Ohio Safety Congress

Greater Columbus Convention Center
Wednesday March 31, 2010
10:30 to 11:30 a.m. Session 333

Machine Safeguarding Overview - What's New

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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

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

1910.211 Definitions
1910.212 General requirements for all machines

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)

Vertical = specific

Horizontal = general

1910.219 Mechanical power transmission apparatus

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

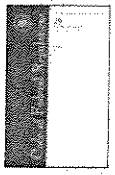
5 (a) (1) OSHA's General Duty Clause
EMPLOYERS to furnish a place of employment free from recognized hazards likely to cause death or serious physical harm to employees

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

OSHA 1910.212 General requirements (a) (1)

protect operator & other employees in the machine area from hazards

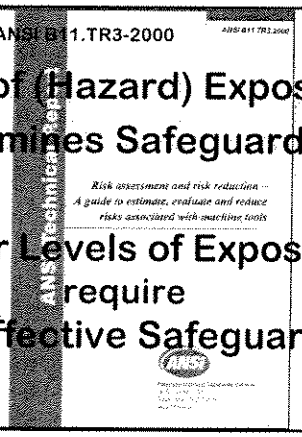
- point of operation
- ingoing nip points
- rotating parts
- flying chips & sparks



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

ANSI B11.TR3-2000

Level of (Hazard) Exposure Determines Safeguarding



Higher Levels of Exposure require More Effective Safeguarding

Residual Risk

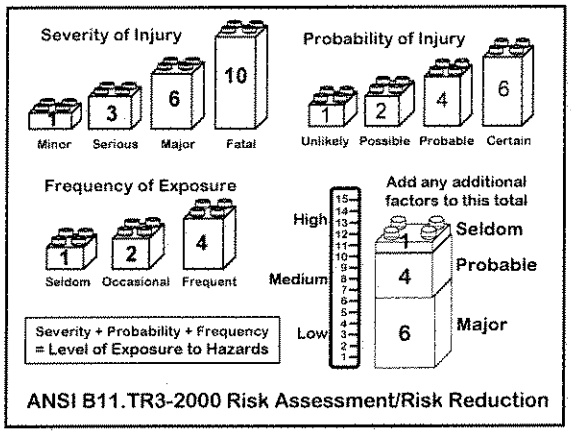
remaining risk after protective measures have been taken

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

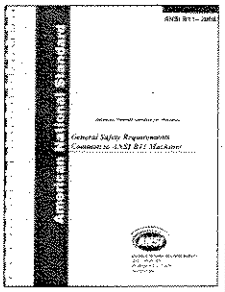
ANSI B11.TR3-2000

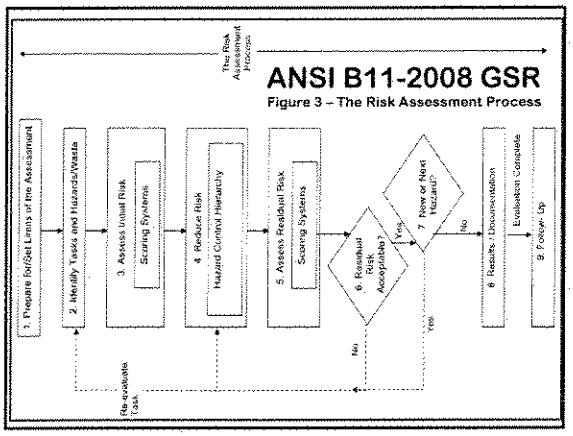


ANSI B11.TR3-2000 Risk Assessment/Risk Reduction

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.





Reasonably Foreseeable

MISUSE

predictable use of a machine in a way not intended by the supplier or user which may result from human behavior

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.)

ANSI B11 Safety Standards for Machine Tools

- B11.1 Mechanical Power Presses
- 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 Grinding
- B11.10 Sawing
- B11.11 Gear Cutting
- B11.12 Roll Forming and Roll Bending
- B11.13 Automatic Screw/Bar and Chucking
- B11.14 Coil Slitting

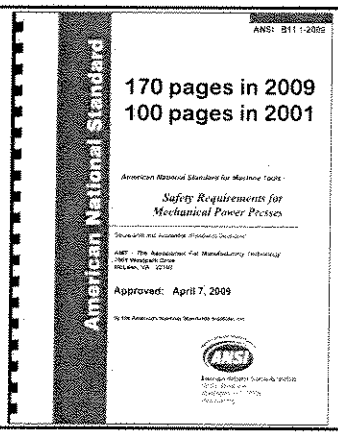
(continued)

- B11.15 Pipe, Tube, and Shape Bending
- B11.16 Metal Powder Compacting
- B11.17 Horizontal Hydraulic Extrusion Presses
- B11.18 Coil Processing Systems
- B11.19 Safeguarding
- 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

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

ANSI/RIA R15.06-1999 - Table A.2 - Hierarchy of Safeguarding Controls

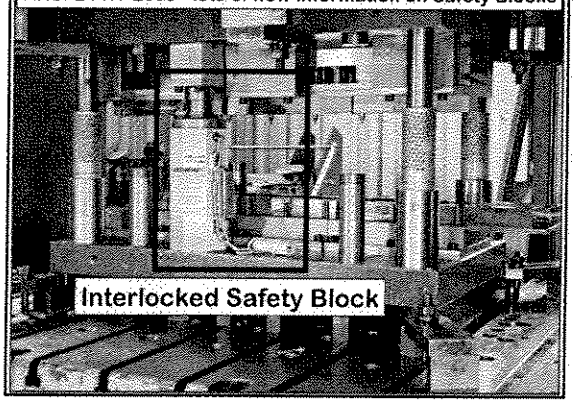


ANSI B11.1.2009 Mechanical Power Press highlights

More agreement with NFPA-79 - expanded electrical requirements: for stop control circuits: Category 0, Category 1, Category 2

- Multi-press production systems – feeds, conveyors, other equipment
- Design/Construction Standards for:
  - slide locks on larger presses
  - moving bolsters
  - scrap chutes
- Safeguarding for:
  - rotating components (flywheels, gears, sheaves, shafts)
  - in-running nip points and pinch points
  - coil feeding equipment
  - automated material handling (robots, shuttles, transfer systems)
  - moving bolsters, dies carts, die shuttles, scrap chutes, crown pits
- Perimeter and area safeguarding for places with multiple hazards not individually guarded – manual reset outside safeguarded area
- Risk Assessment / Risk Reduction – "reasonably foreseeable hazards"
- NFPA Emergency Stops (red button, yellow background, manual latch)
- Synchronous operation of two-hand controls (within 0.5 seconds)

ANSI B11.1-2009 - lots of new information on Safety Blocks

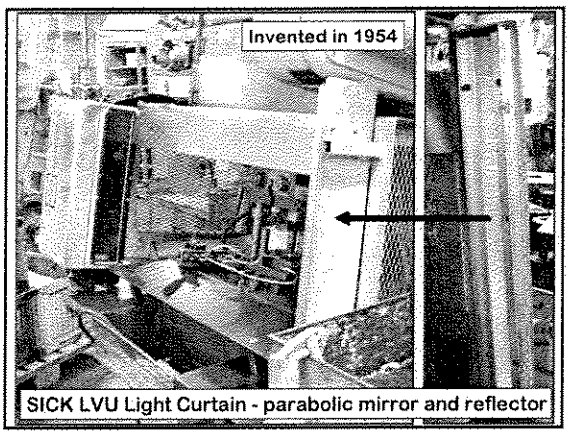


Light Curtain
Presence Sensing Devices

Prevent initiation — if sensing field is obstructed <u>prior to</u> cycle initiation

(and)

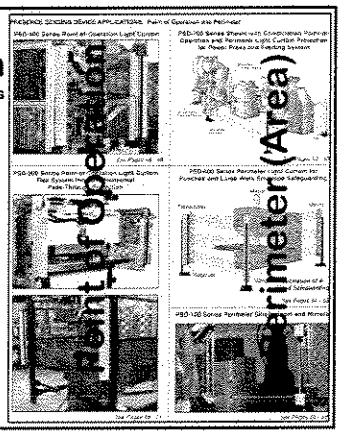
Stop hazardous motion — if sensing field is obstructed <u>after</u> cycle initiation



Light Curtain
Presence Sensing Devices

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

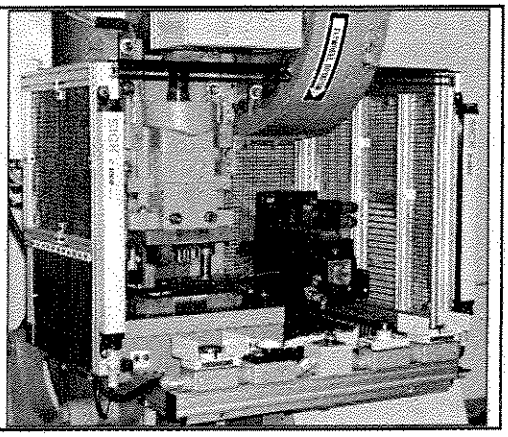
without damaging: machine - tooling - work or creating another hazard



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
Category 2 Detection of faults	components monitored before machine start-up and periodically	DETECTION of faults
Category 3 Detection of faults	dual/monitored system of critical components – single fault does not lead to loss of safety function	DETECTION of faults
Category 4 Detection of faults	dual/monitored system with all foreseeable faults detected	DETECTION of faults

Light Curtain-Single or Continuous



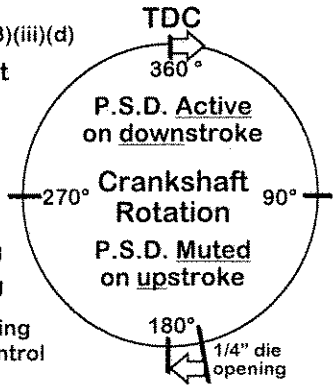
Muting (c)(3)(iii)(d)

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

<u>Muting used for</u>:

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

Muting done in timing circuit of press control

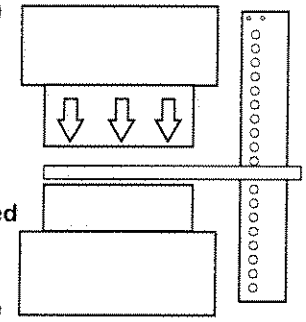


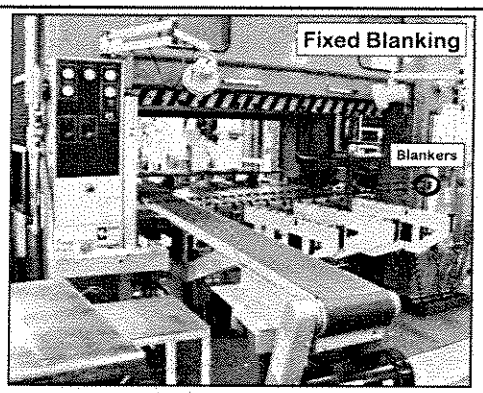
Channel Blanking on Light Curtains (fixed or floating)

Blanking turns off a small portion of the sensing field so an object can block a channel(s) without detection.

