SF04 EN14119 Guard Locking Update

CLASS NAME

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PUBLIC INFORMATION

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Scope: What is ISO 14119:2013?

- ISO 14119:2013 is a B2 standard
  - Interlocking devices associated with GUARDS
    - Some requirements to interlocking device manufactures
    - Most is towards the selection, integration, installation and use of interlocking devices for guards
      - Directed to machine designers/ builders and integrators
      - Integration and use…
  - Replaces ISO 14119:1998 as a harmonized standard (BS EN ISO)
  - Supersedes EN 1088:1995 because it an EU harmonized standard.

C: Detailed Safety Requirements for Particular Machines
B2: Standards on Safeguards
B1: Particular Safety Aspects
A: Basic Concepts & Principles – Applies to all Machinery

foundational standards are A-type standards.
Where does ISO 14119:2013 apply?

- Europe as it is harmonized as EN ISO 14119
- Any country that uses ISO standards
  - ISO 14119 is **THE** global safety interlocking standard
- Anyone who follows ANSI standards
  - ANSI/ISO 12100 – references ISO 14119 (x10)
- US & CA because there is NO equivalent US or CA standard now
  - ANSI B11.19 & CSA Z432 have bits but are not certification standards
  - ANSI RIA R15.06 & CSA Z434 normatively reference ISO 14119
    - However CSA Z434 has a deviation stating that CSA Z432 applies in Canada
- **MOST requirements apply to machine design, integration and use**
  - not the interlocking device manufacturer.
When does ISO 14119:2013 apply?

- It is applicable NOW, however it is not YET mandatory.
- For Europe either EN 1088 or EN ISO 14119:2013 can NOW be used for a presumption of conformity.
  - As of May 1, 2015, EN 1088 is gone…
    - EN 1088 will be withdrawn 30 April 2015 (per the Official Journal of the EU)
  - The grace period (18 months from ISO 14119 publication) allows time to meet ISO 14119 standard:
    - Interlocking device manufacturer:
      - Testing of guard locking devices
      - Updating documentation
      - Updating certs & DoC
    - Design of machines
    - Documentation for everyone
Why ISO 14119:2013 was developed?

- **Times and needs change. Historically...**
  - Electrical integration is NOT the total integration
    - Tongue actuated switches – viewed as a dual channel redundancy
      - Reality – single mechanical device with dual electrical circuits that always agree (right or wrong – due to direct acting contacts)
  - Life and “how it works” was/is not well understood
    - Unsafe component failure
    - Loss of power
    - Interlock hardware design behind functional safety standards
  - Interlock switches viewed simplistically, with wide integration discretion
    - Fault masking
    - Minimum safe distances not understood (guard openings & safe distance formula)
    - Guard locking safety functions & performance level(s)
  - Tampering and MOTIVATION to defeat was not addressed previously and has been found to have a PROFOUND impact on risks and injuries.
ISO 14119 references many standards

- **Normative References:** "Indispensable for its application"
  - ISO 12100 *Risk assessment and risk reduction*
  - ISO 13849-1&2 *Safety-related parts of control systems*
  - IEC 60204-1 *Electrical equipment of machines*
  - IEC 60947-5-3 *Control circuit devices and switching elements*  
    Requirements for proximity devices with defined behaviour under fault conditions
  - IEC 62061 *Functional Safety*

- **Other standards referenced in ISO 14119**
  - ISO 11161 *Integrated Manufacturing Systems*
  - ISO 13855 *Safeguard safe distance and approach speeds*
  - ISO 13857 *Safe distance to prevent reaching hazards by limbs*
  - ISO 14120 *Guards, fixed and moveable*
  - **DRAFT** ISO TR 24119 *Fault masking of series connection*
Major shifts in ISO 14119:2013

- Four types of interlocking devices defined and described
- Coding is defined and described: uncoded, low, medium & high
- Guard locking has added definitions and requirements
  - Mechanical requirements
  - Power to lock vs. power to release
  - Releases (IF PROVIDED) and their requirements
  - Multiple safety functions could apply: interlocking, lock monitoring…
  - Guidance on pull forces is provided in the Annex
- Selection and integration requirements, including safe distances
- Interlock technology and integration affects functional safety
- Must analyze and minimize interlock defeat & motivation to defeat before selection of interlocking device
## Interlocking Device <for guards> Types
Defined by actuation principle and actuator type

