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Standards for CNC and manual machine guarding

EXPORT CLASSIFICATION REQUIREMENT

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Classification	
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LEGAL and CORPORATE requirements

These standards do not replace legal and corporate requirements. They are additional requirements or clarifications.

They may not address all requirements each sites needs to follow.

EXCEPTION to standards

EXCEPTION to these standards shall be managed based on machine risk assessment at each site level and clearly documented.

An « Exception Form » shall be completed and sent to PWC EHS Central Team for review for each machine or group of machines not meeting applicable standard.(Form available on PWC EHS Intranet site under Cardinal Rule/Machine Guarding)

This documentation shall be kept for life of equipment.

PWC Machine Guarding Standards

Definition (PW)

Danger area :

That position or point, in or about a machine or piece of equipment, where part of an employee's body may come in contact with movement on or about the machine. Movement refers to movement of the machine while it cycles, movement of material, movement of energy through a power transmission device or movement of any equipment or device attached to a machine. Nip points, pinch points, the point of operation, etc. are components of the danger point or zone.

Point of operation:

The area(s) of a machine where material or the work piece is positioned and a process is performed.

Fixed Guards:

Guards installed in such a manner that tools are necessary for the adjustment or removal may satisfy this requirement. At two (2) or more fasteners will be acceptable. Examples of some types of fasteners that should not be used are:

Slotted or Phillips head screws; Wing nuts; Magnets; Latches and hasps; Hooks and eyes.

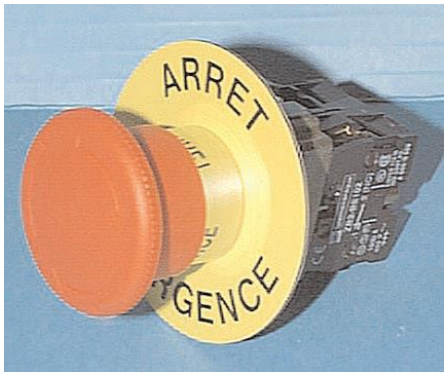
Acceptable fasteners.: Socket head cap screws; Hex head bolts,12 point head, Torx head.

Interlock:

Barrier guard(s) shall be prevented from opening until hazardous motion has ceased, or shall be located so that an individual cannot reach the hazard before cessation of the hazardous motion when the interlocked section is open. The guard must be reinstalled before the machine can be restarted.

PWC Machine Guarding Standards

Emergency Stop button



- Must be installed so that they are clearly visible on each workstation and within reach of the worker so they can be activated safely
- Must be red and mushroom-shape
- The area behind the control must be yellow (standard ISO 13850)
- Must be initiated by a single human action in response to or anticipation of a dangerous situation
- Must safely stop the machine as quickly as possible
- Must stop the machine group if this poses a risk
- Must remain active until a deliberate action is taken to reset it
- Must not start the machine when they are reset
- The emergency stop function must be Category 1 if the circuit is wired logic and Category 3 in other cases (e.g. software)

PWC Machine Guarding Standards

Horizontal Manual Lathe

1. Machine operation shall only be possible when:
   a) Mechanical interlocking guard (category ≥ 3) covering the chuck remains locked until chuck stops rotating
   b) Protective devices are active (category ≥ 3). If, in this mode, it is possible to open an interlock movable guard, the hazardous movements shall cease and be inhibited:
      i. With a electromagnetic brake that stop the rotation within 2 sec.
      ii. With a timer that keep's the guard locked until the deceleration is finished because you don't have a brake on the machine

   NOTE: Closing the interlocked guard shall not reinitiate automatic operation
2. Guard covering the part must be interlocked (category ≥ 3) and go beyond maximum capacity of the part length + 15 cm (6 inches). No need to close the guard on the side.
3. Guards for cutting fluid and spatter of shavings beyond the part don't need to be interlocked
4. The back shield should be appropriate to the size of the lathe and protect from any contact with hazards (shavings, cutting fluid, rotating part). *Ref. ISO 13852 formerly EN294 / Hard guards – Barrier Height and Position*
5. Fixed guard limiting access to the drive belts, pulleys and gears
6. Guards on the lead-screws and feed shafts (e.g. accordion guard)
7. Bar feeding access and ''bar area'' must be protected.
8. Emergency stop button or emergency stop pedal (see standard of emergency stop)
9. Wearing gloves, loose-fitting clothing, jewellery (including rings, necklaces, tie, bracelets, wristwatches, etc.) and long hair that is not tied back is prohibited while operating the machine.

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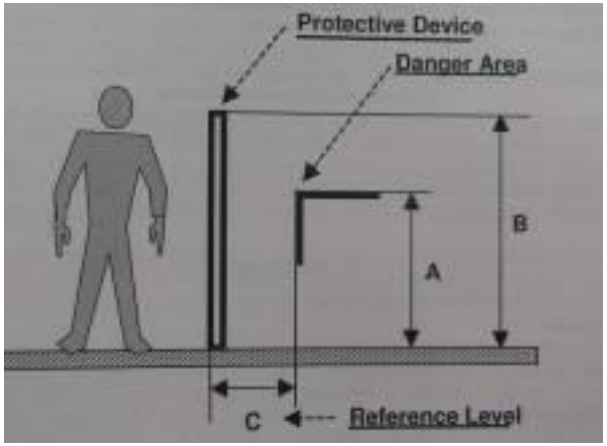
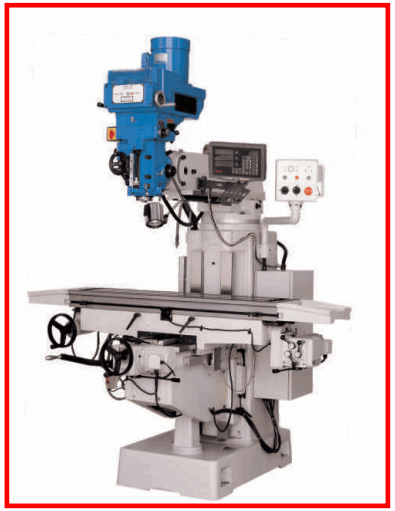
Référence ISO 13852 (EN294) / Hard Guard – Barrier Height and Position