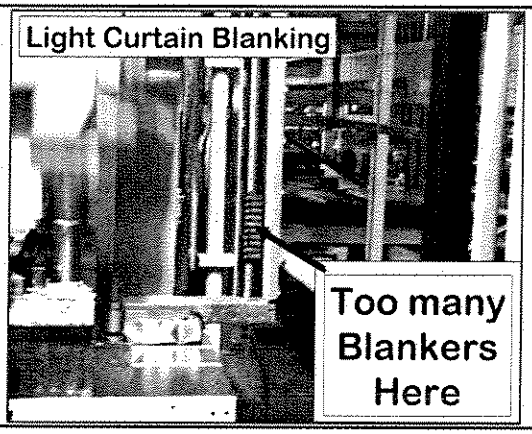
Blanking is controlled in the light curtain (or its 3rd box)

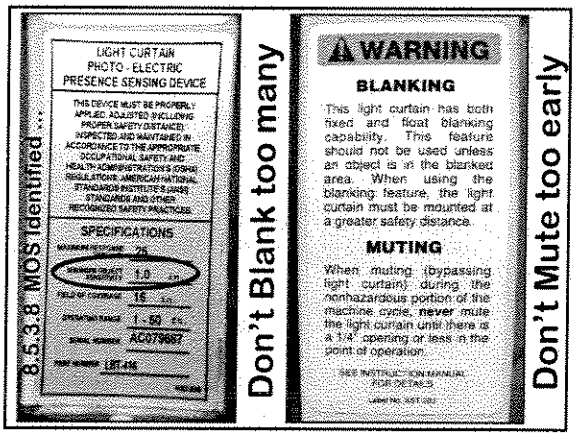
Fixed Blanking must be limited to a small area and be carefully supervised

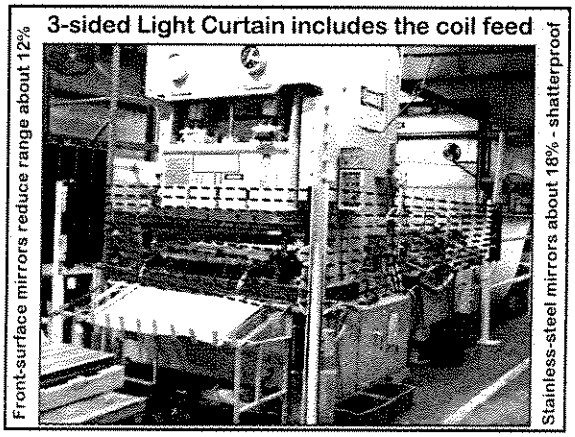


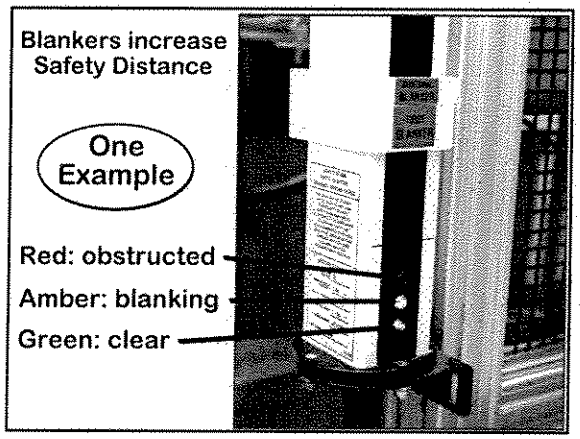


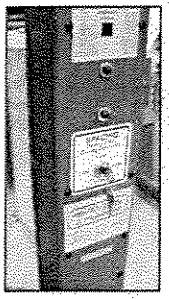
Light Curtain Blankers allow for conveyor

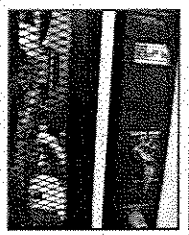


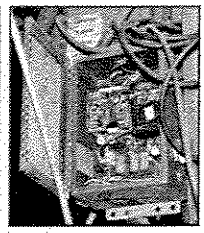






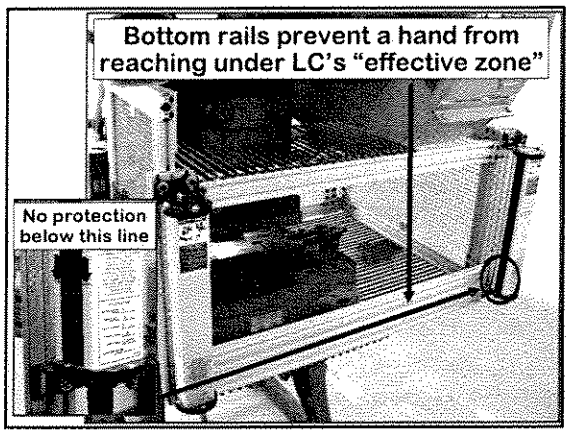




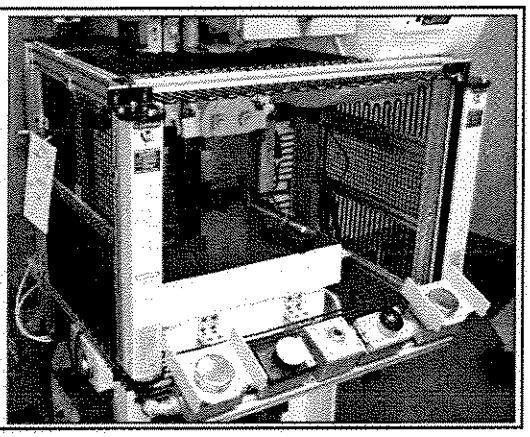


Don't leave Blanking keys in Light Curtain selectors

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



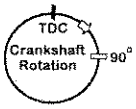
Safety Distance for Light Curtain



OSHA Safety Distance Formula Presence Sensing Device

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



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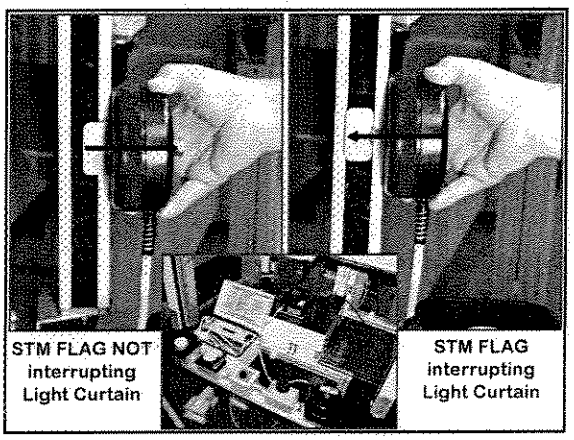
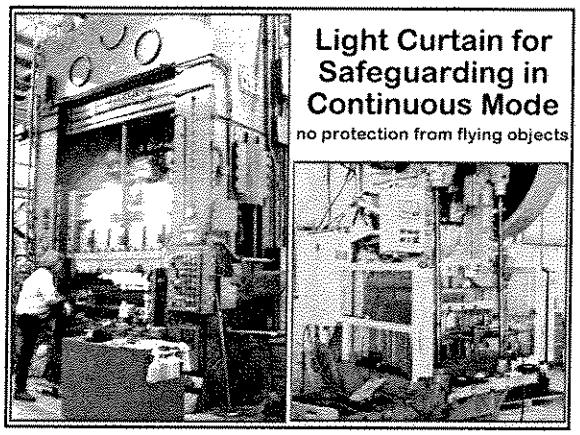


ANSI B11.1 - 2001 E8.5.3 (16) Safety Distance for a Light Curtain Presence Sensing Device

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

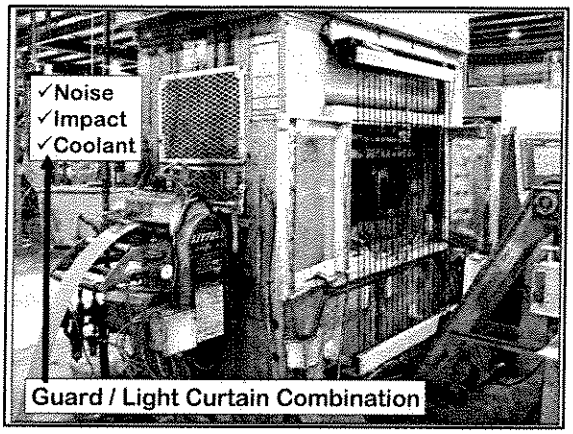
T_s press and T_c press control
T_r light curtain (tag or flag)
T_{bm} added for brake monitor
K hand speed constant
D_{pf} penetration depth factor
D_s Minimum Safety Distance

$$D_s = K (T_s + T_c + T_r + T_{bm}) + D_{pf}$$



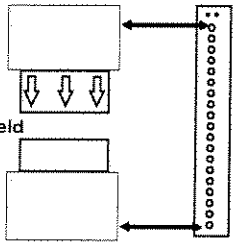
Light Curtain for Safeguarding in Continuous Mode

no protection from flying objects

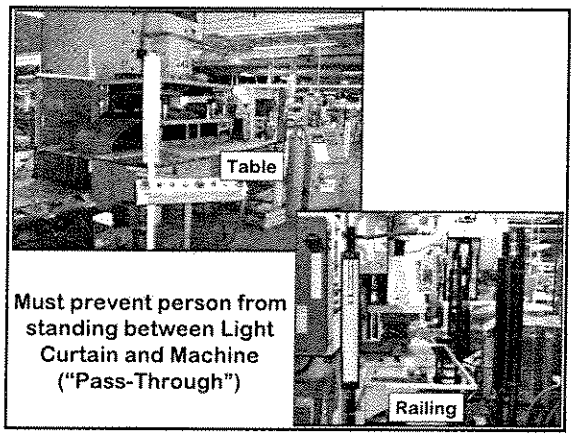


Light Curtain Pass-through Protection

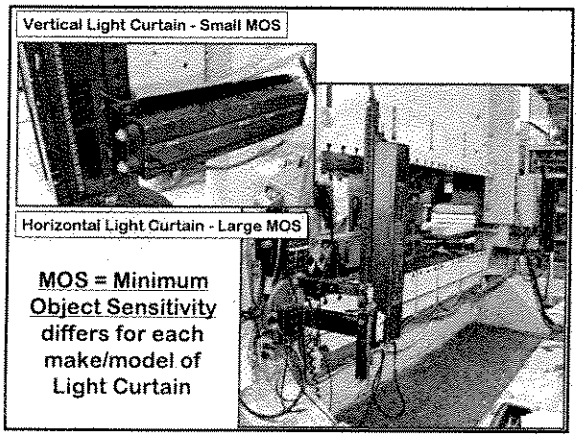
If Operator can get in between LC sensing field and machine, more safeguarding is required:



