Operator Safety

Section 44 of ME 360 Course Notes

Hierarchy of Safety

1. Elimination of hazard
2. Engineering controls/safeguarding
3. Awareness / warning
4. Training and procedures ("administrative controls")
5. Personal protective equipment

Hierarchy of Safety #5

**Personal protective equipment**

► ________ glasses
► ________ plugs
► Face shields
► Gloves

Hierarchy of Safety #4

**Training and procedures**

► Safe job procedures
► Safety ________________ inspections
► Training
► ________________

Hierarchy of Safety #1

**Elimination of hazard**

► Eliminate human interaction in process
► Eliminate _______________________
► Automate material handling

Nip Points

from ANSI/RIA R15.06-1999

from ANSI/RIA R15.06-1999

from ANSI/RIA R15.06-1999

from ANSI/RIA R15.06-1999

from ANSI/RIA R15.06-1999

from OSHA 3067 – Concepts and Techniques of Machine safeguarding
Hierarchy of Safety #2

*Engineering controls*

- Mechanical hard stops
- Barriers
- Interlocks
- Presence sensing devices
- Two hand controls

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Barrier Guards

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Barriers – Minimum Sizes

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“Pusher” or Handles

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Emergency or “Panic” Stop

- Emergency ("panic") buttons are usually large ______________________________ that have a detent mechanism to hold them closed once pressed.
- Emergency stops are usually wired to remove ____________________________ as well as activating an automatic relief.

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Emergency/“Panic” Stop

- With a PLC, it is generally preferable to place at least one emergency stop button outside the ladder logic, such that program malfunctions cannot prevent system shutdown.

How is this done?
Safety – MCR / SCR

Auto / Manual Operation

MCR = ______________________________________

Auto / Manual Operation

Auto

Manual

Jog

X0

X1

X2

Only one of these two is valid

Can "jog" cylinder when switched to Manual

Operator Safety

► A _______________________ switch requires a continuous operator input to maintain system output.
  • A momentary contact switch without a control relay holding circuit will often suffice.
  • Two push-buttons (instead of one) are often spaced far apart such that both hands of an operator are required to press the buttons.

Two-Button Start

How do you prevent this?

No “Tie-Down” Circuit

Press X3

Start Timer T3

X3

Start Timer T3

X3

X4

TMR T3

K10

TMR T4

K10

C1

C52

C77

1 sec later these contacts open

Broomstick holding one pushbutton down continuously

Operates from one pushbutton only
**Physical Barriers**

► Some type of barrier to prevent access to workcell area is necessary

► Most common types of anti-intrusion devices are
  - curtains,
  - perimeter curtains,
  - safety mats, and
  - floor marking and warning lights (not really barriers)

**Light Curtains**

Point-of-operation Guards  Perimeter Area Guards

**Hierarchy of Safety #3**

**Awareness / warning**

► Lights, beacons and strobes
► Computer warnings
► Signs
► Restricted space painted on floor
► Beepers
► Horns
► Labels

**Warning Signals**

► A large flashing (or strobe) light is often used to indicate that the system is powered and operating.

► Additional warning lights can be provided during critical portions of the operating cycle, such as rapid cylinder advances, clamping cycles, etc.

**Warning Lights**

► Flashing red lights within a work zone indicating that an apparently stationary system is activated, but awaiting an input, or performing a time-delayed operation
  - Certain types of warning lights are mandated by law

**Floor Marking**

► Floor marking used to indicate a general warning of a workcell area
  - particularly for maintenance and other personnel that are not always there

► Low-cost way to start a good safety program

from ANSI/RIA R15.06-1999
**Safety Mats**

- Safety mats contain pressure-sensitive electronic switches and are placed on the floor
  - allow quick access to the workcell.
  - less likely to provide a false alarm
  - minimum weight required to activate
- Workcell shuts down when safety mat is activated by person’s weight

**Combination of Safety Methods**

- Perimeter Fencing
- Pressure Sensitive Safety Mat

**Guarded Workcell**

- E-stop buttons
- Barrier fence
- Awareness signal
- Light curtain

**Safety - Redundancy**

- Door fully closed
- Door fully open
- Redundant limit switches used in complimentary fashion

**Initial Design – Door Closed Signal**

- Not recommended, the system relies on a spring return to apply the stopping action, a failed spring or welded contact could result a failure to stop hazardous motion when required.

**“Fail-safe” Design – Door Closed Signal**

- Preferred method, utilizing the direct drive characteristics of the switch the contacts will be forced open even in the event of a welded contact. Safety is not dependent on the spring return.