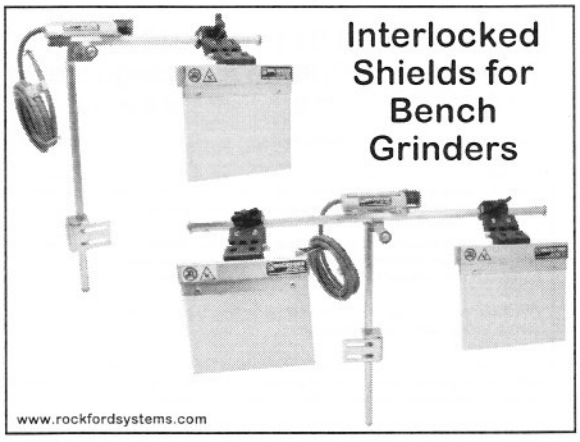

Releasing and Lifting
Down position
Telescopic Chuck Shield
8.2.3 Movable Guards shall provide access to hazard areas without the use of tools
Up position
One section locked up
www.rockfordsystems.com


Universal Ball & Socket Shields
www.rockfordsystems.com

ANSI B7.1-2000 Abrasive Wheels
ANSI B11.9-2010 Grinding Machines
1/4" maximum opening
Both ANSI Standards
Covered spindle end/nut
OSHA 1910.215 (a)(2)(i)
Direction Arrow
Both ANSI Standards
www.rockfordsystems.com
1/8" maximum opening for Work Rest
#1 OSHA Machine Safeguarding violation-every state in the U.S.A.
OSHA 1910.215 (a)(4)


www.rockfordsystems.com
1/4"
1/8"
Wheel Dressing Tool


1/4" Tongue Guard
1/8" Work Rest
www.rockfordsystems.com

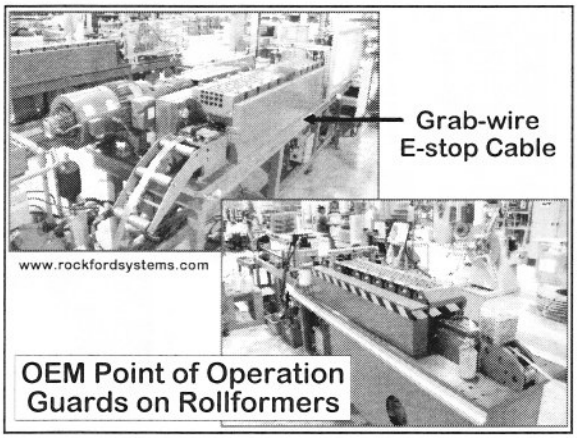

Interlocked Shields for Bench Grinders
www.rockfordsystems.com

Metal Blade Guard provided by OEM

ANSI B11.10 - Metal Saws

Polycarbonate Shield added by end-user

www.rockfordsystems.com




www.rockfordsystems.com

OEM Point of Operation Guards on Rollformers

www.rockfordsystems.com

## American National Standard ANSI B11.19 - 2010

Performance Criteria for Safeguarding

OSHA 1910.212 General Requirements for All Machines
OSHA 1910.219 Mechanical Power Transmission Apparatus
NFPA 79 2007 Electrical Standard for Industrial Machinery

Point of Operation Safeguarding: Guards (all types), Devices (all types), Distance (Safe holding), Operator location, Safe Opening

## Safeguarding Applications and Attributes

ANSI B11.19-2010 Annex F has bullet points on each

- Shields
- Fixed Guard
- Interlocked Guard
- Adjustable Guard
- Type "A" Movable Barrier
- Type "B" Movable Barrier
- Presence Sensing Devices
- Single Trip Device
- Restraint Device
- Drop-Probe Device
- Two-Hand Control Device
- Two-Hand Trip Device
- Single Control Device
- Awareness Barriers
- Awareness Signals
- Awareness Signs
- Safe Distance
- Safe Holding
- Safe Opening
- Safe Work Procedures

www.rockfordsystems.com

## ANSI B11.19 - 2010
## Performance Criteria for Safeguarding
### 13 Inspection and Maintenance of Safeguarding

The user shall document the safeguarding.

www.rockfordsystems.com

The user shall provide maintenance instructions, recommendations, and procedures to maintenance personnel for all safeguarding used to protect individuals from the hazards associated with the machine.

The user shall ensure that the safeguarding is maintained and inspected, and shall ensure the initial training and the continued competency of personnel responsible for the maintenance and inspection of the safeguarding.

Following any maintenance to the safeguarding, the user shall ensure that the safeguarding performs as intended.

When the safeguarding is removed or disabled for maintenance, alternate safeguarding shall be provided to protect maintenance or operating personnel, or other individuals. See ANSI Z244.1 (Control of hazardous energy)

ANSI B11.19-2010 Performance Criteria for Safeguarding

### E13 Inspection and Maintenance of Safeguarding

The documentation of the safeguarding should at minimum, include the following where applicable:

- safety distance calculations
- control schematics
- software program
- records of periodic maintenance checks

www.rockfordsystems.com

The user (who can be the machine supplier that provides or modifies the safeguarding, the integrator of the safeguarding, or the user of the machine) should consider the safeguarding supplier's instructions and recommendations in determining the maintenance program.

The user should determine the period between inspections based on the use of the safeguarding and the safeguarding supplier's recommendations.

Examples of criteria and procedures include but are not limited to verification:

- of the safety distance
- that all safeguarding is in place and functioning correctly
- that complimentary equipment is functioning correctly (e.g. emergency stops).

Alternate safeguarding or lockout/tagout procedures may be required. See 29 CFR 1910.147 and 29 CFR 1910.133(b)(2) for further information.

## ANSI B11.19 - 2010
## Performance Criteria for Safeguarding
### 14 Training on the Use of Safeguarding

The user shall ensure that an appropriate training program is developed for operators, helpers, maintenance personnel , supervisors and other individuals who may be exposed to the hazards of the machine.

The user shall ensure that individuals listed above are trained based on the program developed.

For those individuals trained above, the user shall verify their understanding and provide for their continued competency.

Individuals listed above shall be responsible for following the training and safety procedures provided by the user in the maintenance and use of safeguarding.

www.rockfordsystems.com

---

ANSI B11.19-2010 Performance Criteria for Safeguarding

### E14 Training on the Use of Safeguarding

The user should take into account the safeguarding supplier's instructions, specifications, recommendations, etc., when developing a training program.

