Machine Guards

White Paper 3
ISO 14120

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Explaining the differences between ISO 14120 and EN 953

Jeremy Procter, a Member of standards committees ISO/TC 199/WG 6 (Safety distances and ergonomic aspects) and BSI MCE/3 (Safeguarding of machinery), and Managing Director of Procter Machine Guarding, explains how ISO 14120, the international standard for machine guards, differs from the standard it replaces, EN 953.

ISO 14120 is replacing EN 953

It is anticipated that by the end of 2015 the international standard ISO 14120:2015 (and BS EN ISO 14120:2015 in the UK), *Safety of machinery - Guards - General requirements for the design and construction of fixed and movable guards* will supersede and replace the Harmonised European standard EN 953:1997+A1 (and BS EN 953:1997+A1:2009 in the UK). Soon after the new standard has been published, it will be Harmonised as a European standard (EN ISO 14120) and published in the Official Journal (OJ) of the European Union. It will therefore provide a presumption of conformity with certain Essential Health and Safety Requirements (EHSRs) of the Machinery Directive 2006/42/EC. Whereas EN 953 was a European standard, ISO 14120 is an International standard (the UK equivalent from BSI will be BS EN ISO 14120), so machine builders exporting outside the European Union are likely to benefit by only having to design and manufacture in compliance with one main guarding standard. This present White Paper highlights the key differences between the new and old standards, and the implications for machine builders, though there are also other minor changes that could be significant for a minority. It should be borne in mind that machine builders are responsible for ensuring that they comply with current standards unless they have a very good reason for not doing so.

Most of ISO 14120 will feel familiar for engineers used to working with EN 953. The majority of clauses are similar, though the old clause 7, *Additional design and construction considerations*, has been removed, with its contents being incorporated within clause 5, *General requirements for the design and construction of guards*. The next two clauses, *Verification of the safety requirements for guards* and *Information for use*, have been renumbered from 8 to 7 and 9 to 8, respectively.

In contrast, the annexes have been heavily revised. The EN 953 Annex A, *Guidelines to assist in the selection of guards against hazards generated by moving parts*, has been removed, as has Annex B, *Guidelines for the selection of guards according to the number and location of hazards*, both of which were flow charts illustrating the procedures described in the relevant subclauses. ISO 14120 benefits from three new annexes, all of which are informative only: Annex A, *Examples of retained fastenings* (which is, in fact, little more than the illustration previously found in EN 953 subclause 7.2); Annex B, *Example of projectile test method for mechanically testing guards*; and Annex C, *Example of pendulum test method for mechanically testing guards.*

Clause-by-clause changes

Foreword

Much of the Foreword in ISO 14120 is similar to that in EN 953 but there is a useful summary of the technical revisions compared with the first edition of ISO 12100 (ISO 14120:2002) – but this present White Paper contains more detail about the differences between EN 953 and the new edition of ISO 14120.

Introduction

The Introduction to ISO 14120 provides a better explanation of Type-A, Type-B and Type-C standards, and states that ISO 14120 is a Type-B2 standard (EN 953 only referred to itself as a Type-B standard). Whereas EN 953 makes it clear that the designer shall manage risks by identifying risks, assessing those risks and reducing risks by design before considering safeguards, ISO 14120 makes no reference to risk management in the Introduction, except to say that guards provide a risk reduction for both protection against unintended access and against ejected parts and substances, and that guards can also protect against other hazards such as noise, fire, biological hazards and radiation. Note, however, that clause 4, *Risk assessment*, remains virtually unchanged.

1. Scope

Although it is a relatively small point, it should be noted that the scope now refers to the design, construction and selection of guarding, whereas EN 953 referred only to design and construction (NB in an earlier draft of the new edition of ISO 14120 the standard's title was also changed to incorporate 'selection' but the final draft has reverted to the same as EN 953, ie *Safety of machinery - Guards - General requirements for the design and construction of fixed and movable guards*). As the scope now refers specifically to the selection of machine guards, the inference is that the standard is equally applicable when selecting standard guards or guard components – for example, when creating a perimeter guard by specifying elements from a modular guarding system.

Other small – but possibly significant – changes to the scope include a statement that the standard indicates hazards other than mechanical hazards that can influence the design and construction of guards, and the word 'primarily' has been removed from the statement 'This International Standard applies ~~primarily~~ to guards for machinery which will be manufactured after it is published.' In addition, the list of special systems not covered by the standard now includes 'the ability of machinery to lift loads.'