- 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



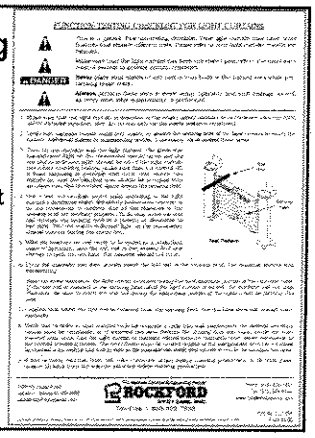
Must prevent person from standing between Light Curtain and Machine ("Pass-Through")

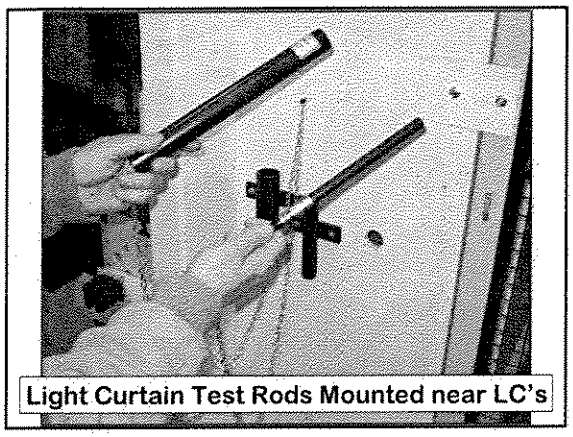


MOS = Minimum Object Sensitivity differs for each make/model of Light Curtain

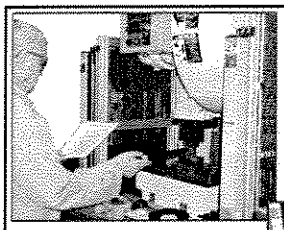
Function Testing Light Curtains

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



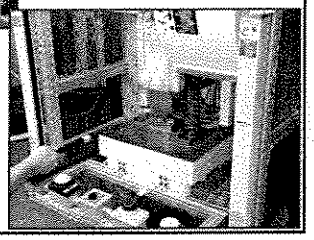


Light Curtain Test Rods Mounted near LC's



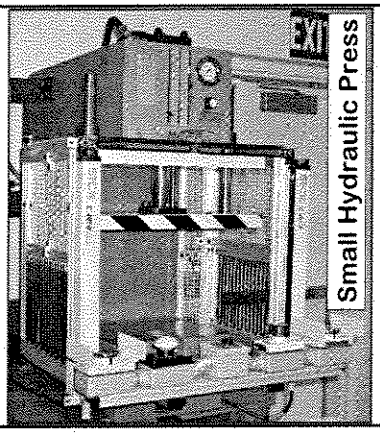
Light Curtains should be only be installed, checked out, and maintained by a "Qualified Person"

"a person or persons who, by possession of a recognized degree or certificate of professional training, or who, by extensive knowledge, training and 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 ...



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)

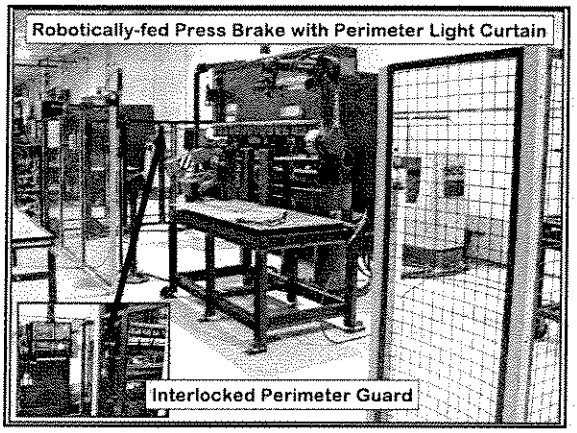
PSDI PERMITTED on Hydraulic Presses

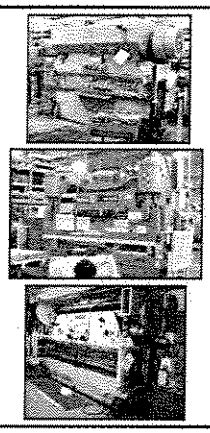
because they are excluded from 1910.217 but are covered under ANSI B11.2 - 1995 which allows PSDI providing it is applied correctly

PSDI is allowed on Hydraulic Presses

Follow the guidelines in ANSI B11.2 -1995

Light Curtain - Press Brake bending operation



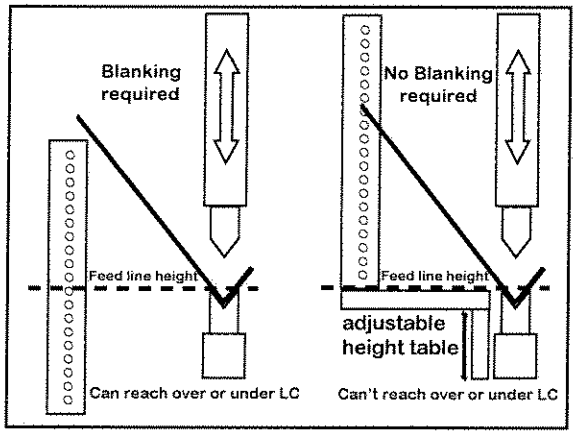


Light Curtains

can be applied to any type of Press Brake:

- Air Clutch
- Hydraulic
- Hydra-Mechanical
- Servo-Drive
- Mechanical Friction (requires new control system)

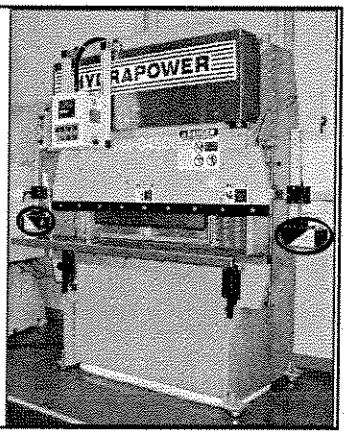
Light Curtains may not be an effective Safeguarding device for everything part bent on a Press Brake

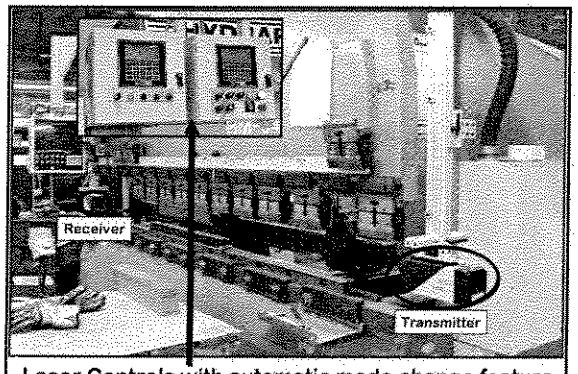


Two types of bends Laser can handle that Vertical Light Curtains are not well suited for:

Large parts with a Side-leg that sticks out through the LC

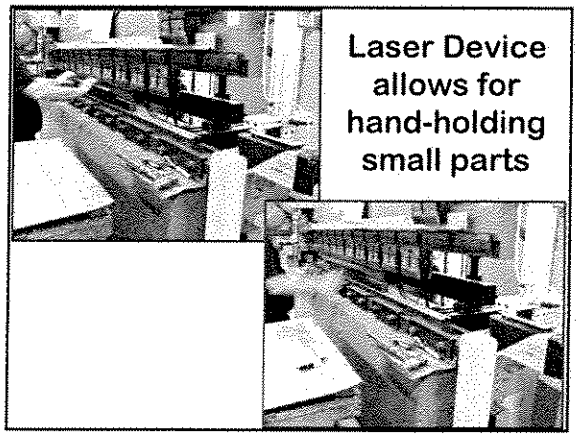
Hand-holding Small Parts



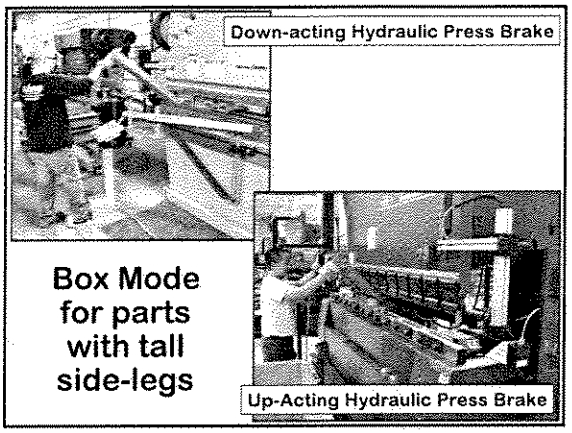


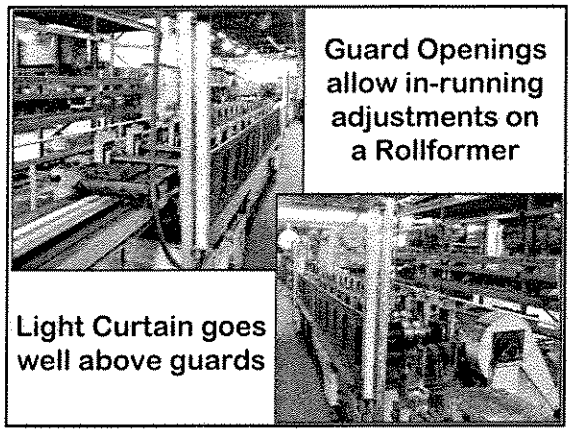
Laser Controls with automatic mode change feature