Training should include, but not be limited to:

- types of safeguarding
- capabilities/options of safeguarding
- description of safeguarding for specific application and hazard
- function of the safeguarding
- proper installation and operation of the safeguarding
- functional testing of the safeguarding
- limitations of the safeguarding
- abnormal or unexpected operation of the safeguarding

www.rockfordsystems.com

---

## ANSI B11.19 - 2010 6.5
# Perimeter Safeguarding

e.g. perimeter guarding with interlocked gate/door, or electro-optical PSD's; light curtain, laser scanner

. . . used in areas containing single or multiple hazards not individually safeguarded . . . designed to stop/prevent hazardous motion while an individual is in the safeguarded area . . . If pass-through is possible, supplementary safeguarding is required . . . Requires manual reset before hazardous motion can occur (not just closing an interlocked door or clearing a sensing field)

www.rockfordsystems.com

---

## Safeguarding of Personnel & Equipment

- Welding robot cells
- Automatic assembly machines
- Packaging machines
- Tire Manufacturing
- Forklifts, Towmotors, Lift Trucks
- Tube-bending machines
- Press/bolster guarding
- Automatic Storage & Retrieval Systems (ASRS)
- Complex material handling processes
- Shrink-wrap machines
- Palletizing robots
- Carton-making machines
- Automatically Guided Vehicles (AGV's)
- General safety mat replacement

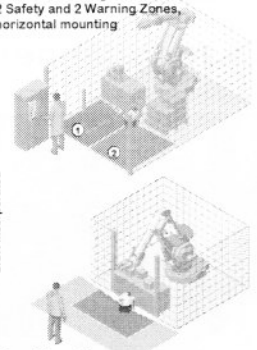
Area Laser Scanner

www.rockfordsystems.com

SICK Incorporated

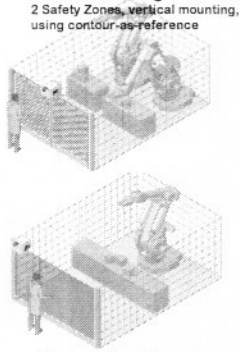
---

Area Guarding:
2 Safety and 2 Warning Zones, horizontal mounting



Area Guarding:
1 Safety and 1 Warning Zone, horizontal mounting

Access Guarding:
2 Safety Zones, vertical mounting, using contour-as-reference



Access Guarding:
1 Safety Zone, vertical mounting, using contour-as-reference

SICK Incorporated

www.rockfordsystems.com

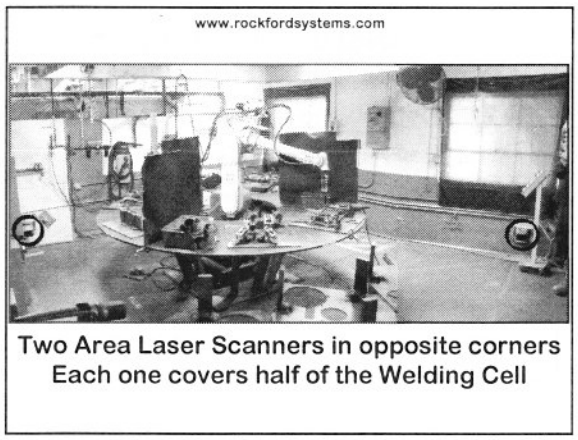
---

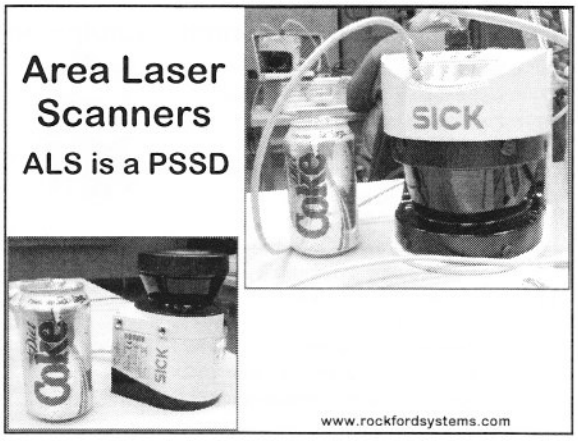
## Area Laser Scanners on AGV's

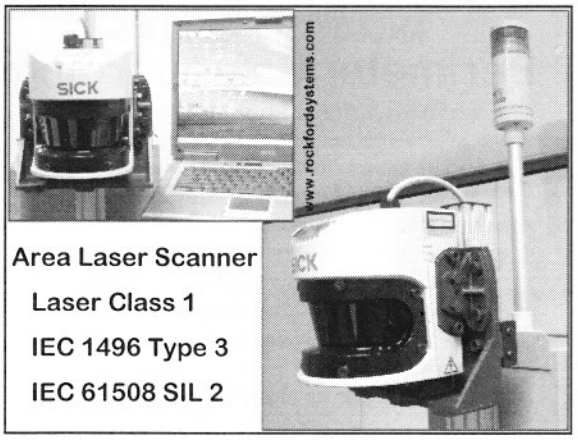
www.rockfordsystems.com

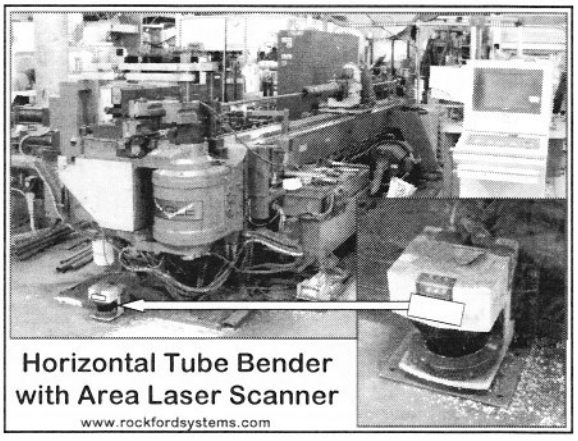
reprinted with permission SICK Inc.

Area
Laser
Scanners
www.rockfordsystems.com


www.rockfordsystems.com
Two Area Laser Scanners in opposite corners
Each one covers half of the Welding Cell

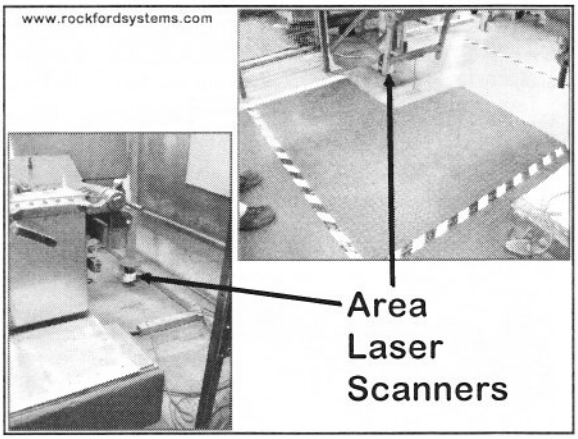

Area Laser
Scanners
ALS is a PSSD
SICK
www.rockfordsystems.com


SICK
www.rockfordsystems.com
Area Laser Scanner
Laser Class 1
IEC 1496 Type 3
IEC 61508 SIL 2