2. Normative references

With the most recent amendment to EN 953 being published in 2009, and the new standard being international rather than European, it is not surprising that the normative references have changed significantly. The following European standards were all referenced in EN 953 but are not in ISO 14120 (NB they are all still current Harmonised standards and, therefore, continue to provide a presumption of conformity with certain Essential Health and Safety Requirements (EHSRs) of the Machinery Directive 2006/42/EC):

- EN 349, *Safety of machinery. Minimum gaps to avoid crushing of parts of the human body* *
- EN 626-1, *Safety of machinery. Reduction of risks to health from Hazardous substances emitted by machinery. Principles and specifications for machinery manufacturers* **
- EN 1127-1, *Explosive atmospheres. Explosion prevention and protection. Basic concepts and methodology* ***
- EN 1672-2, *Food processing machinery. Basic concepts. Hygiene requirements* ****

* EN 349 is still current (BS EN 349:1993+A1:2008 in the UK) but the corresponding international standard is ISO 13854:1996 and this is mentioned elsewhere in ISO 14120, though not listed in the normative references.

** Although EN 626-1 is still current (BS EN 626-1:1994+A1:2008 in the UK), one of the normative references in ISO 14120 is the corresponding international standard ISO 14123-1, *Safety of machinery - Reduction of risks to health from hazardous substances emitted by machinery - Part 1: Principles and specifications for machinery manufacturers*. Note that ISO 14123-1:2015 has recently replaced ISO 14123-1:1998.

*** EN 1127-1 is not included in the normative references but it is in the Bibliography in ISO 14120.

**** Although EN 1672-2 is still current (BS EN 1672-2:2005+A1:2009 in the UK), one of the normative references in ISO 14120 is ISO 14159, *Safety of machinery. Hygiene requirements for the design of machinery*.

One other notable change to the normative references in ISO 14120 is the addition of the following, for which there was no equivalent in EN 953:

- ISO 13855, *Safety of machinery. Positioning of safeguards with respect to the approach speeds of parts of the human body* (NB the European equivalent EN ISO 13855:2010 is Harmonised to the Machinery Directive).

3. Terms and definitions

Throughout this clause there are minor changes to the text, but the following are worth highlighting:

Self-adjusting guard – the term *automatically adjustable guard* has been added and it shares the same definition (in EN 953 the term *automatically adjustable guard* is defined separately, but in a simpler way).

Interlocking guard with a start function - Control guard – a control guard was defined as a type of movable guard in EN 953 (3.3.3) but its definition has been moved to 3.5.1 in ISO 14120 so it is now classed as a type of interlocking guard.

4. Risk assessment

There are no substantive changes to this clause.

5. General requirements for the design and construction of guards

5.1.2, *Access to danger zones*, lists examples of reasons for access to hazard zones. Whereas EN 953 included 'process observation' in the list, ISO 14120 does not list this, the inference being that guarding should be designed to provide sufficient process visibility.

5.1.3, *Containment of ejected parts and other impacts*, has been rewritten and now states that guards shall, as far as practicable, be designed to withstand impacts from parts of machinery and impacts from the operator, as well as impacts from ejection of parts (for example, the workpiece or broken tooling). Note that EN 953 did refer to impacts from parts of the machinery and from the operator in subclause 5.5.2, *Impact resistance*.

5.1.7 has been extended; whereas in EN 953 this clause was *Explosions*, in ISO 14120 it is *Potentially explosive atmospheres*. As well as referring to the guarding containing or relieving an explosion within the machine, the standard now also states that the guard shall not be an ignition source. There is also a note about guards designed to protect against fire and a reference to ISO 19353.

5.3, *Guard design and construction aspects* has been expanded to incorporate the subclauses previously found within EN 953 subclause 5.4, *Guard construction aspects*. The new subclauses are therefore: 5.3.7, *Sharp edges, etc*; 5.3.8, *Integrity of joints*; 5.3.9, *Removal of fixed guards*; 5.3.10, *Mounting of removable fixed guards*; 5.3.11, *Adjustable guards*; 5.3.12, *Movable guards*; 5.3.13, *Closed position of movable guards*; and 5.3.14, *Interlocking guards with a start function (control guards)*.