Hard Guards - Barrier Height and Position **ISO 13852 formerly EN294**								
A-in (mm)	C-in (mm)							
106 (2700)								
96 (2184)	0 (0)	4 (102)	4 (102)	4 (102)	4 (102)	4 (102)	4 (102)	4 (102)
86 (2438)		10 (254)	14 (356)	16 (407)	20 (508)	20 (508)	24 (610)	24 (610)
78 (1981)			14 (356)	20 (508)	24 (610)	28 (711)	36 (915)	43 (1093)
71 (1803)				24 (610)	36 (915)	36 (915)	40 (1016)	43 (1093)
63 (1600)				20 (508)	36 (915)	36 (915)	40 (1016)	51 (1296)
55 (1397)				4 (102)	32 (813)	36 (915)	40 (1016)	51 (1296)
48 (1220)					20 (508)	36 (915)	40 (1016)	55 (1397)
40 (1016)					12 (305)	36 (915)	40 (1016)	55 (1397)
32 (813)						24 (610)	36 (915)	51 (1296)
24 (610)							20 (508)	48 (1220)
16 (407)							12 (305)	48 (1220)
8 (203)							8 (203)	43 (1067)
B-in (mm)	96 (2438)	83 (2108)	78 (1981)	71 (1803)	63 (1600)	55 (1397)	48 (1220)	42 (1067)

PWC Machine Guarding Standards

Milling machine



1. Interlocking three (3) sided guarding (category ≥ 3) covering chuck and tools

   Note: Some exceptions may occur and may require that the side guards will not be interlocked

2. Machine operation shall only be possible when:
   - a) Mechanical interlocking guard (category ≥ 3) covering the chuck remains locked until chuck stops rotating
   - b) Protective devices are active (category ≥ 3). If, in this mode, it is possible to open an interlock movable guard, the hazardous movements shall cease and be inhibited:
     - i. With a electromagnetic brake that stop the rotation within approx. 2-4 sec. If the assessment determine that 4 sec. Is to long, 2 sec. should be applied.
     - ii. With a timer or equivalent that keep's the guard locked until the deceleration is finished because you don't have a brake on the machine

     NOTE: Closing the interlocked guard shall not reinitiate automatic operation

3. Fixed guard limiting access to the drive belts, pulleys and gears or guard with a detector (category ≥ 1) .
4. The back shield should be appropriate to the size of the milling and protect from any contact with hazards (shavings, cutting fluid, rotating cutter).
5. Machines designed for a fixed location shall be securely anchored to prevent walking or moving (according to the manufacturer's recommendations)

   Note: If there is no possibility of machine movement an exception may apply based on evaluation and documentation.
6. All tools/parts must be clamped to the table
7. All tools/parts must be clamped to the table
8. Emergency stop button (see standard of emergency stop)
9. Wearing gloves, loose-fitting clothing, jewellery (including rings, necklaces, tie, bracelets, wristwatches, etc.) and long hair that is not tied back is prohibited while operating the machine

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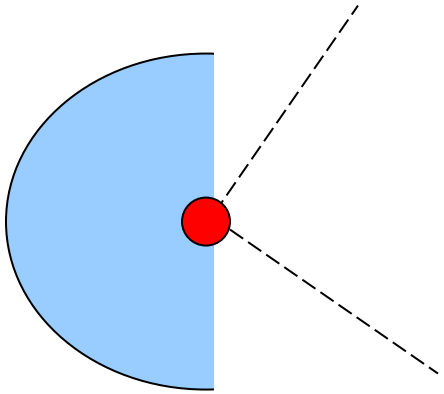
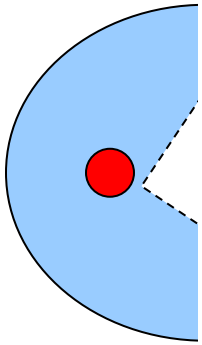
Three sided Mill Guarding examples

Operator



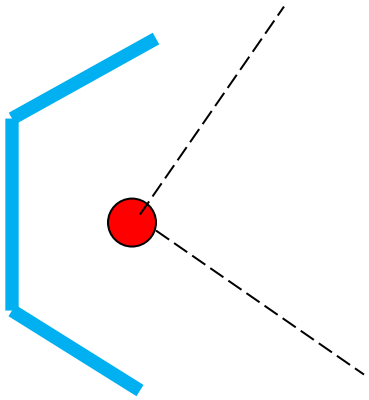
Minimum coverage expected

Operator



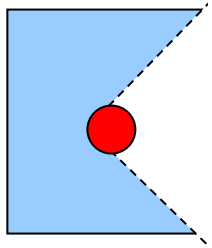
Ideal / Best coverage

Operator



Minimum coverage expected

Operator



Ideal / Best coverage

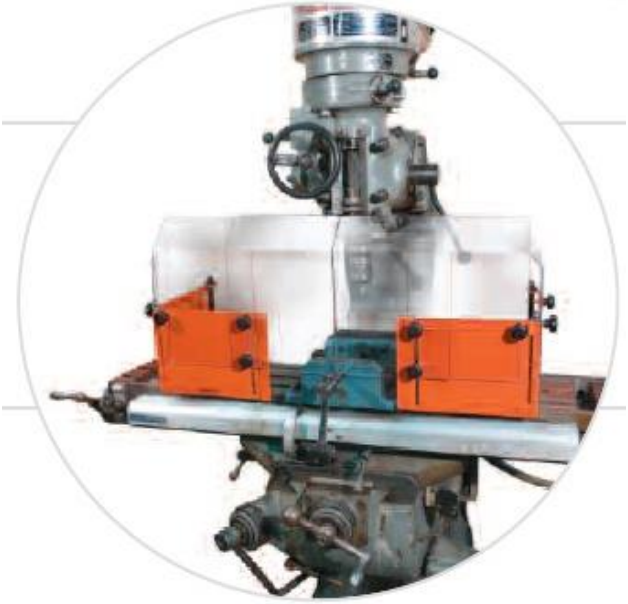
Mill Point of operation (POO)