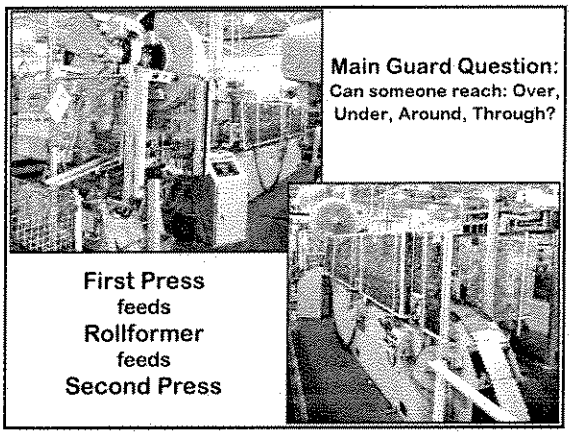
3 Modes: Standard – Box – Back Gauge



Laser Device allows for hand-holding small parts

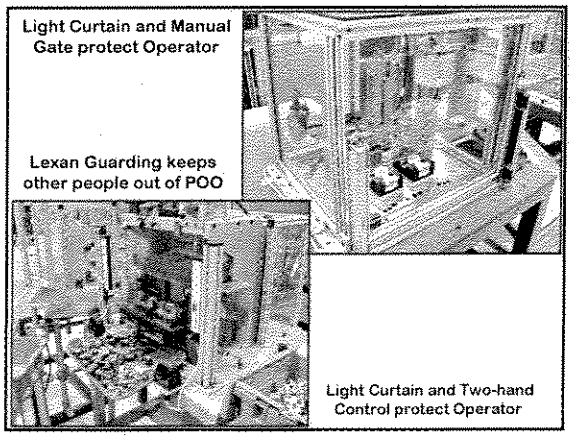


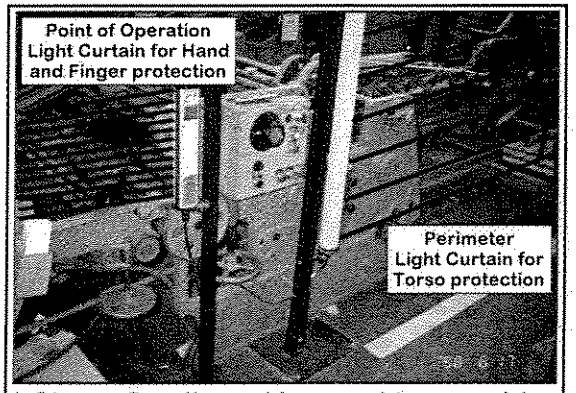




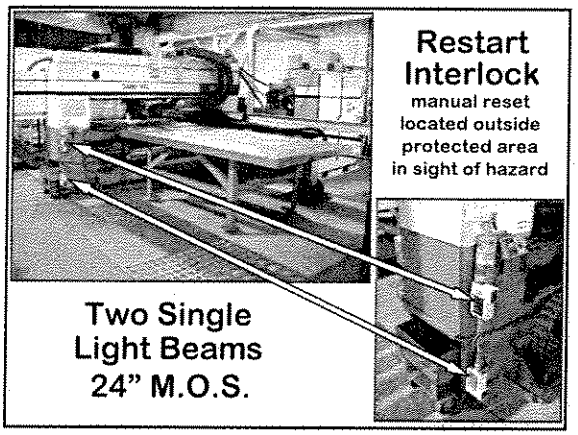
Presence Sensing Safeguarding Devices (PSSD's)

- 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





LC's on Cardboard box-making machine

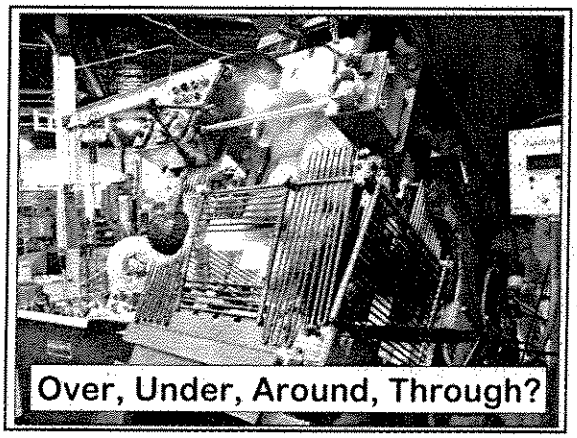


Point of Operation Guard Requirements

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

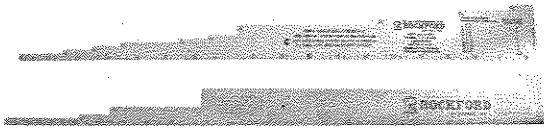
- can't reach through, over, under, around
- meets Table 0-10 for openings and distances
- no pinch points between guard & moving parts
- good visibility into the point of operation
- fasteners not readily removable (tool required)
- *materials strong enough to protect people
- *free from sharp edges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

MPPS pages 26-28



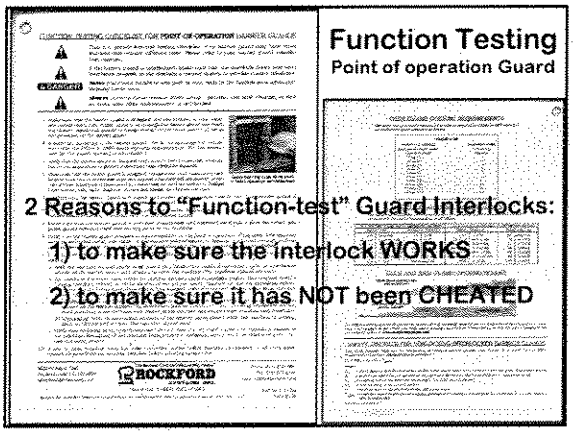
OSHA Guard Opening Scale – 1948

Liberty Mutual and ANSI Standard writing committee



ANSI Guard Opening Scale – 1996

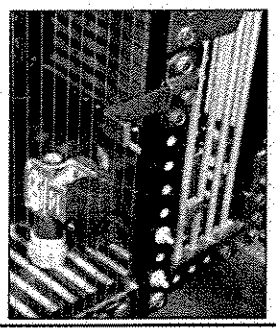
Liberty Mutual and ANSI Standard writing committee

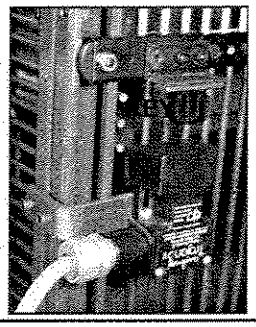


Newer Guard Interlock Switches

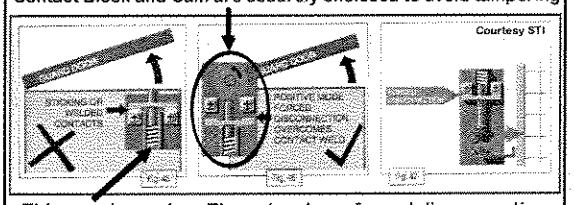
KEY geometry makes it difficult to defeat

KEY forces a make/break of electrical contacts





Contact Block and Cam are securely enclosed to avoid tampering

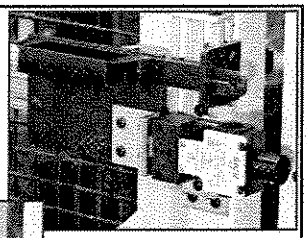


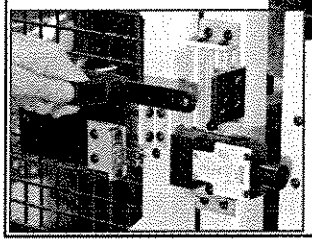
This one depends only upon a spring

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

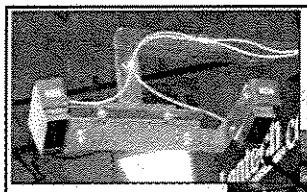
"Positive Mode Guarding" ensures that the interlock switch contacts are physically pulled apart or "Force Disconnected" by the movement of the guard

Risk Assessment for Interlock Reliability

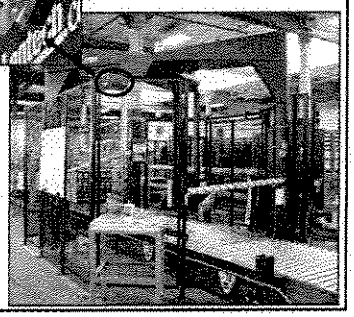




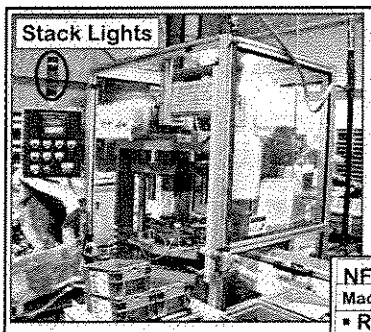
- Minor Risk – Cat. 1
- Serious Risk – Cat. 2
- Major Risk – Cat. 3
- Fatal Risk – Cat. 3



Shrink-wrap Machine



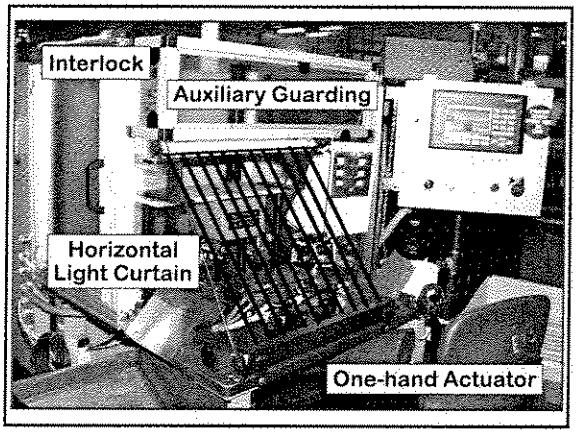
- Perimeter Fence
- Entry/Exit Poles
- Infra-red Sensors