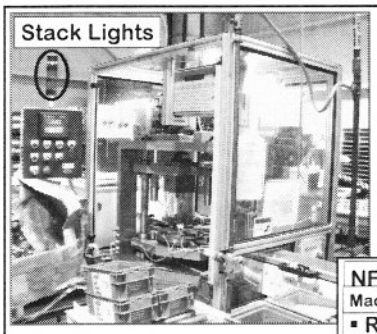

Horizontal Tube Bender
with Area Laser Scanner
www.rockfordsystems.com

www.rockfordsystems.com
Area Laser Scanners
ALS
Pick and Place

www.rockfordsystems.com



Area
Laser
Scanners

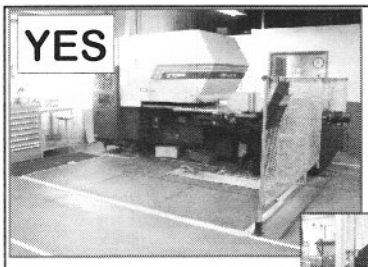



Light Curtain
and
Two- hand
Control

NFPA-79 2007
Machine Indicator Lights
- Red – Danger
- Blue – Action
- Green – Safe
- Yellow – Warning

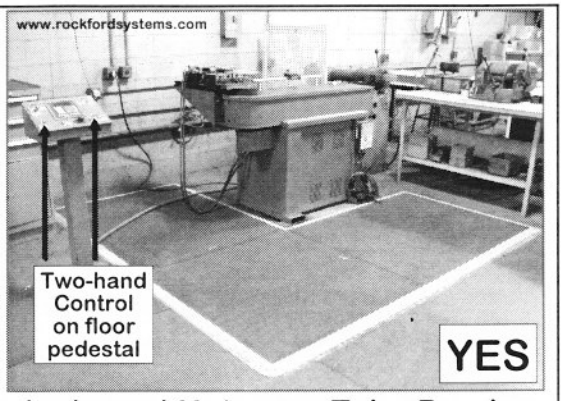
Visual or Audible
Awareness Signals

www.rockfordsystems.com




www.rockfordsystems.com

Pressure
Sensitive
Mats

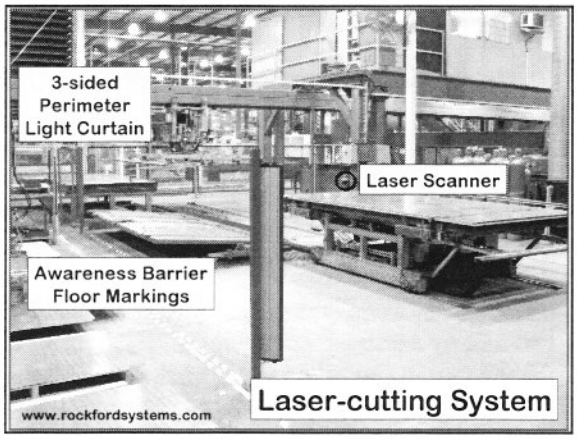


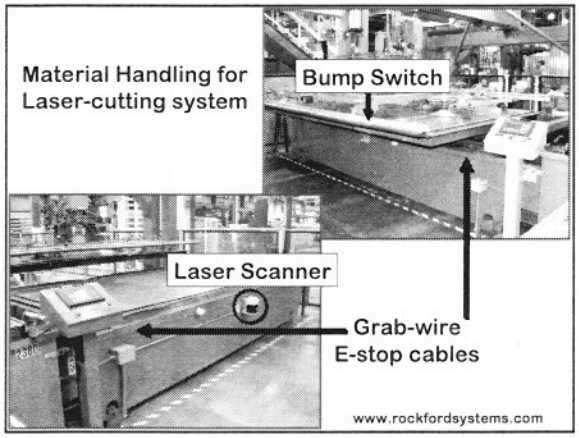

L-shaped Mats on a Tube Bender

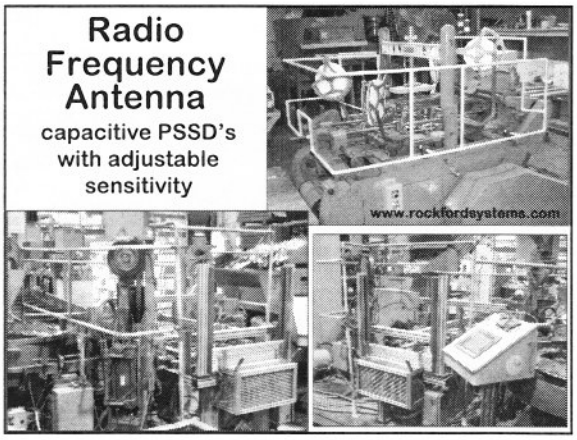
## Safety Mat Devices ANSI B11.19 -2010

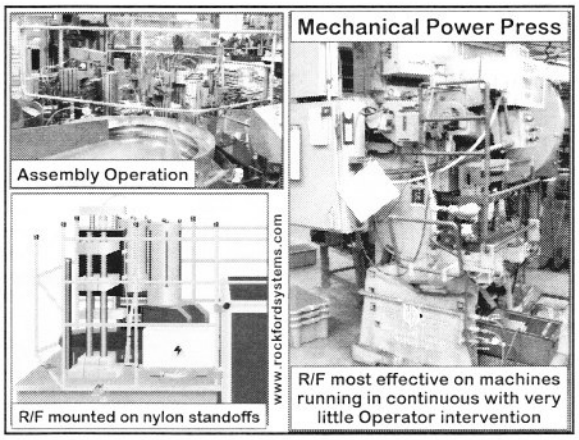
8.5.1.1 Shall not create a hazard in and of itself
E8.5.1 Should detect 66 pounds - 3" disc anywhere on surface
E8.5.1.1 Installation hazards: sharp edges, slipping/tripping, electromagnetic interference, electrical shock
E8.5.1.2 Indicator lamps to show device is functioning
8.5.1.3 Maximum response time remains consistent
8.5.1.4 All components meet Performance of Safety Related Function (8.5.2.5 same)
8.5.2.1 Adjustments shall be capable of supervision
8.5.2.2 Reaching over, under, around mat requires additional safeguarding and shall be adequate width and length to detect individual's entry
E8.5.2.2 Additional safeguarding if individuals can get in between
8.5.2.3 Only authorized individuals may relocate the mat and means to prevent inadvertent movement (like securing mat to floor)
E8.5.2.3 Fixed at a safety distance based on speed of approach, response times of mat device, interface, control system, machine stopping time, depth penetration factor of the (mat) device
8.5.2.4 Manual reset from a location outside the safeguarded space
8.5.2.6 Bypassing conditionally allowed
8.5.2.7 Muting conditionally allowed
8.5.2.8 Foreign materials not under joining strips
8.5.2.9 Mats shall not be used to enable initiation or continuation of hazardous motion