### Reference: ISO 14119 – Table 1

<table>
<thead>
<tr>
<th>Actuation Principle</th>
<th>Actuator Coding &amp; Examples</th>
<th>Type Interlock per ISO 14119</th>
<th>Example Rockwell Automation® Product Line</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mechanical</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical contact</td>
<td>uncoded</td>
<td>Type 1</td>
<td>Safety Limit Switch</td>
</tr>
<tr>
<td>force</td>
<td></td>
<td></td>
<td>Rotocam™ &amp; Safety Limit Switch</td>
</tr>
<tr>
<td></td>
<td>coded</td>
<td></td>
<td>Trojan™ / TLS GD2</td>
</tr>
<tr>
<td></td>
<td>Tongue <strong>low coding</strong></td>
<td></td>
<td>ProSafe®</td>
</tr>
<tr>
<td></td>
<td>(shaped actuator)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trapped-key <strong>med or high</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Non-contact</strong></td>
<td></td>
<td>Type 2</td>
<td>Safety Limit Switch</td>
</tr>
<tr>
<td>Inductive</td>
<td>suitable ferric metal</td>
<td></td>
<td>Ferrogard™</td>
</tr>
<tr>
<td>Magnetic</td>
<td>Magnet, solenoid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacitive</td>
<td>Any suitable object</td>
<td>Type 3 (see 7.1a)</td>
<td></td>
</tr>
<tr>
<td>Ultrasonic</td>
<td>Any suitable object</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optic</td>
<td>Any suitable object</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnetic</td>
<td>Coded magnet</td>
<td></td>
<td>SensaGuard™, TLSZ &amp; LZ</td>
</tr>
<tr>
<td>RFID</td>
<td>Coded RFID tag</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optic</td>
<td>Optically coded tag</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Coded actuator (3.13)

Actuator which is specially designed (e.g. by shape) to actuate a certain position switch

<manufacturer must specify the coding>

- **Low level coded actuator (3.13.1)**
  - Coded actuator for which 1 to 9 variations in code are available
  - Example: most coded magnetic actuators and standard coded safety RFID actuators

- **Medium level coded actuator (3.13.2)**
  - Coded actuator for which 10 to 1,000 variations in code are available

- **High level <unique> coded actuator (3.13.3)**
  - Coded actuator for which more than 1,000 variations are available
  - Example: Unique coding for most RFID safety switches

→ with high coded safety switches, there are fewer installation requirements due tamper-resistance of the product (not required to provide tamper-resistance installation)

### ISO 14119 Coded actuator definition

<table>
<thead>
<tr>
<th>Actuation</th>
<th>Actuator Coding &amp; Example</th>
<th>ISO 14119</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical contact force</td>
<td>Uncoded</td>
<td></td>
</tr>
<tr>
<td>Coded</td>
<td>Tongue low coding</td>
<td>Type 1</td>
</tr>
<tr>
<td></td>
<td>Trapped-key med or high coding</td>
<td>Type 2</td>
</tr>
<tr>
<td>Non-contact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inductive</td>
<td>Suitable ferric metal</td>
<td>Type 3</td>
</tr>
<tr>
<td>Magnetic</td>
<td>Magnet, solenoid</td>
<td></td>
</tr>
<tr>
<td>Capacitive</td>
<td>ANY suitable object</td>
<td></td>
</tr>
<tr>
<td>Ultrasonic</td>
<td>Coded magnet</td>
<td>Type 4</td>
</tr>
<tr>
<td>Optic</td>
<td>Coded RFID tag</td>
<td></td>
</tr>
<tr>
<td>Magnetic</td>
<td>Optically coded tag</td>
<td></td>
</tr>
<tr>
<td>RFID</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Guard locking definitions & requirements