Light Curtain and Two- hand Control

Visual or Audible Awareness Signals

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



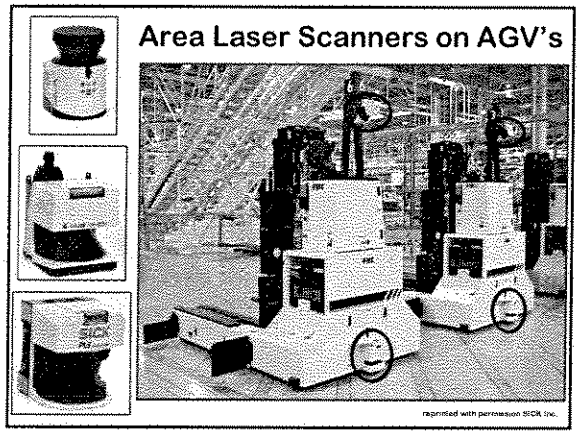
Safeguarding of Personnel & Equipment

- 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

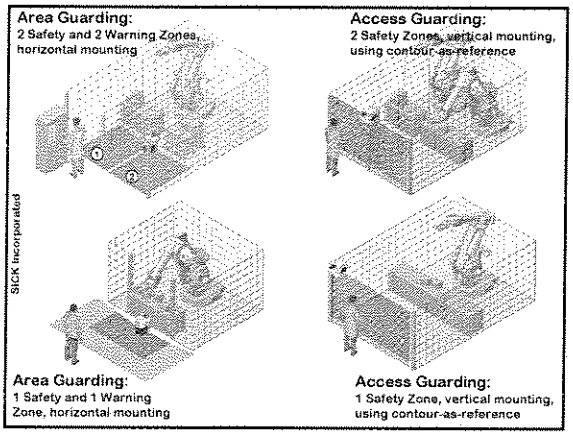
Area Laser Scanner

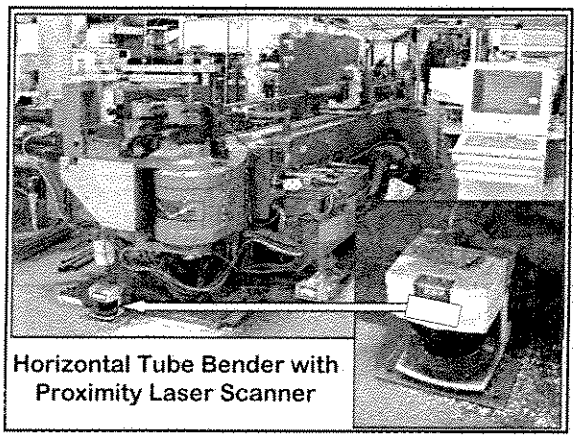
SICK Incorporated

Area Laser Scanners on AGV's

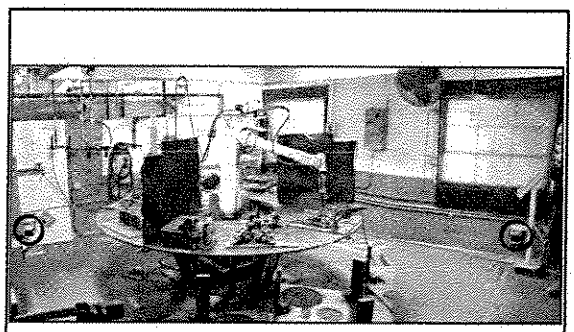


reprinted with permission SICK Inc.

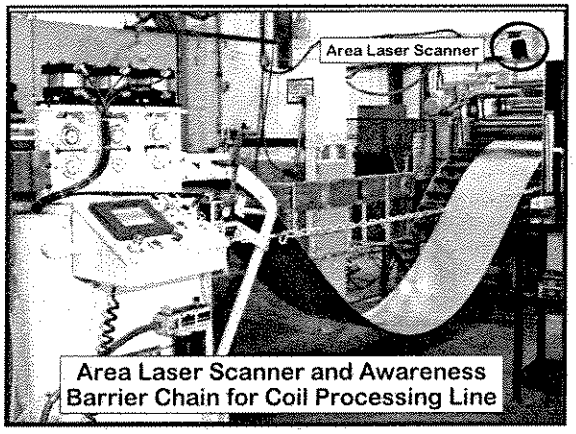




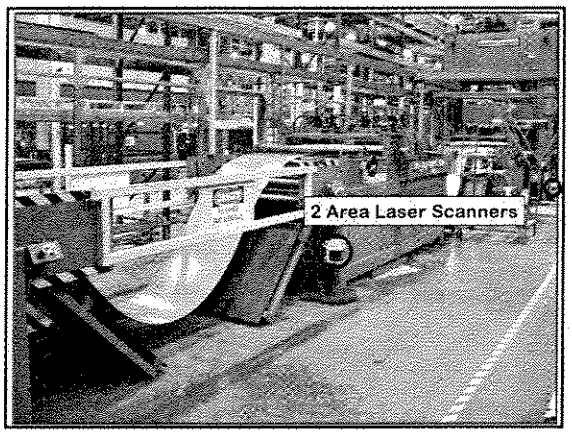
Horizontal Tube Bender with Proximity Laser Scanner

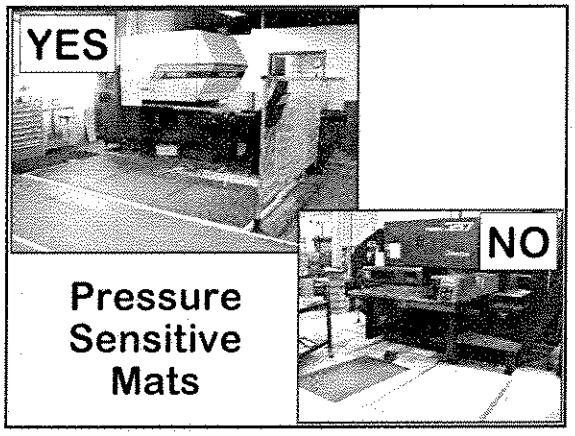


Two Area Laser Scanners in opposite corners
Each one covers half of the Welding Cell

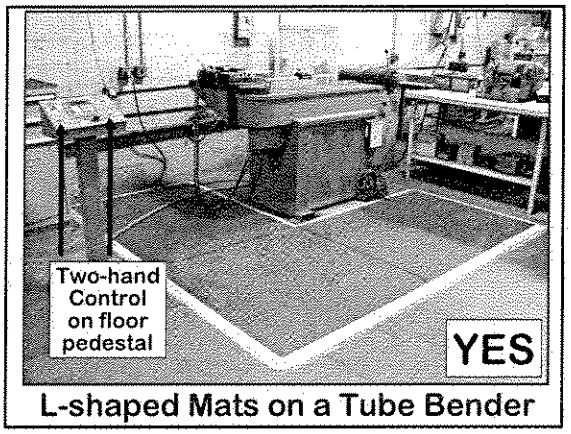


Area Laser Scanner and Awareness Barrier Chain for Coil Processing Line



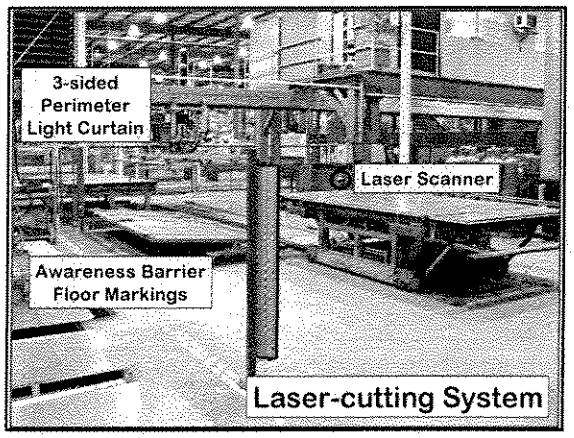


Pressure Sensitive Mats

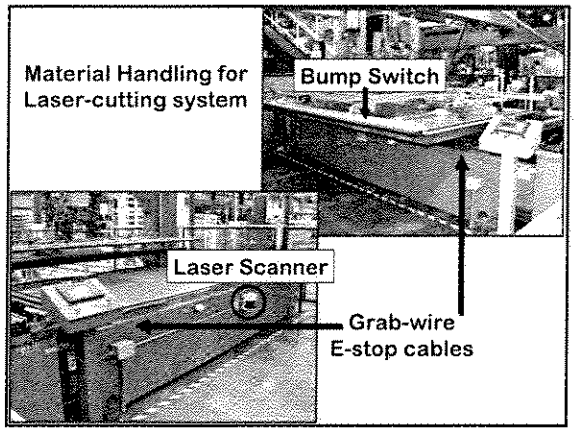


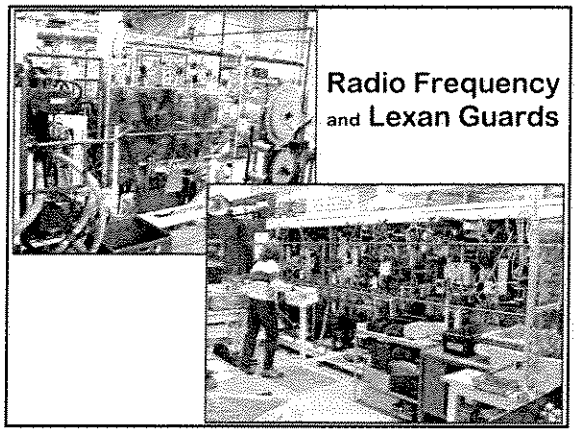
L-shaped Mats on a Tube Bender

Mats must be fastened to floor to prevent moving them too close to the hazard area