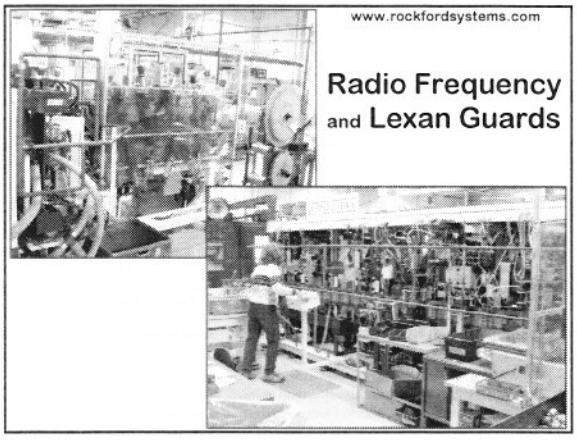
www.rockfordsystems.com

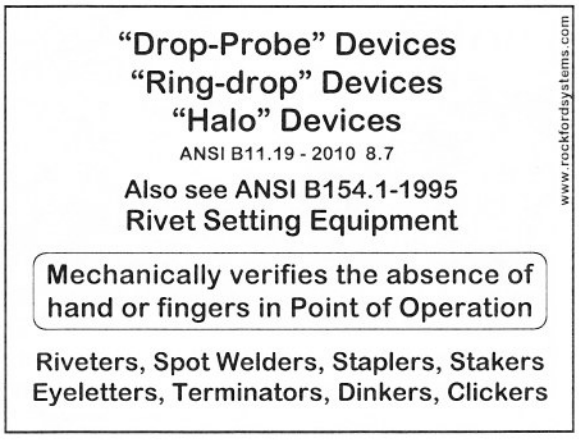

3-sided
Perimeter
Light Curtain
Laser Scanner
Awareness Barrier
Floor Markings
Laser-cutting System
www.rockfordsystems.com


Material Handling for
Laser-cutting system
Bump Switch
Laser Scanner
Grab-wire
E-stop cables
www.rockfordsystems.com


Radio
Frequency
Antenna
capacitive PSSD's
with adjustable
sensitivity
www.rockfordsystems.com

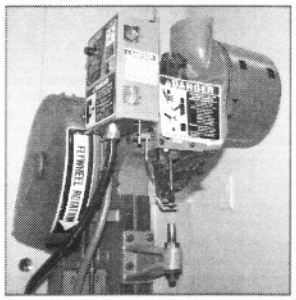

Mechanical Power Press
Assembly Operation
www.rockfordsystems.com
R/F mounted on nylon standoffs
R/F most effective on machines
running in continuous with very
little Operator intervention


www.rockfordsystems.com
Radio Frequency
and Lexan Guards

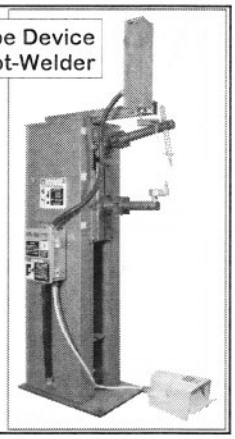

"Drop-Probe" Devices
"Ring-drop" Devices
"Halo" Devices
ANSI B11.19 - 2010 8.7
Also see ANSI B154.1-1995
Rivet Setting Equipment
Mechanically verifies the absence of
hand or fingers in Point of Operation
Riveters, Spot Welders, Staplers, Stakers
Eyeletters, Terminators, Dinkers, Clickers
www.rockfordsystems.com

www.rockfordsystems.com

## Drop-Probe Device on a Spot-Welder

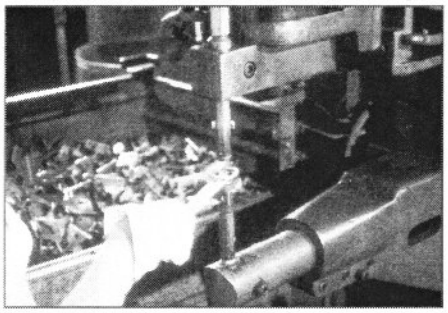


Riveter with a Drop-Probe



Object under probe is thicker than intended piecepart therefore the welder won't cycle

www.rockfordsystems.com



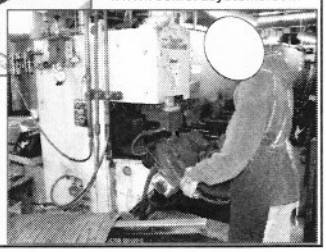
Probe must drop it's full travel - if probe can't drop all the way down, the machine cycle is prevented

www.rockfordsystems.com

Zig-Zag probes prevent fingers from getting above after the drop

## "Safe Holding"?

www.rockfordsystems.com



Part is fixtured with Two-Hand Control

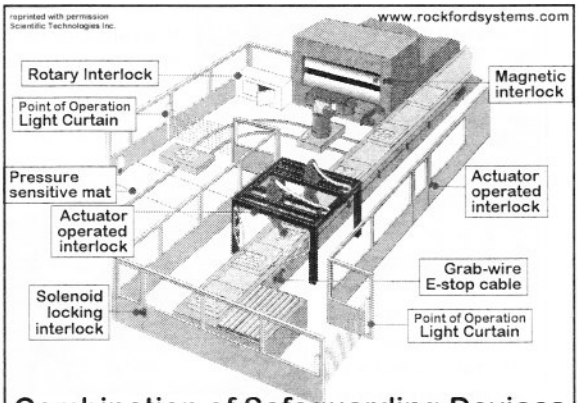
| | | |
|---|---|---|
| Most Effective ↓ Least Effective | 1) Elimination or Substitution | • eliminate human interaction in the process<br>• eliminate pinch points (increase clearance)<br>• automated material handling |
| | 2) Engineering Controls (Safeguarding Technology) | • mechanical hard stops<br>• barriers<br>• interlocks<br>• presence sensing devices<br>• two hand controls |
| | 3) Awareness Means | • lights, beacons, and strobes<br>• computer warnings<br>• restricted space painted on floor<br>• beepers, horns, labels, signs |
| | 4) Training & Procedures (administrative controls) | • safe job procedures<br>• safety equipment inspections<br>• training<br>• lockout |
| | 5) Personal Protective Equipment | • safety glasses<br>• earplugs<br>• face shields<br>• gloves |