PWC Machine Guarding Standards

Example of a lathe guard

PWC Machine Guarding Standards

Example of a milling machine guard



Export Classification: No Technical Data,

PWC Machine Guarding Standards

Drill press (part 1)

1. Guard preventing access from the front and sides of the chuck**,** rotating parts of the spindle and attached tooling is required on all drills regardless of size or HP.
2. Interlocking guards (category ≥ 3) will be required on drills that have any one or more of the following conditions:
   a) Drills with chucks with a maximum drill size capacity at or above ¾ inch (.750) or 19 mm designation
   b) 36B Jacob key chuck or anything that can drill a hole of ¾ inch or larger
   c) 4MT spindle tapers (MT = moorse taper)
   d) above 3 HP regardless of chuck size or taper

3. Machine operation on drill press considered in point 2. shall only be possible when:
   a) Mechanical interlocking guard (category ≥ 3) covering the chuck remains locked until chuck stops rotating
   b) Protective devices are active (category ≥ 3). If, in this mode, it is possible to open an interlock movable guard, the hazardous movements shall cease and be inhibited:
      i. With a electromagnetic brake that stop the rotation within approx. 2-4 sec. If the assessment determines that 4 sec. is to long, 2 sec. should be applied.
      ii. With a timer or equivalent that keep's the guard locked until the deceleration is finished because you don't have a brake on the machine

   NOTE: Closing the interlocked guard shall not reinitiate automatic operation
4. Fixed guard preventing access to the drive belts and pulleys is required or guard with a detector (category ≥ 1).

See next slide…

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PWC Machine Guarding Standards

Drill press (part 2)

5. All parts will be secured with a hold down device allowing the part being worked on to be firmly fixed in position, e.g. a vice or flange or by combination fixture and part. At no time will parts be allowed to be secured or held by hand.
6. All drill bases will be secured to the floor or onto table.
7. Emergency stop button (see standard of emergency stop) or red stop button not flush-mounted.
8. Wearing gloves, loose-fitting clothing, jewellery (including rings, necklaces, tie, bracelets, wristwatches, etc.) and long hair that is not tied back is prohibited while operating the machine.
9. Recommend the use of “spring loaded chuck keys” to prevent inadvertent chuck key ejection. http://www.rockfordsystems.com/Downloads/pdf/SLK-Catalog.pdf

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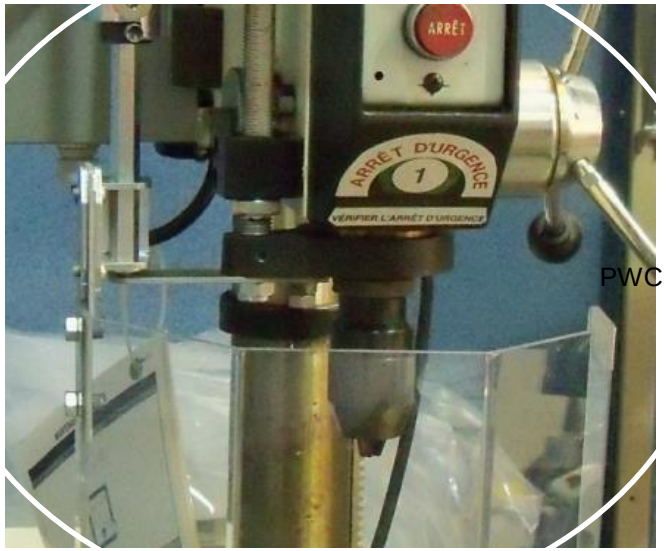
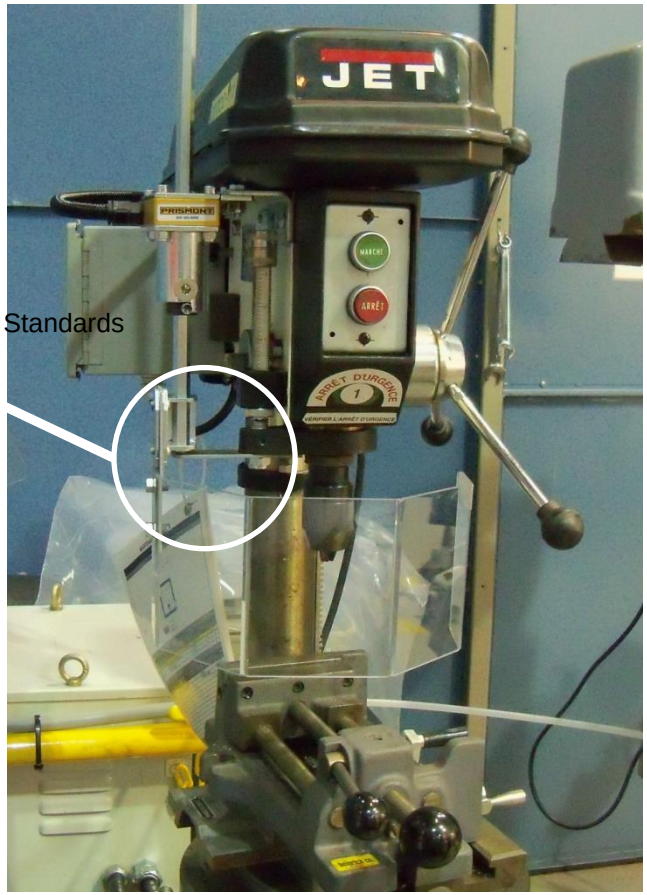
PWC Machine Guarding Standards