Of these, 5.3.9, *Removal of fixed guards*, has been expanded beyond what was in EN 953 (5.4.3, *Removal only by tool*). In particular, ISO 14120 makes it clear that quick-release fasteners such as quarter-turn screws shall not be used to secure fixed

guards from outside the guarded area (the standard does not prohibit the use of such fasteners if they are accessed from inside the guards, but makes it clear that such fasteners should not be used as an alternative to providing an emergency exit).

In 5.3.11, *Adjustable guards*, there is a new requirement: automatically adjustable guards shall, as far as practicable, be designed to prevent the automatic adjustment being defeated – though there is a note stating that it will not be possible in all cases to prevent automatically adjustable guards from being defeated, bypassed or rendered non-operational in an easy way.

5.3.14, *Interlocking guards with a start function (control guards)* (the equivalent subclause in EN 953 was 5.4.9, *Control guards*), contains only two indented points compared with five in the old standard. However, the points that are not included here are covered by ISO 12100:2010, subclause 6.3.3.2.5, the requirements of which must be met in addition to the two points made in ISO 14120 subclause 5.3.14.

5.13, *Guards with electrically conductive parts*, is a new subclause for which there was no equivalent in EN 953. This subclause states that where guards are made of electrically conductive material used in electrically powered machines, they may need to be considered as 'extraneous conductive parts of the machine' according to IEC 60204-1:2005 clause 8. Guard designers will therefore need to have knowledge of the machine being guarded and refer to IEC 60204-1:2005 to decide whether or not the guards need to be included in the protective bonding circuit.

5.18, *Climbing*, is a new clause in subclause 5 but is the equivalent of 7.1 in EN 953.

5.19, *Retained fastenings*, is a new subclause in clause 5 but is the equivalent of 7.2 in EN 953. However, the new text includes an explanation of when the requirement to use retained fastenings does not necessarily apply, such as guards that are only likely to be removed when the machinery is completely overhauled, is subject to major repairs or is dismantled for transfer to another site. In addition, ISO 14120 states that the requirement to use retained fastenings may not be applicable if the manufacturer's instructions specify that the repairs requiring removal of the casings are only to be carried out in a specialist repair shop **and** the fastenings shall only be removable by the use of a tool (and remember that 'tool' is defined in subclause 3.7 as 'implement such as a key or wrench designed to open and close a fastener'). The final point to note about subclause 5.19 is that whereas the equivalent subclause 7.2 in EN 953 included an illustration of an example of a retained fastening, the illustration has been removed from the subclause and a new illustration can now be found in Annex A instead.

5.20, *Vibration resistance*, is a new subclause in clause 5 but is the equivalent of 7.3 in EN 953.

5.21, *Warning signs*, is a new clause in subclause 5 but is the equivalent of 7.4 in EN 953.

5.22, *Colour*, is a new subclause in clause 5 that expands on the equivalent subclause 7.5 in EN 953.

5.23, *Appearance*, is a new subclause in clause 5 but is similar to 7.6, *Aesthetics*, in EN 953. However, the new subclause 5.23 is more explicit, stating that guards shall be designed so that they do not add adverse physiological and psychological effects.

6. Selection of types of guards

Subclause 6.1, *General*, contains an important new addition to the indented points: one of the most important selection criteria is now 'the foreseeable misuse and defeat of the guards'. Although foreseeable misuse should be covered in the formal risk assessment, adding this requirement to ISO 14120 serves as a useful reminder to machine guard designers and specifiers.

Subclause 6.3, *Selection of guards according to the number and size of the hazards*, has been redrafted and is now much clearer. There is no longer a prioritised list of guards, though the redrafted clause does indicate the top priority by means of this opening statement: 'Where practicable hazards shall be guarded by enclosing guards'. Because the prioritised list has been dispensed with, so has the corresponding Annex B from EN 953, *Guidelines for the selection of guards according to the number and location of hazards*.

Subclause 6.4, *Selection of guards according to the nature and frequency of access required* also includes changes. In subclause 6.4.1, *General*, there is now a reference to ISO 12100 for requirements and guidelines on the selection of guards. Because subclause 6.4 has been redrafted, the EN 953 Annex A, *Guidelines to assist in the selection of guards against hazards generated by moving parts*, has not been carried over to ISO 14120.