Laser-cutting System





"Ring-drop" Devices
"Drop Probe" Devices

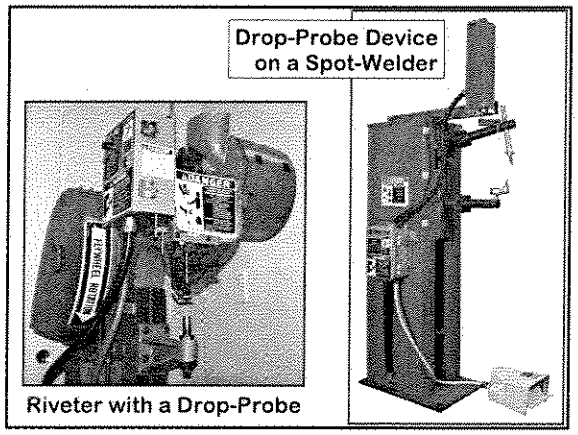
ANSI B11.19 - 2003 8.7

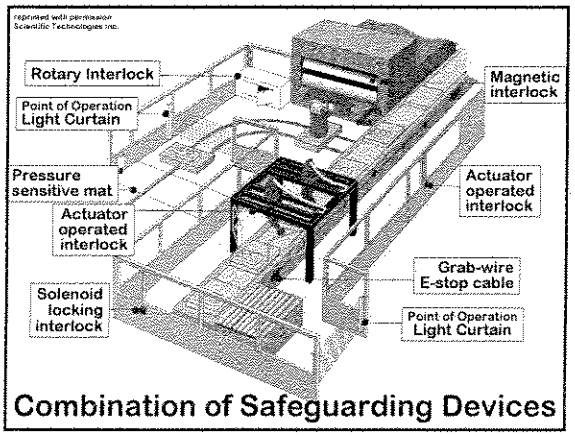
Also see ANSI B154.1-1995

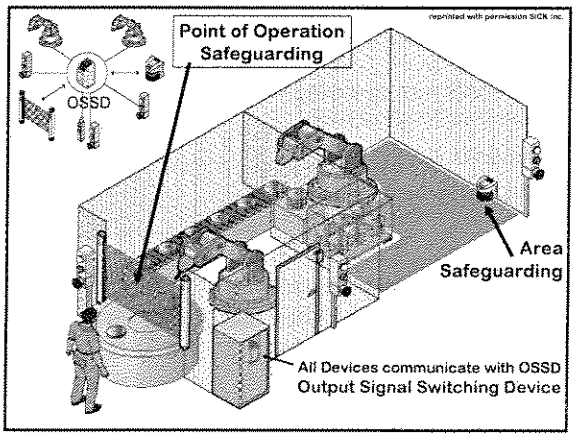
Rivet Setting Equipment

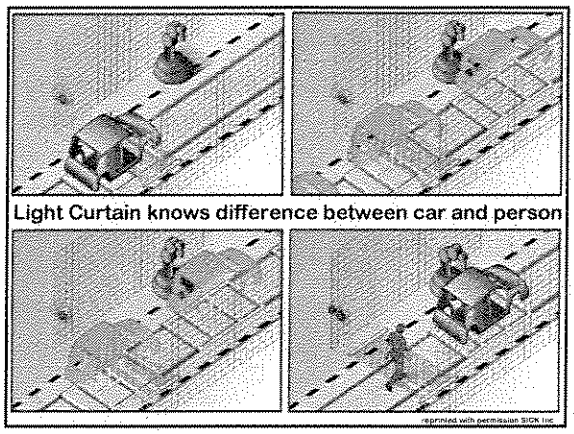
Mechanically verifies the absence of hand or fingers in Point of Operation

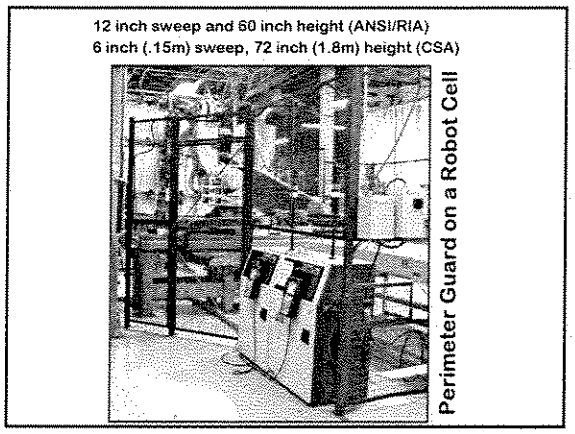
Spot Welders, Riveters, Staplers, Stakers Eyeletters, Terminators, Dinkers, Clickers

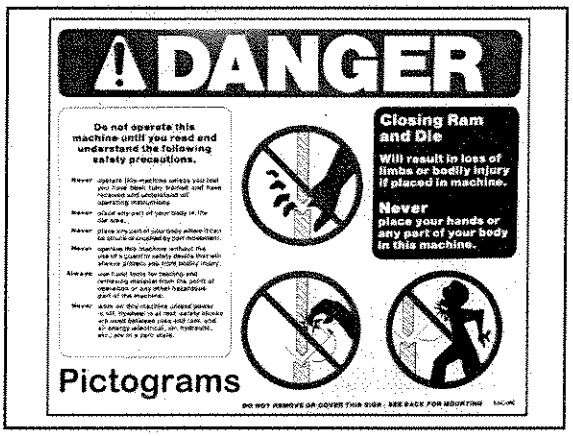


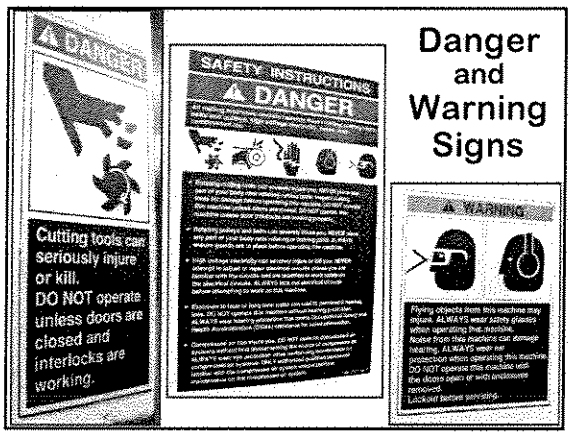


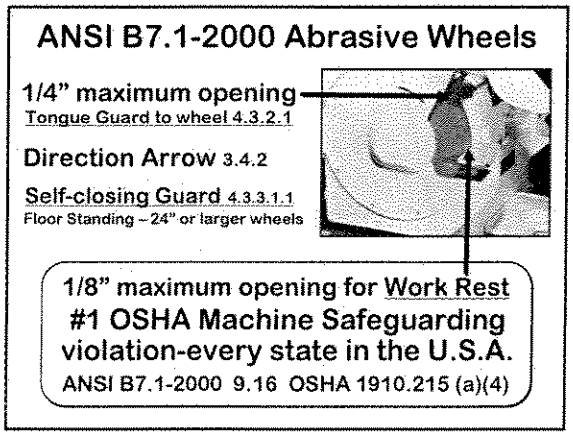


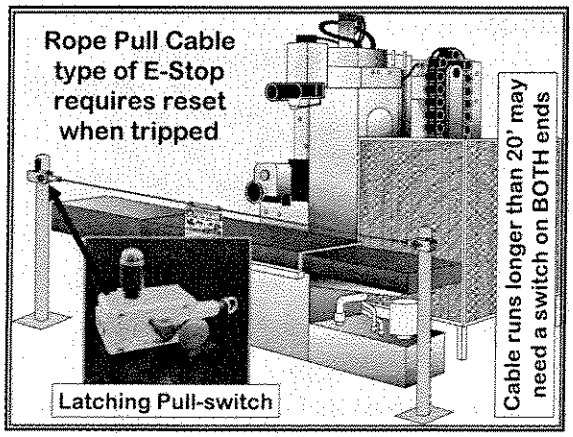

Light Curtain knows difference between car and person
reprinted with permission SICK Inc.


12 inch sweep and 60 inch height (ANSI/RIA)
6 inch (.15m) sweep, 72 inch (1.8m) height (CSA)
Perimeter Guard on a Robot Cell


DANGER
Do not operate this machine until you read and understand the following safety precautions.
Closing Ram and Die
Will result in loss of limbs or bodily injury if placed in machine.
Never
place your hands or any part of your body in this machine.
Pictograms


DANGER
Cutting tools can seriously injure or kill.
DO NOT operate unless doors are closed and interlocks are working.
SAFETY INSTRUCTIONS
DANGER
Danger and Warning Signs
WARNING


ANSI B7.1-2000 Abrasive Wheels
1/4" maximum opening
Tongue Guard to wheel 4.3.2.1
Direction Arrow 3.4.2
Self-closing Guard 4.3.3.1.1
Floor Standing ~24" or larger wheels
1/8" maximum opening for Work Rest
#1 OSHA Machine Safeguarding violation-every state in the U.S.A.
ANSI B7.1-2000 9.16 OSHA 1910.215 (a)(4)

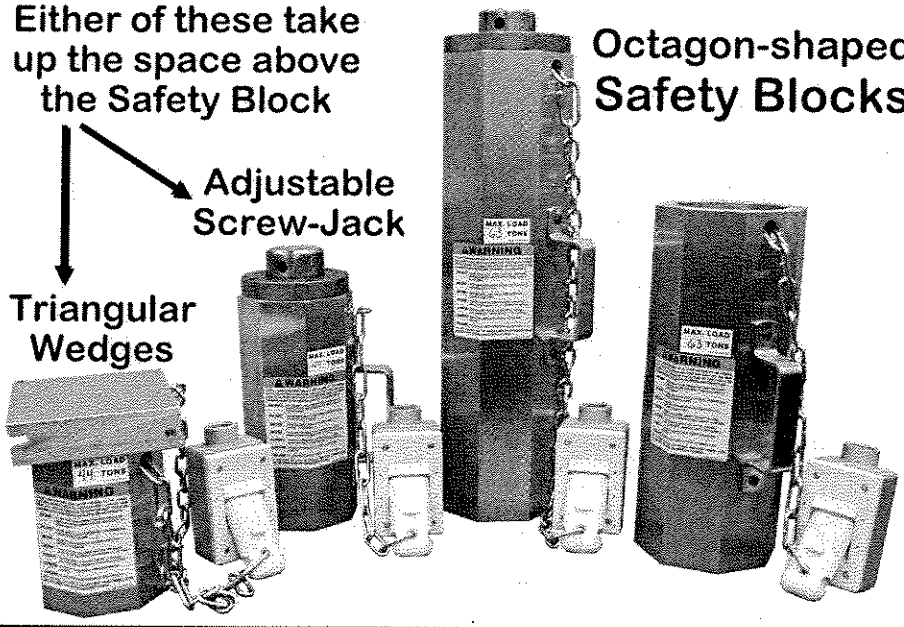

Rope Pull Cable type of E-Stop requires reset when tripped
Latching Pull-switch
Cable runs longer than 20' may need a switch on BOTH ends

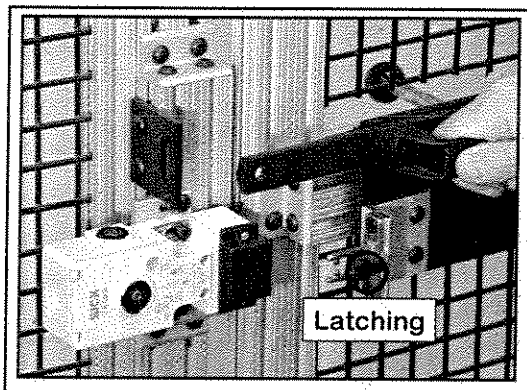
Either of these take up the space above the Safety Block