- **Definitions**
  - 3.4 **Guard Locking Device**: a device intended to lock a guard in the closed position and linked to the control system
  - 3.5 **Interlocking Guard with Guard Locking**
  - 3.24 **Prevention of inadvertent locking position** (G3.3.)
  - 3.25 **Emergency release of guard locking** (from outside) (5.7.2, 5.7.5.3)
  - 3.26 **Auxiliary release of guard locking** (from outside) (5.7.5.4)
  - 3.27 **Escape release of guard locking** (from inside) (5.7.5.2)
  - 3.28 **Guard locking for protection of a person**
  - 3.29 **Guard locking for protection of the process** (or production)

- **5.7 Additional requirements** on guard locking devices: manufacturer of device, machine builder, integrator of device
  See 5.7.6: requirement that fastening & installation must withstand holding force.
Risk assessment determines IF any “release” is required (can be separate from the device) due to “foreseeable access” need

<table>
<thead>
<tr>
<th>Release Type</th>
<th>Guard Locking Safety</th>
<th>Actuated</th>
<th>Operating</th>
<th>Release Result</th>
<th>Reset</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Where</td>
<td>Aids</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Escape</td>
<td>People</td>
<td>Inside</td>
<td>No</td>
<td>Directly on Locking Mechanism</td>
<td>Stop Command</td>
<td>-Emergency and Escape release can be SAME, if Escape Release Requirements are met (mount the release mechanism inside)</td>
</tr>
<tr>
<td>Emergency</td>
<td>People</td>
<td>Outside</td>
<td>No</td>
<td>Directly on Locking Mechanism</td>
<td>Stop Command and Lock Blocking</td>
<td>Tool, Replacement, Control System</td>
</tr>
<tr>
<td>Auxilary</td>
<td>Machine</td>
<td>Outside</td>
<td>Tool or Key</td>
<td></td>
<td>Tool, Replacement, Control System</td>
<td>-For Exceptional Use</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-Shielded from accidental use</td>
</tr>
</tbody>
</table>
## Guard Locking Selection

### Holding Force, PTL vs PTR, release…

<table>
<thead>
<tr>
<th>Direction of force</th>
<th>Posture</th>
<th>Force application</th>
<th>Force value N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal pull-</td>
<td>Sitting</td>
<td>Single handed</td>
<td>600</td>
</tr>
<tr>
<td>ing (dragging)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical upward</td>
<td>Standing, torso and legs bent, feet parallel</td>
<td>Bi-manual, horizontal grips</td>
<td>1 400</td>
</tr>
<tr>
<td>Vertical upward</td>
<td>Standing, free</td>
<td>Single-handed, horizontal grips</td>
<td>1 200</td>
</tr>
<tr>
<td>Horizontal, parallel to body symmetry plane backward</td>
<td>Standing, upright, feet parallel, or in step posture</td>
<td>Bi-manual, vertical grips</td>
<td>1 100</td>
</tr>
<tr>
<td>Pull</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal, parallel to body symmetry plane forward</td>
<td>Standing, feet parallel, or in step posture</td>
<td>Bi-manual, vertical grips</td>
<td>1 300</td>
</tr>
<tr>
<td>Push</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal, normal to body symmetry plane body off</td>
<td>Standing, torso bent sideward</td>
<td>Shoulder pushing on metal plate on the side</td>
<td>1 300</td>
</tr>
<tr>
<td>Standing, feet parallel</td>
<td>Single-handed, vertical grip</td>
<td>700</td>
<td></td>
</tr>
</tbody>
</table>

### Holding Force

The guard locking device manufacturer shall state the holding force ($F_h$) & test to 1.3 times the stated $F_h$ (holding force).