www.rockfordsystems.com

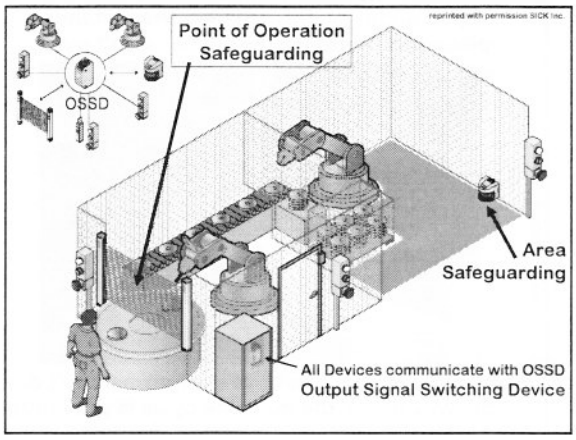
ANSI/RIA R15.06-1999 - Table A.2 - Hierarchy of Safeguarding Controls
"Industrial Robot Safeguarding" available from: www.robotics.org

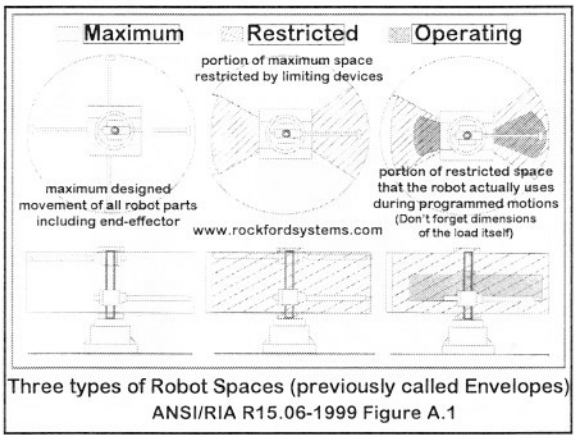
reprinted with permission Scientific Technologies Inc.

www.rockfordsystems.com

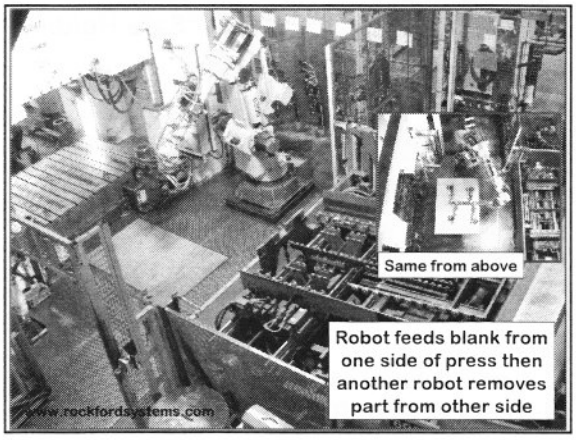


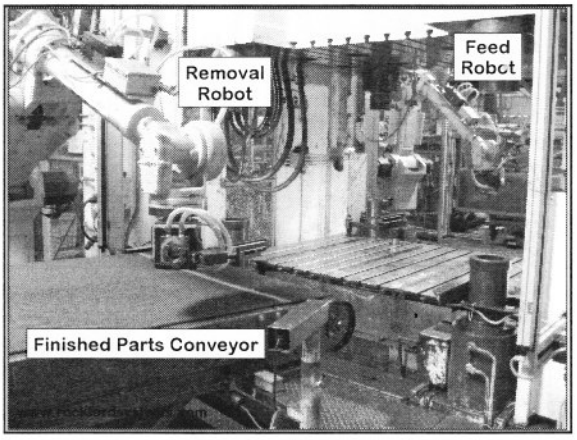

Combination of Safeguarding Devices

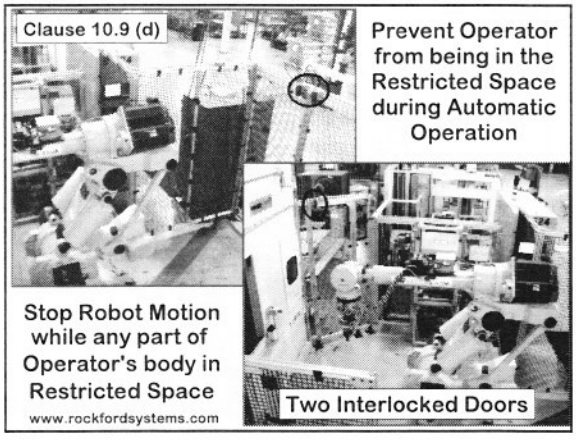


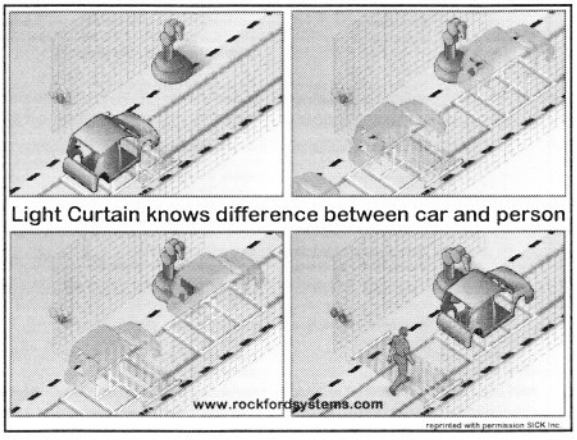



Three types of Robot Spaces (previously called Envelopes)
ANSI/RIA R15.06-1999 Figure A.1

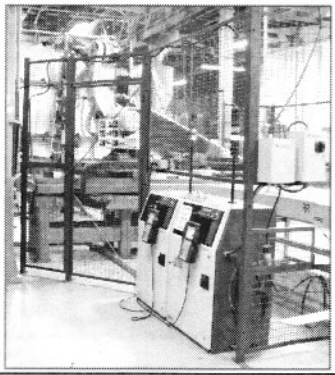


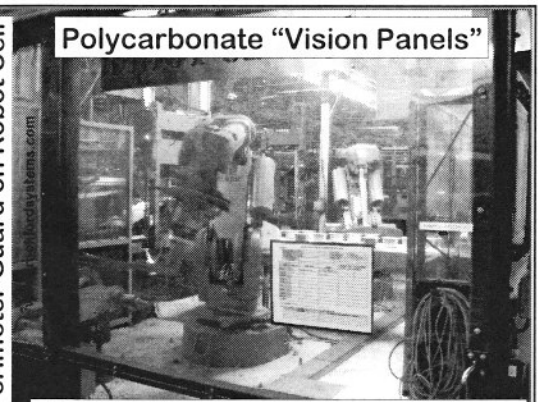
CURRENTLY 12 inch sweep and 60 inch height (ANSI/RIA)
WILL SOON BE 6 inch (.15m) sweep, 72 inch (1.8m) height (CSA)



Perimeter Guard on a Robot Cell

www.rockfordsystems.com

Polycarbonate "Vision Panels"



Perimeter Guard on Robot Cell

www.rockfordsystems.com

ANSI B11.19 - 2010 Annex E "Considerations for Transparent Guards"

## ANSI B11.0 - 2010 General Requirements and Risk Assessment 7.9.2.2 - Visibility

Guards, safeguarding devices, awareness devices, and safeguarding methods shall not cause undue obstruction to the view of the production process.