Example of a drill guard

Plant 5 Dept. 9568 – Tool room



PWC Machine Guarding Standards



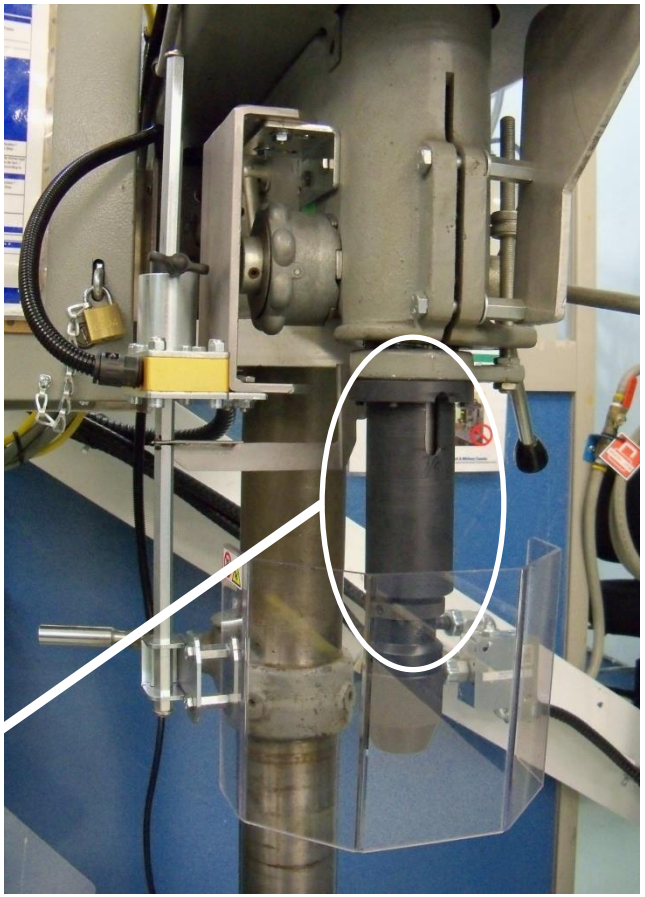
Guard attachement following spindle

PWC Machine Guarding Standards

Example of a drill guard

Plant 5 Dept. 9512 – PT6

Base adaptor



Spindle guard

PWC Machine Guarding Standards

Example of a drill guard

PWC Machine Guarding Standards

Cylindrical grinder (O.D., I.D., Plunge, Creep feed, Centerless grinder,)

1. Grinding wheel:
    a) Are used at manufacturers specified R.P.M. and intended usage. Never faster and check pulley combinations (RPM of the equipment shall be known by the operator)
    b) Always ring test and visually inspect wheels before mounting and inspect before use
    c) Assure that the grinding wheel is well balanced (when required by the manufacturer)
    d) Must install grinding wheel blotter paper if not already attached to the grinding wheel (distribute the clamping force evenly across the wheels surface)
    e) Use of a holder (to protect fingers) when:
        i. Dressing the wheel with a diamond-tip (or mounted on the machine)
        ii. Profiling the wheel with a carbon (Norbide) stick
        iii. Checking the profiling to take the radius print
2. Guards:
    a) Original non modified fixed guard on the grinding wheel
    b) Interlock guard (category ≥ 3) covering the part when grinding (interlock connected only on the movement of the chuck).
    c) Fixed guard preventing access to the drive belts and pulleys is required if the guard doesn't have any detector
    d) If there is a need to rotate the part for centering with interlock guard deactivated, jog mode shall comply with EN 13218 (reduced speed & hold-to-run command)
3. The back shield should be appropriate to the size of the cylindrical grinder and protect from any contact with hazards (cutting fluid, grinding wheel). *Ref. ISO 13852 formerly EN294 / Hard guards – Barrier Height and Position*
4. Emergency stop button (see standard of emergency stop).
5. Wearing gloves, loose-fitting clothing, jewellery (including rings, necklaces, tie, bracelets, wristwatches, etc.) and long hair that is not tied back is prohibited while operating the machine.

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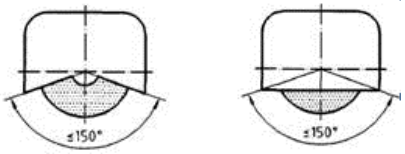
PWC Machine Guarding Standards

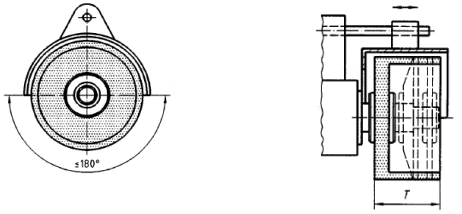
Surface Grinder/Tool Grinder

1.Grinding wheel shall be protected and be exposed only at the point of operation. This requirement is met by use of appropriate wheel carter. The carter opening angle can not exceed 150° for the surface grinder and 180 ° for tool grinder. (ref. EN 13218)

Surface Grinder



Tool Grinder



During loading, unloading or measurements, additional precautions are needed.

These can included any of the following:

•Stopping rotation of the wheel *(in accordance with grinding wheel manufacturer specifications) or*

•Automatic protection of the wheel (cover) or

•Removal of the grinding wheel in a safe position (Safe distance rules respected)

•For surface grinder, it is recommended to install an interlocked barrier guard to prevent opening until the table has reached its “home” position or wheel has stopped.

2.Fixed guard limiting access to the drive belts, pulley, drive shafts and gears

3.Emergency stop button or emergency stop pedal (see standard of emergency stop)

4.Wheel dressing shall be performed without removal of the physical guard

5.Fixed guards shall be installed in such a manner that tools are necessary for their adjustment or removal. (As such not immediately removable.)