Adjustable Screw-Jack

Triangular Wedges

Octagon-shaped Safety Blocks

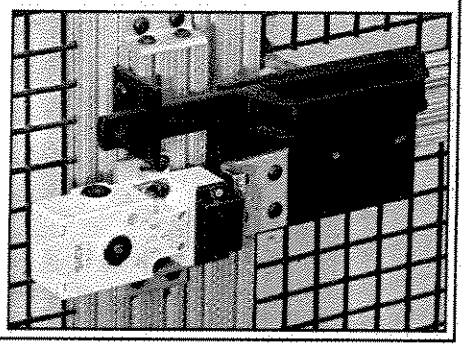


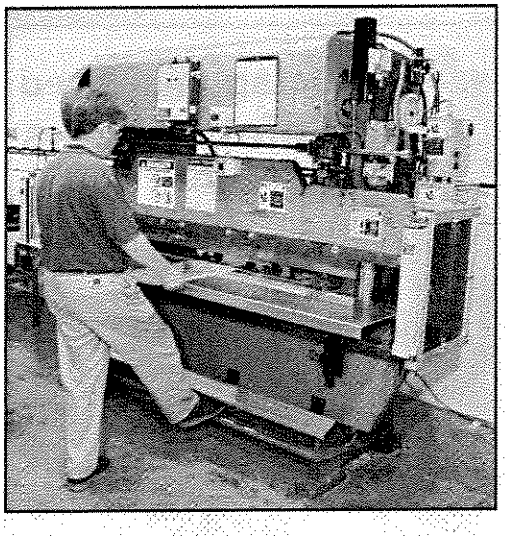


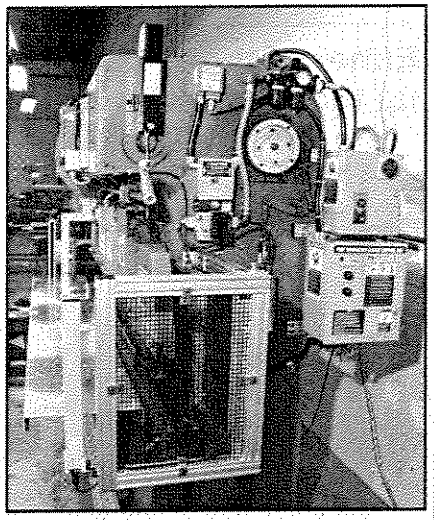
Interlocked Guard

with a latching motion sensor

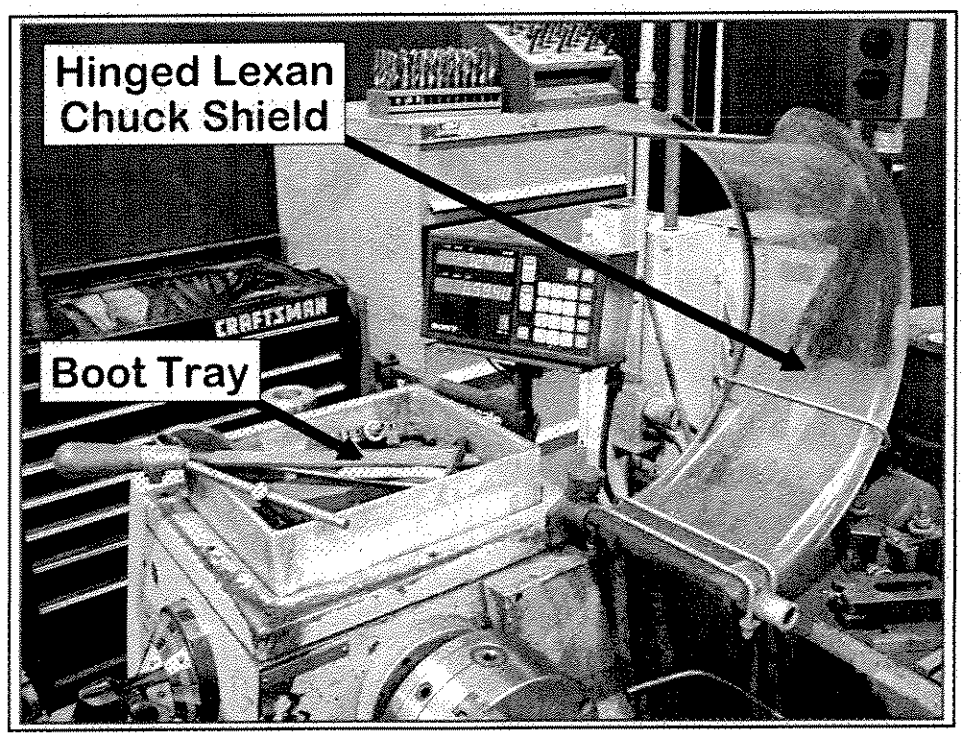
Request for access button is pushed - Safety relay then looks for motion or time-out. Guard can be opened when solenoid inside the switch is energized.

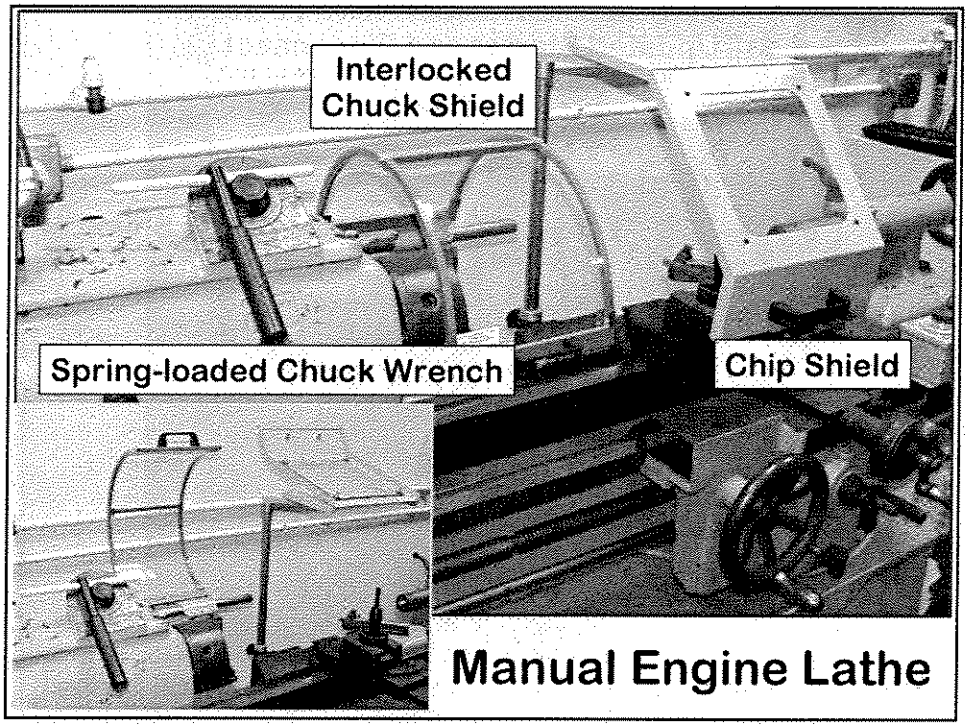


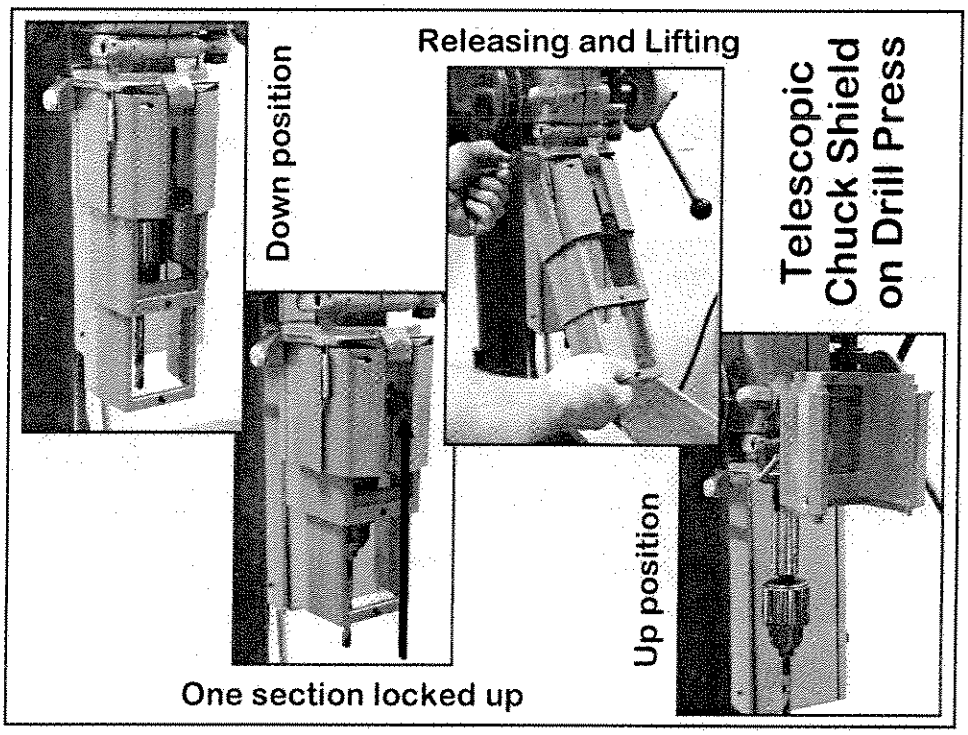


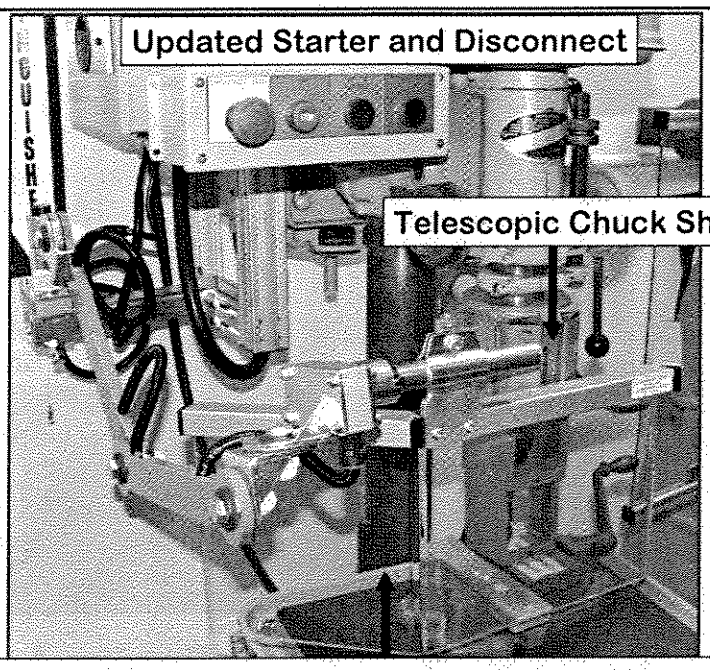


Old Mechanical Press Brake updated to ANSI B11.3-2002



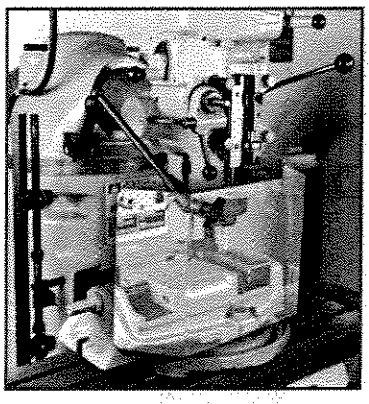

Interlocked
Chuck Shield
Spring-loaded Chuck Wrench
Chip Shield
Manual Engine Lathe