*Informative Note: Polycarbonate or other plastic materials often used for viewing panels may be subject to loss of mechanical strength due to the operating environment. The speed and amount of degradation of polycarbonates is dependent upon the environment, the lubricants, metal removal fluids, etc, and the conditions of use. Further, such degradation is not always visible.*

www.rockfordsystems.com

Also see ANSI B11.19 - 2010 Annex B "Considerations for Transparent Guards"

Danger and Warning Signs

## Conveyor Hazards Include:

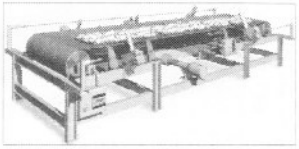
- In-running nip points
- Shear, pinch, crush points
- Rotating parts
- Power Transmission
- Counterweights
- Material dropping or falling
- Long hair, loose clothing getting caught
- Servicing or maintenance without proper lockout

Overhead Conveyor 2000' long with multiple drives

www.rockfordsystems.com

# Conveyor Safety

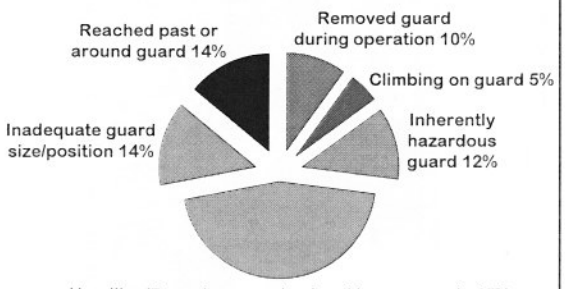
5(a)(1) General Duty Clause
1910.212 General Requirements for All Machines
1910.219 Mechanical Power Transmission
1910.147 Lockout/Tagout
ANSI B20.1 Safety for Conveyors/Related Equipment
Specialty Industries also contain some requirements
1910.218 Foundries
1910.261 Pulp/Paper
1910.263 Bakeries



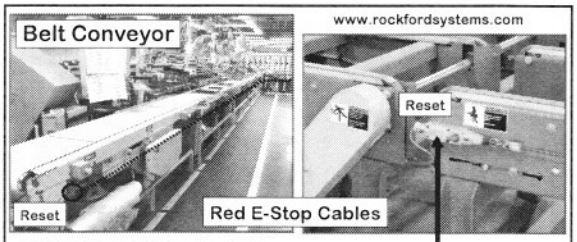
www.rockfordsystems.com

www.rockfordsystems.com

## Injuries Related to Equipment Guarding



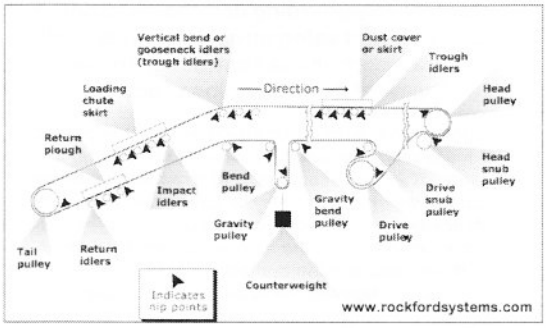

Source MSHA

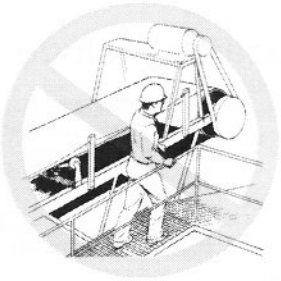



ANSI B20.1-2006 5.11.2 (1)
Conveyors that start up automatically require an Audible or Visual Warning Device that can be clearly seen or heard at all points that people may be present

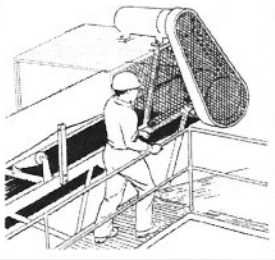
ANSI B20.1-2006 5.11.4
Manual reset or start at the location where the Emergency Stop was initiated required to resume operation

# Belt Conveyor – Nip Points



OSHA 1910.219
Covers for rotating components up to 7' OSHA or 8' ANSI



# MPTA

www.rockfordsystems.com

These and others are free downloads; cemanet.org
Conveyor Equipment Manufacturers Association

These and others are free downloads; cemanet.org
Conveyor Equipment Manufacturers Association

These and others are free downloads; cemanet.org
Conveyor Equipment Manufacturers Association

Conveyors are covered by OSHA 29 CFR SubPart O in 1910.212 General Requirements for all machines and 1910.219 Mechanical Power Transmission Apparatus

Safety Standard for Conveyors and Related Equipment ANSI/ASME B20.1-2006 ← Main One

Specifications for Welded Steel Conveyor Pulleys with Compression Type Hubs ANSI B105.1-1983

Terms and Conveyor Definitions ANSI/CEMA 402-1985

Unit Handling Conveyors - Belt Conveyors ANSI/CEMA 402-1985

Unit Handling Conveyors – Belt Driven Live Roller Conveyors ANSI/CEMA 403-1985

Unit Handling Conveyors – Chain Driven Live Roller Conveyors ANSI/CEMA 404-1985

Unit Handling Conveyors – Roller Conveyor Non-powered ANSI/CEMA 401-1985

Unit Handling Conveyors – Slat Conveyors Live Roller Conveyors ANSI/CEMA 405-1985

www.rockfordsystems.com

Two Conveyor CD's available from The Conveyor Equipment Manufacturers Association in Punta Gorda, Florida phone (301) 738-2448 or fax (301) 738-0076 www.cemanet.org

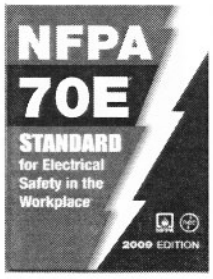
www.rockfordsystems.com

Conveyor Safety Standards available from www.global.ihs.com

## Article 119.7 Electrical Safety Program

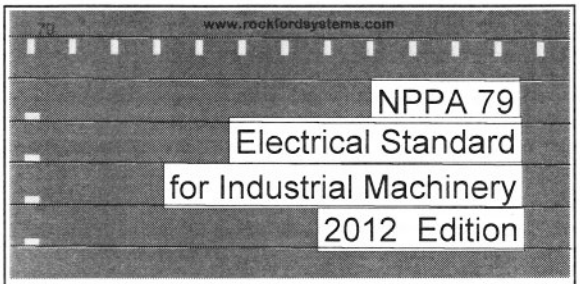
### (A) General.