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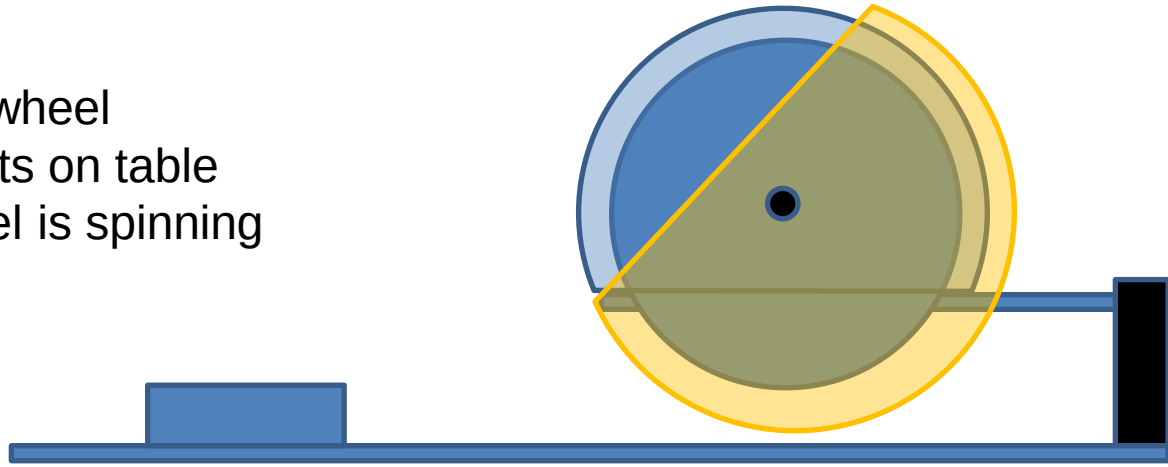
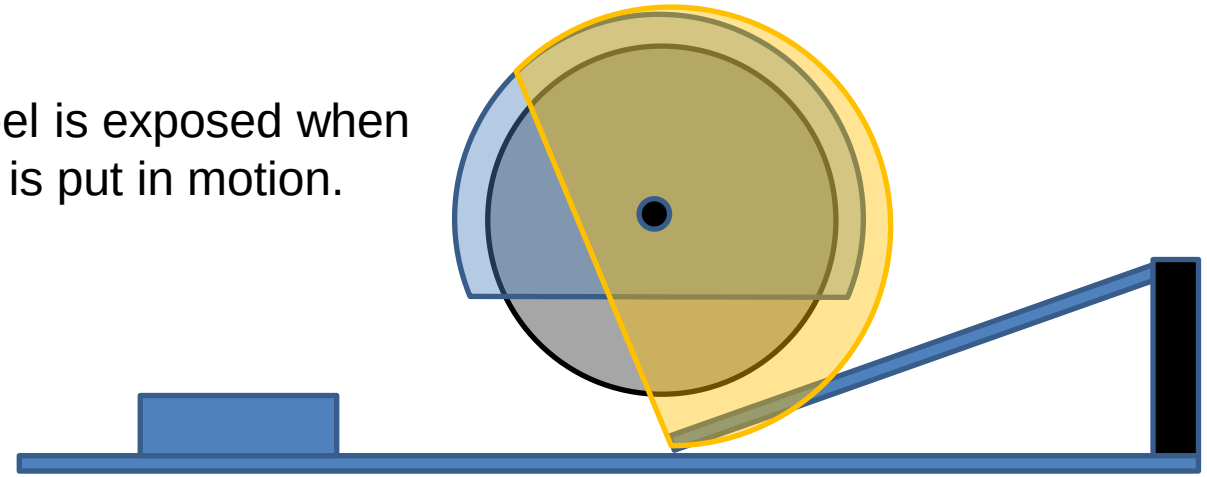
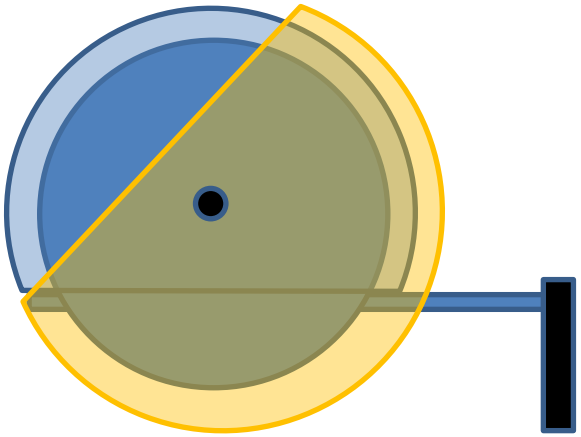
Example of moving guard

Enclosed grinding wheel
Safe to replace parts on table
while grinding wheel is spinning

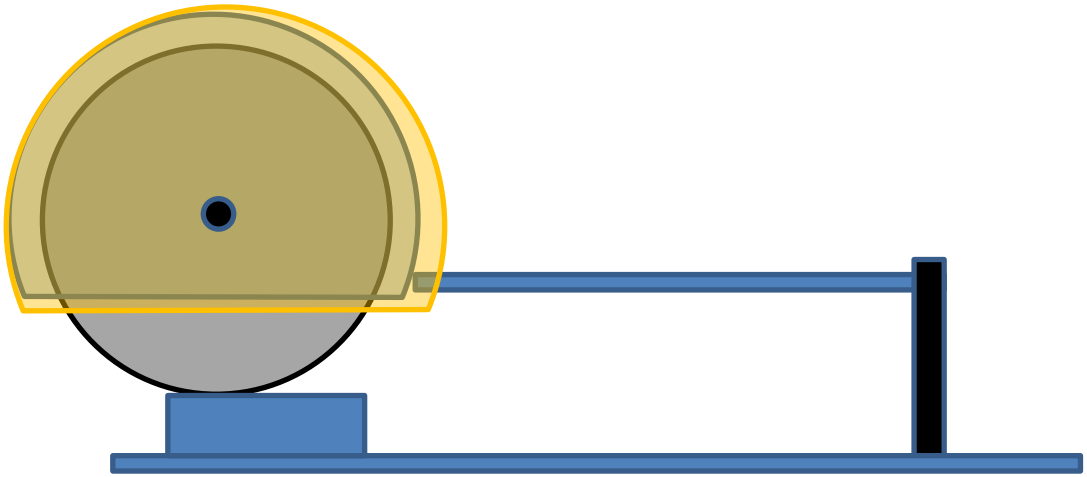


Grinding wheel is exposed when
surface table is put in motion.