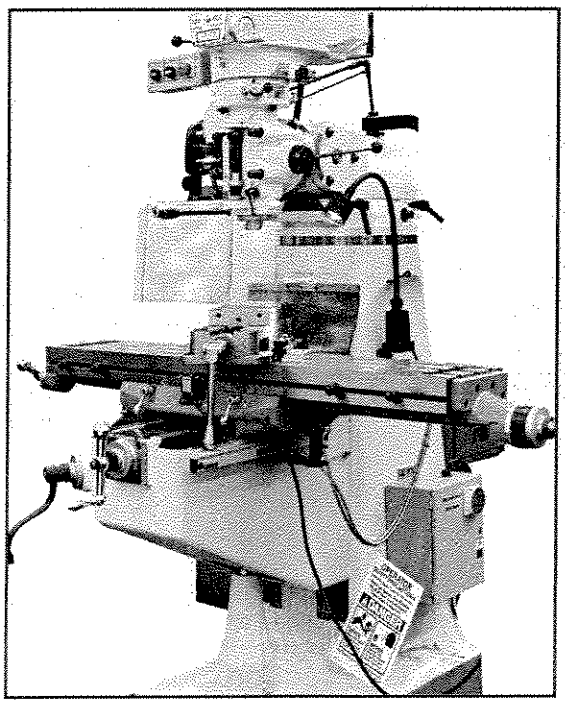

Down position
Releasing and Lifting
Telescopic
Chuck Shield
on Drill Press
Up position
One section locked up



Electrically Interlocked Chip/coolant Shield on Drill Press

Universal swing-away Shields

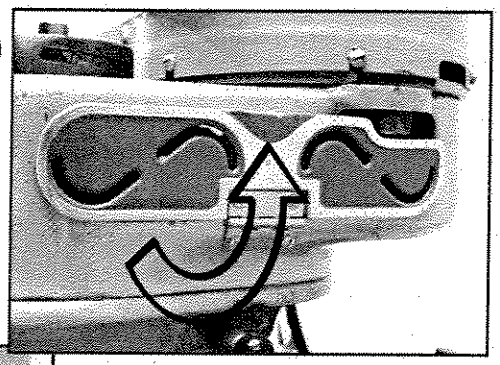


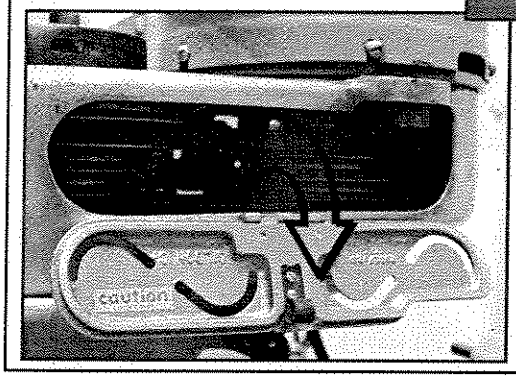


Vertical Mills

Belt Cover (closed)

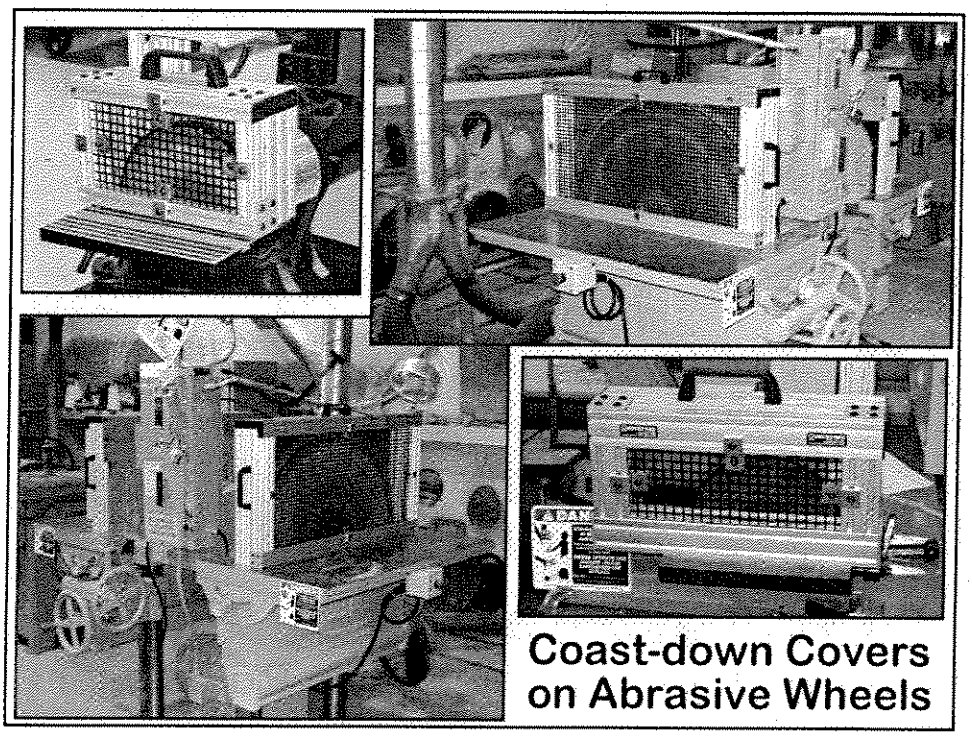
For pre-1957 J-head Bridgeport Vertical Milling Machines



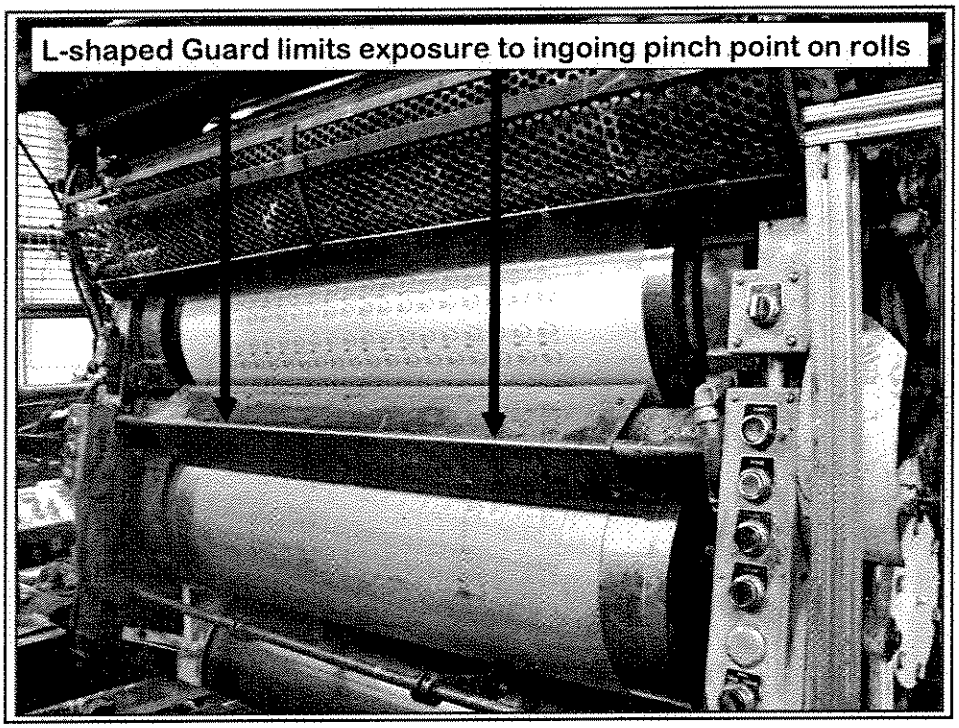


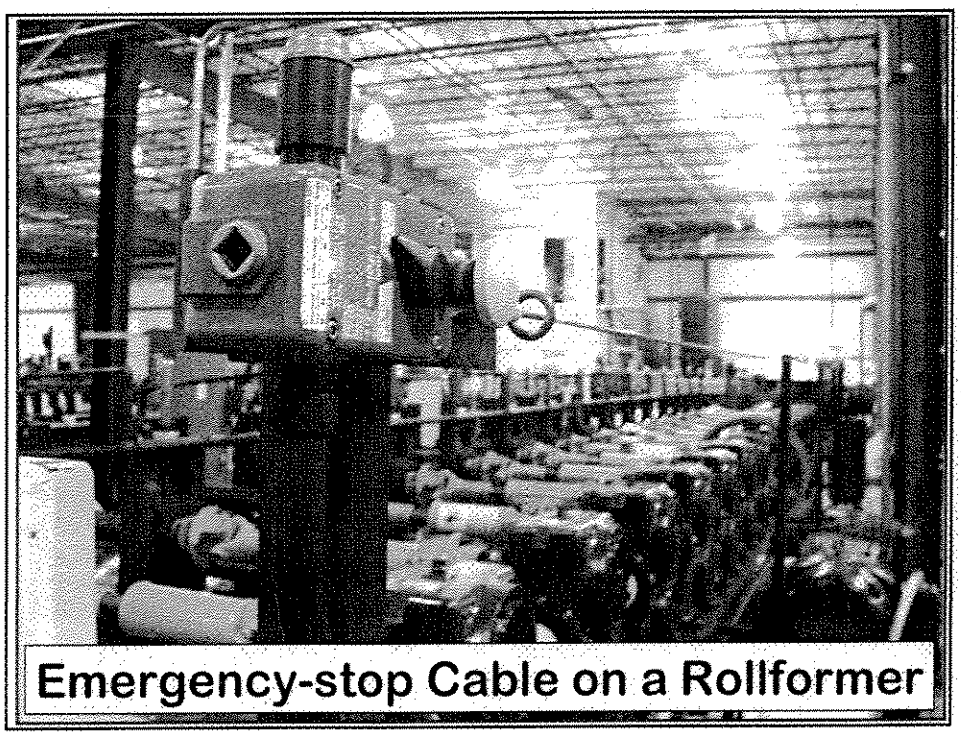
Bridgeport Mill

Belt Cover (open)



Coast-down Covers on Abrasive Wheels


L-shaped Guard limits exposure to ingoing pinch point on rolls


Emergency-stop Cable on a Rollformer