The employer shall implement and document an overall electrical safety program that directs activity appropriate for the voltage, energy level, and circuit conditions.




Source: Littlefuse

www.rockfordsystems.com




Main Power Disconnects - Motor Starters
Voltages - Grounds - E-stops - and more
Category 1 Stop Controls
Category 2 Stop Controls
Category 3 Stop Controls

## This meets NFPA 79

Electrical Standard for Industrial Machinery

Engaged

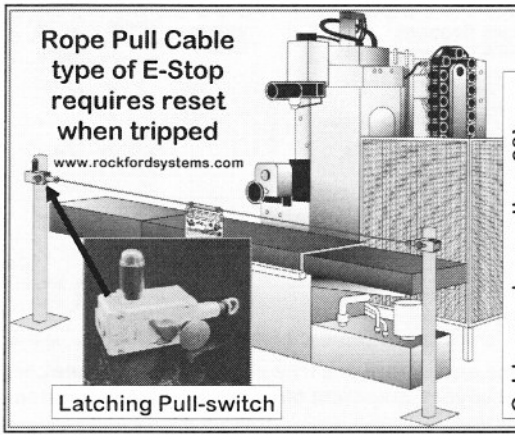
Disengaged

- Red Button
- Yellow Background
- Manual Latch

www.rockfordsystems.com

## Rope Pull Cable type of E-Stop requires reset when tripped

www.rockfordsystems.com



Latching Pull-switch

Cable runs longer than 20' may need a switch on BOTH ends

## ANSI B11.19 - 2010 3.83 STOP definitions

*Controlled Stop*: The stopping of machine motion while retaining power to the machine actuators during the stopping process. Also referred to as a Category 1 or 2 stop.

*Emergency Stop*: The stopping of a machine, manually initiated, for emergency purposes.

*Normal Stop*: The stopping of a machine, initiated by the control system, at the completion of a cycle.

*Protective Stop*: The stopping of a machine, initiated by safeguarding for safeguarding purposes.

*Uncontrolled Stop*: The stopping of machine motion by removing power to the machine actuators, all brakes or other mechanical stopping devices being activated. Also referred to as a Category 0 stop.

www.rockfordsystems.com

## ANSI B11.19-2010 10.4 Safe Location

Individuals should be made aware of the nature and location of the hazards through the use of awareness device(s) in vicinity of the hazard

a) Inadvertent access from a walking or working surface to the hazard shall be prevented by:
- vertical distance of sufficient height
- horizontal distance
- combination of vertical and horizontal distance

b) Access to the recognized hazard shall be limited by locating the hazard:
- in a room, vault, or similar enclosure
- behind permanent, substantial partitions fencing/railing or screens . . .

www.rockfordsystems.com

## ANSI B11.19-2010 8.8 Single Control Safeguarding Device

**One-hand Trip or One-hand Control or Foot-Switch must be protected from unintended / inadvertent actuation**

If more than one operator, each one shall have an individual device. Selection of the single control safeguarding device shall be capable of being supervised. Each device selected shall be concurrently operated and require release and reactivation of all single devices before another machine cycle can be initiated. There must be an indication for each Operator that single device is selected or de-selected.

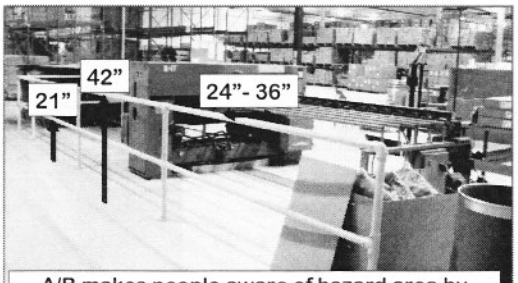
Devices must meet Performance of Safety-related Function.

Safety Distance
- speed of approach of the individual
- total response time of the device (from supplier)
- response time of the interface
- response time of the control system
- time it takes machine to stop hazardous motion
- safeguarding device's depth penetration factor

www.rockfordsystems.com

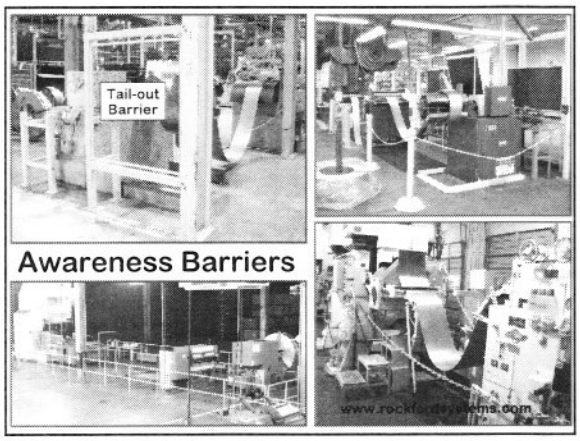
## Awareness Barriers ANSI B11.19 - 2010 9.1

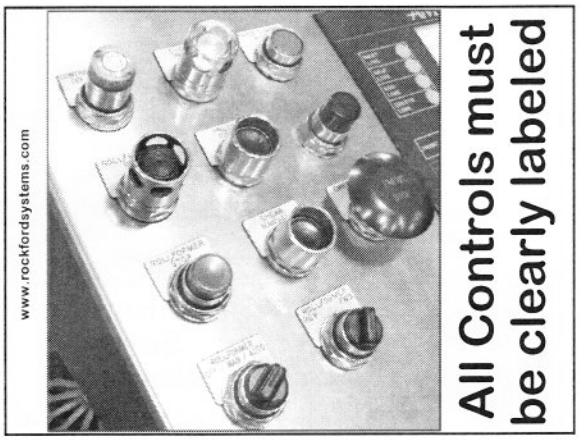
provide a visual boundary to hazards . . . person must make a . . . conscious effort and contact with the barrier . . .