Exposed grinding wheel



PWC Machine Guarding Standards

Bench and pedestal grinder

1. Side guards shall cover the spindle, nut and flange and 75% of the wheel diameter
2. The work rest shall be used and kept adjusted to within 1/8-inch (0.3175cm) of the wheel. Never adjust rests while wheels are moving.
3. The adjustable tongue guard on the top side of the grinder used and kept to within 1/4-inch (0.6350cm) of the wheel
4. The maximum RPM rating of each abrasive wheel compatible with the RPM rating of the grinder motor
5. Select correct wheel for your operation
6. Before new abrasive wheels are mounted, they shall be visually inspected and ring tested
7. Before use, wheel shall be visually inspected
8. Check that wheel have blotter paper on each side
9. Face shield have to be always worn when grinding or shield attached to the grinder
10. Pedestal and Bench Grinder shall have a red stop button not flush-mounted
11. When grinder is used in dry condition, local ventilation system must be in place in compliance with local regulation and industrial hygiene results
12. Losing power will not reinitiate the operation

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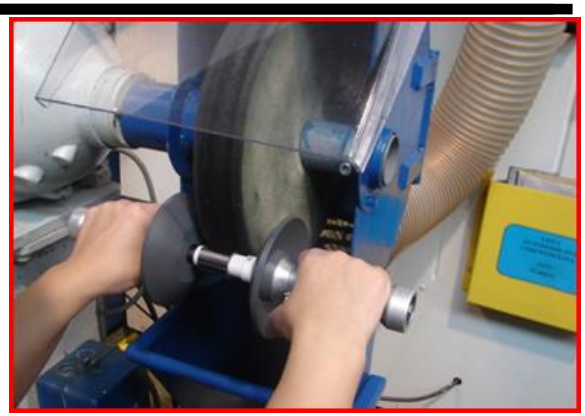
PWC Machine Guarding Standards

Buffer and Polisher



1. Guarding shall enclosed all accessible moving part of the machines such the tapered spindles by means of fixed guards
2. The guards shall allow the spindle to run freely and the mop or polishing wheel to be fitted without rubbing on the guard. Design shall eliminate the presence of nip points where fingers could get catches (distance between wheel and guard:10 mm or less)
3. Flat screw eliminating risk of entanglement shall be used at the spindle end when applicable
4. A mop/wheel must be kept on the tapered spindle at all times as a protective measure or be covered by an enclosure rending the spindle not accessible if not in use
5. Jigs and work holding devices shall be used when buffing/polishing small work pieces or any parts that would necessitate the operators hands to be in close proximity of the rotating wheel
6. Grinding wheel shall never be mounted on a polisher or buffer.
7. Operator shall wear adjusted cloth and if required net for long hair. Operator are not allowed to wear gloves, ample clothing, watch, ring, jewel or any other objet that create risk to be entangle around mobile elements of the machine.
8. Face shield have to be always worn when grinding or a shield be attached to the buffer/polisher
9. Machine shall have a red stop button not flush-mounted
10. Local ventilation system must be in place in compliance with local regulation and industrial hygiene results

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PWC Machine Guarding Standards

Horizontal band saw

1- Full guard (housing) on the blade drive wheels. Shall be fixed or with a detector (category ≥ 1 as long as the security functions are not processed by a programmable electronic system. If yes, a category ≥ 3 is necessary).

2- Adjustable guard that prevents access to the blade along its entire length, except at the cutting area

3- Before sawing, set the adjustable blade guard not to exceed 6 mm from the part being cut (see next slides)

4- Emergency stop button or emergency stop pedal (see standard of emergency stop)

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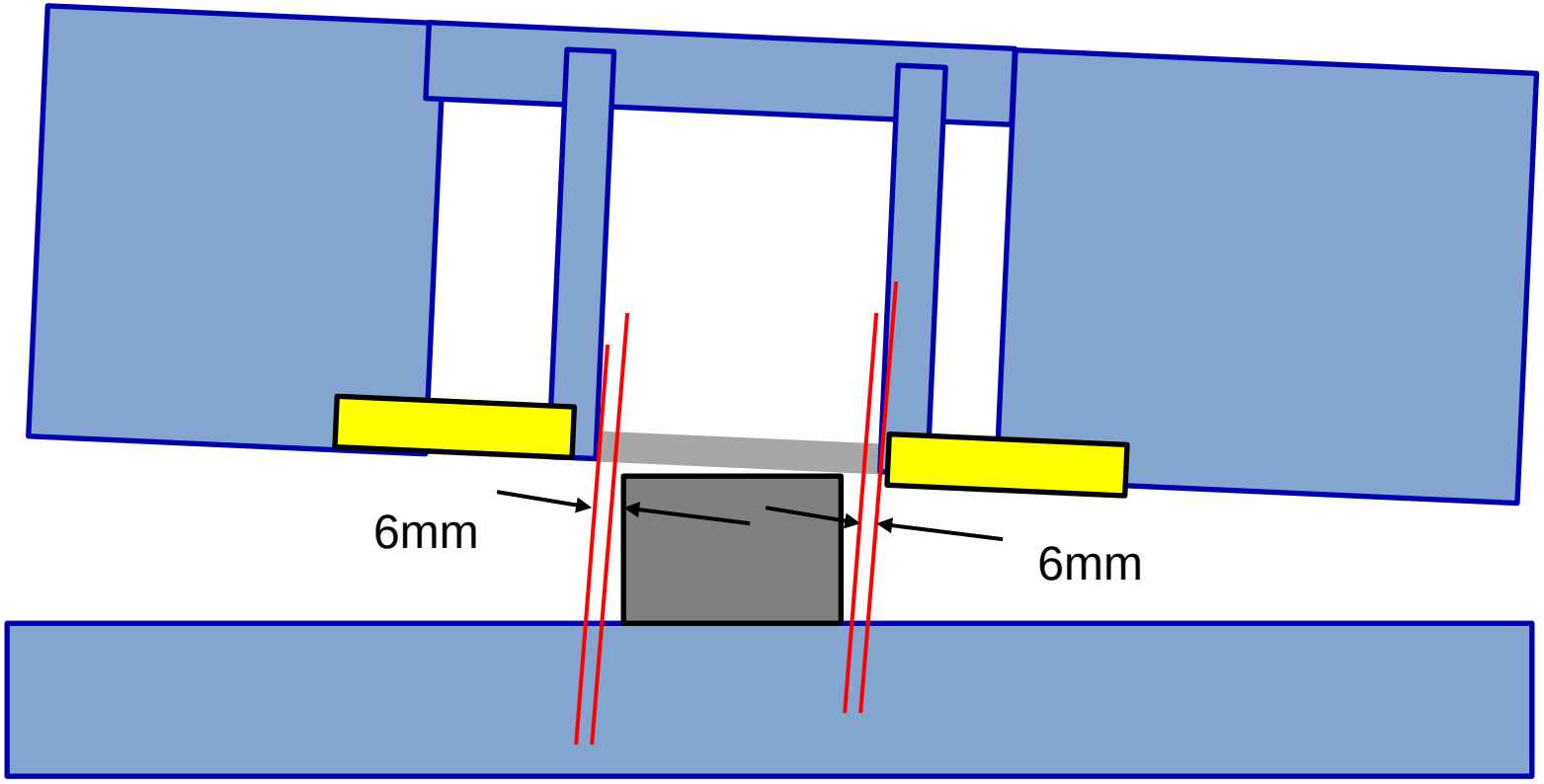
PWC Machine Guarding Standards