**Electromagnetic products:**
- 500 to 1000 N holding force typical
- **Lock releases on power loss**
- Minimum safe distance is required
- Lock function cannot be used for personnel safety
- Listed by manufacturers as “Process Protection”

### Power to Lock Guard Locking Devices

- **Lock releases on power loss**
- Minimum safe distance is required
- Lock function NOT for personnel safety
- Listed by as “Process or Machine Protection”

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Interlocking Device Manufacturer
Requirements

- Interlocking Devices SHALL comply with
  - Type 1 & Type 2: EN (IEC) 60947-5-1 (direct acting contacts)
  - Type 3 & Type 4 (non-contact): EN (IEC) 60947-5-3
  - + ISO 13849 and the referenced standards contained in the IEC 60947 standards

- Guard locking switches now have requirements for …
  - “holding force” where the maximum force is at least 30% greater than holding force
  - “Releases” (emergency, escape, manual) **IF they are provided by the switch**
  - If lock monitoring is part of switch, state & use this symbol

- Manufacturers shall provide
  - Functional safety information (B10d or PL & Cat)
  - Warnings about
    - Motivation to defeat and issues relating to tampering, defeating and substitute actuation (including spare actuators)
  - Statement about the
    - Type Interlocking Device
    - Coding (low, medium, high)
    - Intended use and functionality of the Interlocking Device
Most requirements are selection, integration and use

- Risk assessment is the start
  - Identify the interlocking need and the required PL
  - Can fault exclusion be used (this is its own assessment)?
  - Is Guard Locking needed?
    - Is Power to Release needed (insufficient safe distance)?
    - What minimum holding force is needed?
  - Determine if Escape or Emergency Release is needed
    - Can be part of guard locking device or separate
  - Determine the motivation to Defeat
    - How/ where to install?
    - What coding is needed?
  - Engineer the guarding so that the interlock is secure and for contact type, that the installation will withstand the forces that it could be subjected.
Defeat (3.7): action that makes interlocking devices inoperative or bypasses them with the result that a machine is used in a manner not intended by the designer or without the necessary safety measures.

Defeat in a reasonably foreseeable manner (3.8): defeat of an interlocking device either manually or by using readily available objects (see Note 2)

Note 1: This definition <defeat in a reasonably foreseeable manner> includes the removal of switches or actuators using tools that are needed for the intended use of the machine or that are readily available (screwdrivers, wrenches, hexagon keys, pliers).

Note 2: Readily available objects for substitute actuation include screws, needles and sheet-metal pieces, objects in daily use such as keys, coins, adhesive tape, string and wire, spare keys for the trapped-key interlocking devices, and spare actuators.

Emphasis on HIGH coding due to its resistance to defeating
ISO 14119, Clause 7.1 a): **Design (integrate)** to minimize defeat possibilities of interlocking devices

- a) Implement the basic measures described in
  - 5.2 **Arrangement and fastening** of switches,
  - 5.3 Arrangement and fastening of actuators,
  - 5.4 **Actuation modes** of interlocking devices,
  - 5.7.3.3 **Basic measures for minimizing defeat possibilities** and
  - 6.2.2 **Specific requirements for selection of guard locking** devices.

  **Type 3 interlocking devices shall not be used unless it is shown by risk assessment that the device cannot be defeated in a reasonably foreseeable manner in that application.**

- b) Check whether the motivation to defeat the interlocking devices in reasonably foreseeable manner exists.

- c) Check whether the motivation can be minimized or minimized by:
  - design measures and/or **alternative modes**.
  - Implement those measures if possible.

  **NOTE 3:** The implementation of alternative modes of operation can avoid the motivation to defeat. Alternative modes of operation can be, for example, special modes for setting, tool changing, fault finding, maintenance or process observation. They depend highly on the type of machine and its application and cannot be dealt with comprehensively in this standard.

- d) If foreseeable motivation for defeat continues, additional measures are required (see 7.2).
Minimize the "Motivation to Defeat" - Requirements

**Basic Measures:** Arrangement & fastening, actuation mode, issue of electromagnetic guard lock being opened by force, guard locking devices ability to withstand expected forces. 5.2, 5.3, 5.4, 5.7.3.3 and 6.2.2

Type 3 interlocking devices shall not be used unless it is shown by the application risk assessment, the device cannot be defeated in a reasonably foreseeable manner.