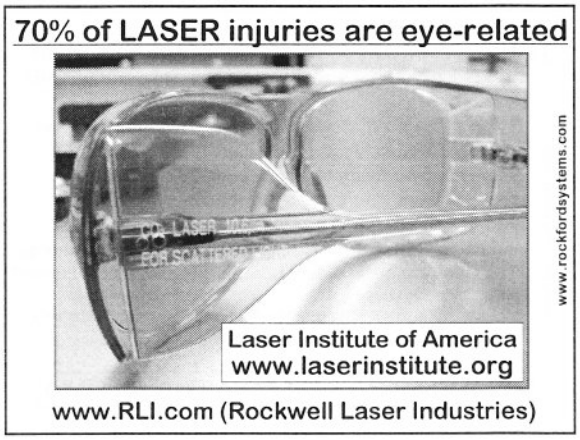


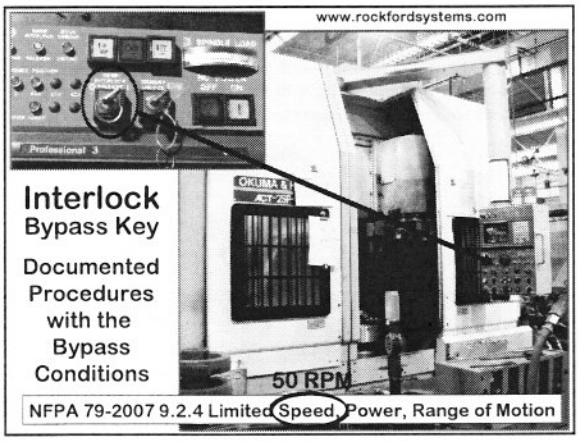

A/B makes people aware of hazard area by surrounding it with an obstacle (railing, chain, cable) requiring an intentional act to get beyond

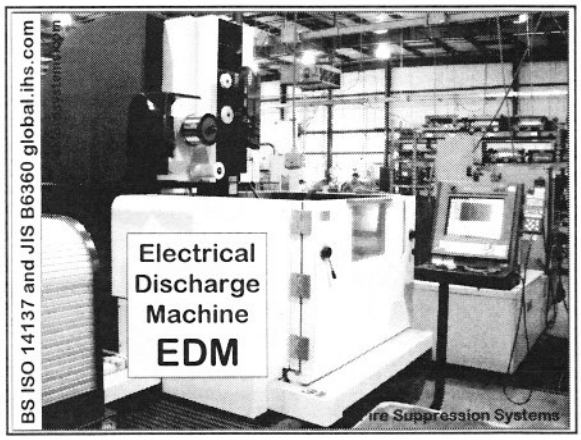
www.rockfordsystems.com


Tail-out Barrier
Awareness Barriers
www.rockfordsystems.com


www.rockfordsystems.com
All Controls must be clearly labeled


70% of LASER injuries are eye-related
Laser Institute of America
www.laserinstitute.org
www.RLI.com (Rockwell Laser Industries)
www.rockfordsystems.com


www.rockfordsystems.com
Interlock
Bypass Key
Documented Procedures with the Bypass Conditions
50 RPM
NFPA 79-2007 9.2.4 Limited Speed, Power, Range of Motion


BS ISO 14137 and JIS B6360 global.ihs.com
Electrical Discharge Machine
EDM

ANSI/SPI B151.1-1997
Horizontal Plastic Injection Molder
www.rockfordsystems.com

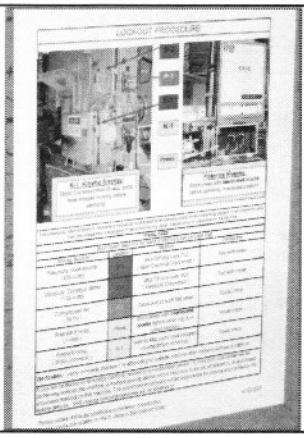
www.rockfordsystems.com

## Automatic Screw Machine

ANSI B11.13-1992 (R98)

www.rockfordsystems.com

LOTO procedures are visual and color-coded for energy sources



Visual and Color-Coded

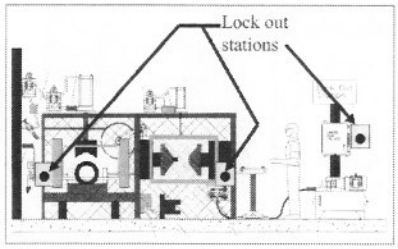
www.rockfordsystems.com

## "Single Point" Lockout

Alternate LOTO Method with only one Lockout Point and a control reliable system to isolate all energy sources

reduces time for LOTO - Fewer locks - Remote low-voltage system

www.rockfordsystems.com




Caution: OSHA may consider this "Soft Lockout" and may therefore be considered unacceptable

## ANSI / ASSE Z244.1-2003 Control of Hazardous Energy Lockout/Tagout and Alternative Methods

*5.3.2.4 Machine, Equipment, or Process Isolation*

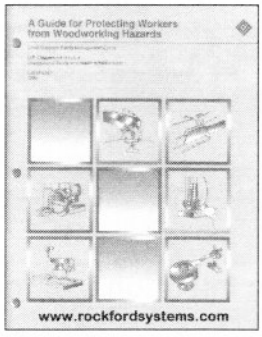
"On complex machinery, equipment and processes where it is necessary to isolate power or motion for a specific component while maintaining power to control systems, support utilities, and other devices and components, SECTIONAL (localized) lockable energy ISOLATION or other safety related steps may be required"

NOTE: Hazardous energy may exist in adjacent machinery, equipment and processes to that being worked on . . .

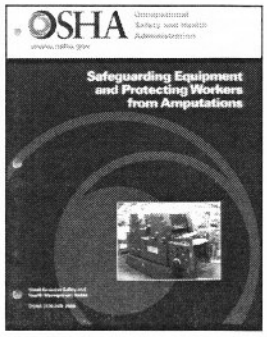
www.rockfordsystems.com

Above does NOT meet OSHA 1910.147 LOTO

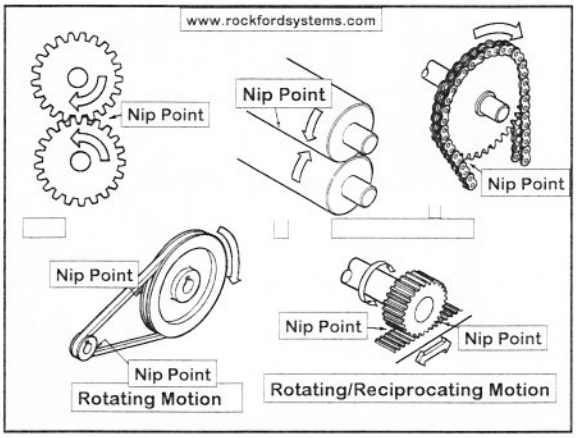
OSHA 3157– 1999
Small Business Safety Management Series




OSHA 3170-07R-2003
Small Business Safety Management Series




www.rockfordsystems.com



- Points of view, ideas, products, demonstrations or devices presented or displayed at the Ohio Safety Congress & Expo do not constitute endorsements by BWC. BWC is not liable for any errors or omissions in event materials.