Horizontal band saw

Point of Operation

Adjust right and left arms to bring guards within 6 mm of the part to minimize exposure



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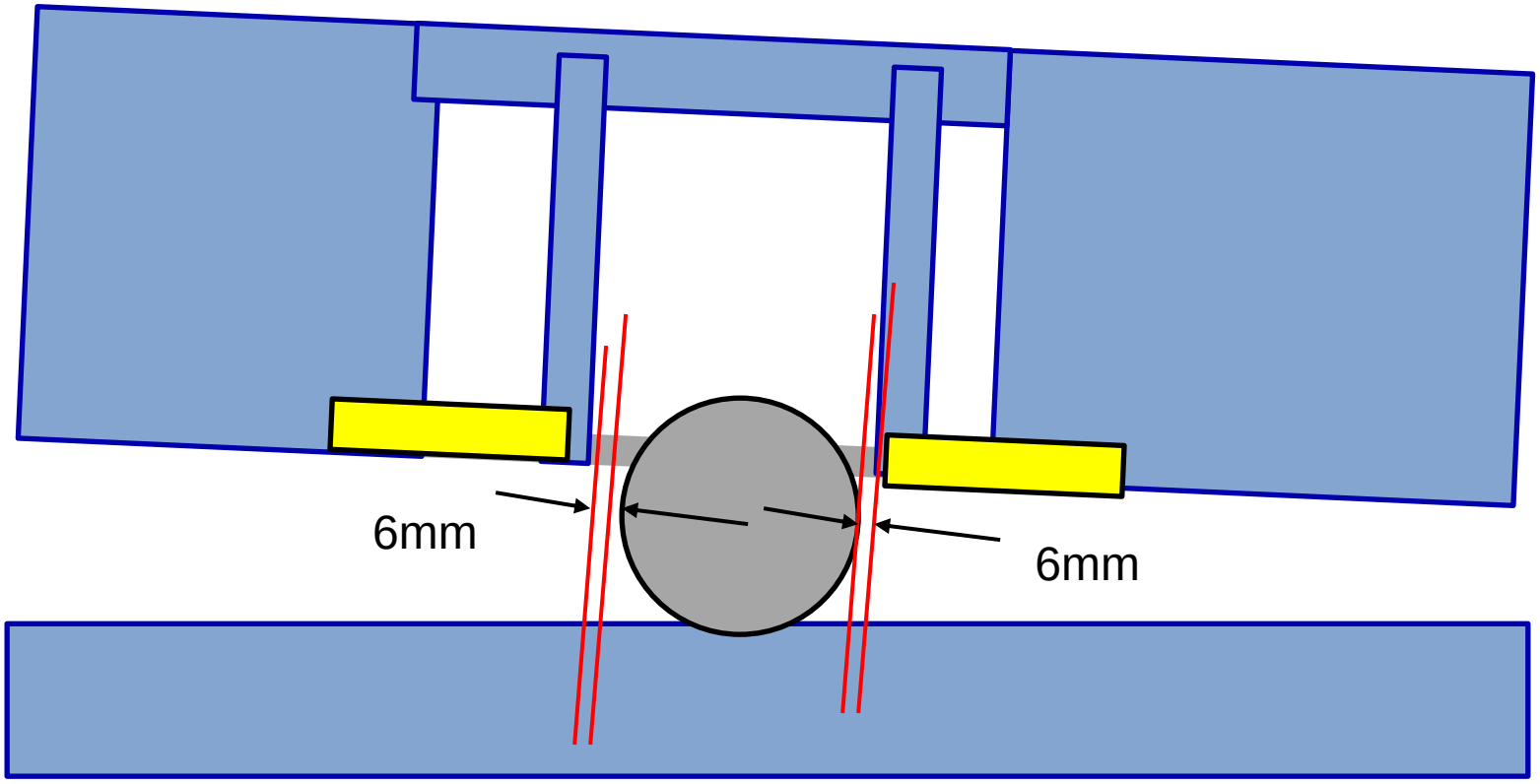
PWC Machine Guarding Standards

Horizontal band saw

Point of Operation

Adjust right and left arms to bring guards within 6 mm of the part to minimize exposure



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PWC Machine Guarding Standards

Vertical band saw

1- Full guard (housing) on the blade drive wheels. Shall be fixed or with a detector (category ≥ 1 as long as the security functions are not processed by a programmable electronic system. If yes, a category ≥ 3 is necessary).).