Annex H - evaluation

**Annex H - evaluation**

*a lot of work for the integrator*

Modify the machine (add modes with risk reduction features) to minimize the motivation to defeat

Figure 9 – Methodology for determining the possible incentive and the required measures by the manufacturer <integrator>
## Measures Against Defeat:

### Part of Clause 7.2: Additional measures to minimize defeat possibilities

<table>
<thead>
<tr>
<th>Principles and Measures</th>
<th>See Clause</th>
<th>Type 1 not Hinge &amp; Type 3 – uncoded</th>
<th>Type 1 HINGE</th>
<th>Low &amp; Medium Code Type 2 (tongue) &amp; Type 4 (non-contact)</th>
<th>High Code Type 2 (Trapped Key) Type 4 (non-contact)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mounting out of reach</td>
<td>7.2 a) 1)</td>
<td><strong>Mandatory Select 1</strong> (minimum)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical obstruction/Shielding</td>
<td>7.2 a) 2)</td>
<td><strong>Mandatory Select 1</strong> (minimum)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mounting in hidden position</td>
<td>7.2 a) 3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-detachable fixing of…</td>
<td>7.2 c)</td>
<td><strong>Part of the Select 1</strong>&lt;Switch &amp; Actuator&gt;</td>
<td>Switch &amp; Actuator</td>
<td>Actuator (mandatory)</td>
<td>Actuator (mandatory)</td>
</tr>
<tr>
<td>Status monitoring or cyclic testing</td>
<td>7.2 d) 1) i) &amp; 7.2 d) 1) ii)</td>
<td><strong>Part of the Select 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional interlocking device and checking for plausibility</td>
<td>7.2 d) 2)</td>
<td></td>
<td>R Recommended (additional)</td>
<td>R Recommended (additional)</td>
<td></td>
</tr>
</tbody>
</table>

If detachable fixing used ➔  **Add at least one more from above**
## Annex H
### Evaluation of Motivation to Defeat

#### Table H.1 — Evaluation of motivation to defeat interlocking devices

|-----------------------------|---------|---------|---------|---------|---------|-----------------------------------------------|---------------------------------|-----------------------|----------------------------------|---------------------------------------|-----------------|-------------------|-----------------|------------------------|----------------|-------------------------|--------------------------|------------------------|... |
| Initial operation           |         |         |         |         |         |                                               |                                 |                       |                                  |                                       |                 |                   |                 |                        |                 |                         |                          |                        |... |
| Program test/Test run       |         |         |         |         |         |                                               |                                 |                       |                                  |                                       |                 |                   |                 |                        |                 |                         |                          |                        |... |
| Setup/adjustment conversion/tooling |         |         |         |         |         |                                               |                                 |                       |                                  |                                       |                 |                   |                 |                        |                 |                         |                          |                        |... |
| Machining                   |         |         |         |         |         |                                               |                                 |                       |                                  |                                       |                 |                   |                 |                        |                 |                         |                          |                        |... |
| Manual intervention for swarf removal |         |         |         |         |         |                                               |                                 |                       |                                  |                                       |                 |                   |                 |                        |                 |                         |                          |                        |... |
| Manual change of workpiece  |         |         |         |         |         |                                               |                                 |                       |                                  |                                       |                 |                   |                 |                        |                 |                         |                          |                        |... |
| Manual intervention for trouble shooting |         |         |         |         |         |                                               |                                 |                       |                                  |                                       |                 |                   |                 |                        |                 |                         |                          |                        |... |
| Checking/random sampling     |         |         |         |         |         |                                               |                                 |                       |                                  |                                       |                 |                   |                 |                        |                 |                         |                          |                        |... |
| Manual intervention for measuring/fine tuning |         |         |         |         |         |                                               |                                 |                       |                                  |                                       |                 |                   |                 |                        |                 |                         |                          |                        |... |

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**a** Modes of operation.

- Op. Mode 1: ............................................
- Op. Mode 2: ............................................
- Op. Mode 3: ............................................
- Op. Mode 4: ............................................
- Op. Mode 5: ............................................

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**IFA Manipulation Worksheet**

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The standard requires non-detachable fixing for SOME interlocking devices and this is described in **7.2 c) Prevention of dismantling or de-positioning of the elements of the interlocking device by use of non-detachable fixings**.

- There is a note at the end of 7.2 c) at top of page 24

  NOTE: Use of non-detachable fixing can be an inappropriate solution in cases where a failure of the interlocking device during lifetime of the machinery can be expected and a fast change is necessary. **In this case other measures, e.g. a), b) and d), should be used to provide the required level of risk reduction.**

- What are these “other measures” (detailed in 7.2):
  
  a) Prevention of accessibility to the elements of the interlocking device
  
  b) Prevention of substitute actuation of the interlocking device by readily available objects
  
  d) Prevention of defeat
    
    1) Integration of defeat monitoring in the control system by means of status monitoring or cyclic testing.
    
    2) Checking for plausibility using an additional interlocking device where defeat is only possible by an additional action — for example, separate mounting and wiring, or different actuation principles require an additional action for defeating.
Risk Assessment

- Machine & task risks to determine mitigation
- Stopping time and floor space to determine PTL or PTR, plus machine floor space with guarding
- Motivation to defeat, releases, and more (see slide 15)

Minimize motivation to defeat interlock devices:

Selection and Mechanical Installation / Location

- Protected from foreseeable damage
- Guarding must be sufficiently rigid to maintain operation (critical to minimize sag)
- Withstand expected forces: vibration, door slamming
- Not used as a door stop, unless impact rating declared by manufacturer
- Fastening & installation shall be designed to withstand the guard locking device holding force (for example, if the guard lock has Fhz of 10,000N, the attachment and guarding must withstand 10,000N.)
Referenced Tech Report and Standards

- Some key points and considerations that you should know…
Applies to Ferrogard, Sipha, MC1, MC2, and all contact block type switches

Restrictions for series connected contacts (not OSSD outputs) because the detection of a single fault can be masked by the actuation of any interlocking device connected between the fault and the safety related control system.

6.2 Simplified method for the determination of the maximum achievable DC

<table>
<thead>
<tr>
<th>Number of frequently used movable guards(^1,2)</th>
<th>Number of additional movable guards(^3)</th>
<th>Maximum Achievable Diagnostic Coverage(^4)</th>
<th>MAXIMUM (might not be easy) Achievable PL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2 to 4</td>
<td>Medium</td>
<td>PL d</td>
</tr>
<tr>
<td></td>
<td>5 to 30</td>
<td>Low</td>
<td>PL d</td>
</tr>
<tr>
<td></td>
<td>&gt; 30</td>
<td>NONE</td>
<td>PL c</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Medium</td>
<td>PL d</td>
</tr>
<tr>
<td></td>
<td>2 to 4</td>
<td>Low</td>
<td>PL d</td>
</tr>
<tr>
<td></td>
<td>&gt; 5</td>
<td>NONE</td>
<td>PL c</td>
</tr>
<tr>
<td>&gt; 1</td>
<td>-</td>
<td>NONE</td>
<td>PL c</td>
</tr>
</tbody>
</table>

\(^1\) Switching frequency greater than once per hour  
\(^2\) If # of operators capable of opening separate guards exceeds 1, then # of frequently used guards increases by 1  
\(^3\) # of movable guards may be reduced by 1, if min distance is more than 5m or other guards not reachable  
\(^4\) If fault masking is foreseeable (multiple guards open at same time), DC is limited to NONE
When the guards are closed and equipment can operate, guard openings and the distance to the hazards