2- Adjustable guard or protection device that prevents access to the blade along its entire length, except on the side where work is carried out, between the blade guard and the table

3- Before sawing, set the adjustable blade guard not to exceed 6 mm from the part being cut

4- Emergency stop button or emergency stop pedal (see standard of emergency stop)

5- Must use a tool or wooden block to push part when your hand come within 20 cm of the blade

6- Local ventilation system must be in place in compliance with local regulation and industrial hygiene results

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PWC Machine Guarding Standards

Hobbing machine

1. Interlocking guarding (category ≥ 3) covering chuck and tools
2. Machine operation shall only be possible when:
   a) Mechanical interlocking guard (category ≥ 3) covering the chuck remains locked until chuck stops rotating
   b) Protective devices are active (category ≥ 3). If, in this mode, it is possible to open an interlock movable guard, the hazardous movements shall cease and be inhibited:
      i. With a electromagnetic brake that stop the rotation within 2 sec.
      ii. With a timer or equivalent that keep's the guard locked until the deceleration is finished because you don't have a brake on the machine

   NOTE: Closing the interlocked guard shall not reinitiate automatic operation
3. Fixed guard limiting access to the drive belts, pulleys and gears or guard with a detector (category ≥ 1).
4. The back shield should be appropriate to the size of the hobbing and protect from any contact with hazards (shavings, cutting fluid, rotating cutter).
5. Machines designed for a fixed location shall be securely anchored to prevent walking or moving (according to the manufacturer's recommendations).

   Note: If there is no possibility of machine movement an exception may apply based on evaluation and documentation.
6. All tools/parts must be clamped to the table.
7. Emergency stop button (see standard of emergency stop).
8. Wearing gloves, loose-fitting clothing, jewellery (including rings, necklaces, tie, bracelets, wristwatches, etc.) and long hair that is not tied back is prohibited while operating the machine.

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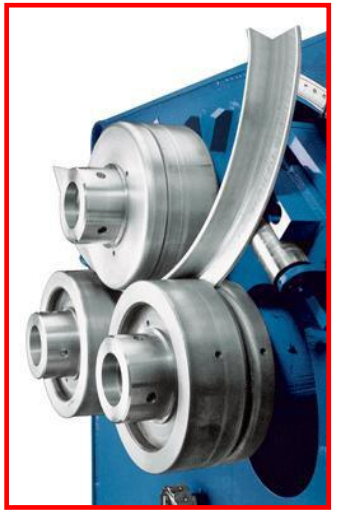
PWC Machine Guarding Standards

Roll bending and Angle roll machine

1- Guard preventing access to the danger area (front, side and back of the machine) when the machine is operating, namely:

- Fixed guards (note: section 2. below is optional), **or**;
- Adjustable guards, **or**;
- Controls (levers, buttons, pedals, etc.) at an adequate distance (e.g. possibility of a feed support or table) to prevent the worker from entering the danger area during operation, (category ≥ 3)

2- When the machine is controlled by a pedal (category ≥ 3), it shall be a three-position pedal, protected from the sides and above and cannot be accidentally activated. Upon releasing the pedal, machine shall stop immediately (cycle shall not complete).



3- Emergency stop (see standard of emergency stop) :

- Precision : Emergency stop button **and** stop cord or bar at knee or foot level (unless the equipment is too small to justify such additional safety system)

4- Loose-fitting clothing, jewellery (including rings, necklaces, tie, bracelets, wristwatches, etc.) and long hair that is not tied back is prohibited while operating the machine.

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PWC Machine Guarding -Jig Bore

1. Guarding of Manual Jig Bore shall be done by following the Standard for “Milling Machine” whenever possible.
2. If ever interlocking the point of operation guard can not be accomplished without rending the machine non-operational, the following measures shall be taken:
    1. Evaluate and document the residual risks through a machine hazard risk covering all operating condition including set-up and maintenance.
    2. Determine if local regulation allows alternative controls methods else than interlocked guard of the hazardous area.
    3. For each residual risk identified ,define and document the proper alternate control in place including training required, work instructions, conditions to operate the machine, authorized employees restriction, personal protective equipment required.
    4. Get senior management documented approval of the alternate controls measures.
    5. Ensure those measures are audited periodically to ensure they are maintained and effective.
3. **Please note that if the machine can not be equipped with an interlocked guard covering the chuck and tool, an “Exception Request” shall be completed and sent to PWC EHS Central Team.**

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CNC Machine Standards

General health and safety requirements for MV machine tools

1. It is permissible to work in the setting mode (with open covers) for lathes, milling machines and MV grinders, under condition to meet the requirements in accordance with:

- for lathes: PN EN ISO 23 125 + A1: 2012E;
- for milling machines: PN EN 13 128 + A2: 2011P;
- for grinders: PN EN 13 218 + A1: 2011P.

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CNC Machine Standards

The required working conditions in the set-up mode for CNC machine tools:

- Axis feed movements limited to 2,000 mm / min or indexed movements at maximum every 6 mm
- The rotational speed of the tool spindle must not exceed 20 rpm, allowable in when manual rotation is blocked / impossible
- It is allowed to leave the rotation of the grinding wheel with the door / covers underneath open condition for complete protection of the rotating grinding wheel with an additional automatic guard
- Rotational speed of the work piece clamping device (work table, turning spindle) it must not exceed 50 rpm at the equivalent peripheral speed of 1.3 m / s, allowed when manual rotation is blocked
- All displacements in the linear and rotary axes with the shields open must be controlled by a continuously held button using the control knob (hold-on button or hand wheel)
- Chip conveyor blocked with door open
- The possibility of automatic tool change is blocked (movement of the paw, tool magazine, head revolver) with the possibility of manual removal / insertion of the tool from / to the spindle
- Category I emergency stop switch in accordance with IEC 60204-1: 2009, ISO 12 100-2: 2003 and ISO 13850

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