<table>
<thead>
<tr>
<th>Opening (e) (smallest dimension)</th>
<th>Minimum (safe) distance $S_r$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Slotted</td>
</tr>
<tr>
<td>mm 0 &lt; e ≤ 4</td>
<td>≥ 2</td>
</tr>
<tr>
<td>in. 0 &lt; e ≤ 0.16</td>
<td>0.08</td>
</tr>
<tr>
<td>mm 4 &lt; e ≤ 6</td>
<td>≥ 10</td>
</tr>
<tr>
<td>in. 0.16 &lt; e ≤ 0.24</td>
<td>0.39</td>
</tr>
<tr>
<td>mm 6 &lt; e ≤ 8</td>
<td>≥ 20</td>
</tr>
<tr>
<td>in. 0.24 &lt; e ≤ 0.31</td>
<td>0.79</td>
</tr>
<tr>
<td>mm 8 &lt; e ≤ 10</td>
<td>≥ 80</td>
</tr>
<tr>
<td>in. 0.31 &lt; e ≤ 0.39</td>
<td>3.1</td>
</tr>
<tr>
<td>mm 10 &lt; e ≤ 12</td>
<td>≥ 100</td>
</tr>
<tr>
<td>in. 0.39 &lt; e ≤ 0.47</td>
<td>3.9</td>
</tr>
<tr>
<td>mm 12 &lt; e ≤ 20</td>
<td>≥ 120</td>
</tr>
<tr>
<td>in. 0.47 &lt; e ≤ 0.79</td>
<td>4.7</td>
</tr>
<tr>
<td>mm 20 &lt; e ≤ 30</td>
<td>≥ 850\textsuperscript{T}</td>
</tr>
<tr>
<td>in. 0.79 &lt; e ≤ 1.2</td>
<td>33</td>
</tr>
<tr>
<td>mm 30 &lt; e ≤ 40</td>
<td>≥ 850</td>
</tr>
<tr>
<td>in. 1.2 &lt; e ≤ 1.6</td>
<td>33</td>
</tr>
<tr>
<td>mm 40 &lt; e ≤ 120</td>
<td>≥ 850</td>
</tr>
<tr>
<td>in. 1.6 &lt; e ≤ 4.7</td>
<td>33</td>
</tr>
<tr>
<td>mm Reaching through 120 &lt; e</td>
<td>Openings within a guard &gt;120 mm (4.7 in.) are not permitted without additional safeguarding</td>
</tr>
<tr>
<td>in. 4.7 &lt; e</td>
<td></td>
</tr>
</tbody>
</table>

Source: ISO 13857:2008, 4.2.4.1, Table 4
Machine system stopping performance is critical. If the machine’s stopping time is more than the time for a person to access a hazard, EITHER
– move back the guard to the required MINIMUM <safe> distance (more floor space)
OR
– guard locking is REQUIRED which must meet the required PL & Cat (functional safety) for protection of personnel (Power to Release).

Figure 7 – Determination of the need for guard locking devices
Minimum (Safe) Distance Formula

For Interlocked Guards (plus PTL guard locking)

- **ISO 13855:2010 is required by ISO 14119**
  
  \[ S = (K \times T) + C \]
  
  Where:
  
  - \( S \) = Minimum (safe) distance between the safeguarding device and the hazard, in mm
  - \( K \) = Speed constant, based on approach speeds of the body or parts of the body (either \( \geq 1,600 \) or \( 2,000 \) mm/sec)
  - \( T \) = Overall system stopping time, in seconds (anticipated worst case – see standard for details)
  - \( C \) = Intrusion distance (Depth penetration factor), in mm

- **For info:** ANSI B11.19-2010, RIA R15.06-1999, CSA Z432 & CSA Z434
  
  \[ D_s = [K \times (T_s + T_c + T_r)] + D_{pf} \]
  
  Where:
  
  - \( D_s \) = Minimum (safe) distance between the safeguarding device and the hazard, in mm
  - \( K \) = Speed constant, based on approach speeds of the body or parts of the body (\( \geq 1600 \) mm/sec)
  - \( T_s \) = Worst anticipated stopping time of the machine or equipment, in seconds
  - \( T_c \) = Worst anticipated response time of the control system, in seconds
  - \( T_r \) = Response time of the protective device, including its interface, in seconds
  - \( D_{pf} \) = Depth penetration factor (intrusion distance), in millimeters

*not all guarding shown*
ISO 14119 – Key Impacts

- European machines moving toward PLe solutions
  - Less documentation and analysis required when using PLe interlocking devices with high coded actuators

- Existing versus New Application
  - Existing systems - no requirement to change or update
  - Applies to new or modified equipment

- Safe distance requirements apply to ALL interlocking devices (not just now)

- Machine builders and integrators need time to understand their requirements for risk assessment, analysis, and documentation (motivation to defeat, fault exclusion)

- Diagnostic Coverage (DC) and functional safety link ISO 14119 to ISO 13849

- Fault masking limits DC and achievable PL (not applicable to TLSZ, LZ, MAB, & SensaGuard)

- Interlock Selection: type, coding, holding force, power-to-release
Questions?