There are two important changes in subclause 6.4.4.1 (6.4.3.1 in EN 953), *Where access is required only for machine setting, process correction or maintenance*:

- first, EN 953 states that movable guards should be used if the frequency of access is 'high (e.g. more than once per shift)' but now ISO 14120 defines 'high' as 'e.g. more than once per week';
- second, in EN 953 fixed guards should only be used 'if the foreseeable frequency of access is low, its replacement is easy, and its removal and replacement are carried out under a safe system of work', with no definition provided for 'low', so users were left to assume that 'low' is any frequency that falls outside the scope of 'high'. In contrast, ISO 14120 defines 'low' as 'e.g. less than once per week'.

There is an ambiguity here that raises the question of whether fixed or movable guards should be used if access is required once per week (not more, not less), as this is a foreseeable situation (maintenance, calibration, checking/adjustment might all be scheduled to take place weekly). It could be argued that the machine designer should err on the side of safety and specify movable guards rather than fixed guards that are removed and replaced under a safe system of work. On the other hand, the

designer may be tempted to save costs by installing fixed guards that do not require hinges or linear bearings, or the interlock, wiring and additional inputs on the safety-related control system.

The other issue here is that under EN 953 the frequency of access was considered to be high if access was required more than once per shift; in contrast, ISO 14120 redefines 'high' as once per week, which could result in many more machines meeting this criterion and therefore having to be equipped with movable rather than fixed guards. The implications for design and manufacturing costs could be considerable.

7. Verification of the safety requirements for guards

The first point to note in subclause 7.1, *General* (equivalent to 8.1 in EN 953) is that the standard now states 'The aspects of guard design and construction shall be subject to verification by examination, inspection, testing or calculation'; in contrast, EN 953 referred only to 'Certain aspects of guard design and construction', so manufacturers must now verify **all** aspects.

In addition, there is a new note saying some test methods mentioned in the informative annexes B and C contain optional requirements but, unless a Type-C standard specifies these requirements for certain machines, there is no need to comply with these optional requirements in order to claim compliance with this standard. In ISO 14120, Annex B is *Example of projectile test method for mechanically testing guards* and Annex C is *Example of pendulum test method for mechanically testing guards*.

The remainder of ISO 14120 clause 7 has been heavily revised compared with EN 953 clause 8. Whereas EN 953 contained short clauses relating to the verification of impact strength, safety distances, containment, noise, guard operating forces and visibility, ISO 14120 provides a non-exhaustive list of six methods by which verification and validation can be satisfied:

- Visual inspection (A)
- Practical tests (B)
- Measurement (C)
- Observation during operation (D)
- Review of task-based risk assessment (E)
- Review of specifications, layout and documentation (F)

What follows is a substantial table listing the 65 safety requirements and/or measures for guards that are given in clause 5 and that require validation, together with cross-references to the relevant subclauses; a column is provided for each of the verification and/or validation methods (A to F) so the appropriate ones can be used to evaluate whether the requirement has been adequately met by the design and construction of the guard.

This requirement for a more formalised validation/verification process is likely to have cost implications due to the time and resources that will be required.

8. Information for use

The subclauses include small changes to the text. Subclause 8.3, *Installation*, has been expanded to give examples of the information to be provided in relation to fixings for guards. Subclause 8.6, *Inspection and maintenance*, now includes a statement that 'deformed or damaged parts shall be repaired or replaced if the damage has negative influence on safety'. In addition, this subclause specifies that 'the information for use shall include a warning that fixings for guards (e.g. bolts, screws) should only be replaced with fixings of the same or an equivalent type, e.g. fixing requiring the use of a tool.'

Annex A, Examples of retained fastenings

As mentioned above, the illustrated examples of retained fastenings are now provided in an informative annex, rather than being included within the body of the standard. Note, however, that there are many more types of retained fastening than are shown in Annex A.

Annex B, Example of projectile test method for mechanically testing guards

This is a new informative annex that gives guidance on testing guards for their performance in terms of containing parts of the machine (including the workpiece) within the guarded zone, rather than preventing persons from accessing dangerous parts of the machine. Annex B gives information about the mechanical testing of guard materials that may be subject to impacts from high-velocity projectiles. Note that the Annex makes it clear that test results are valid only for the test object, and the conclusions for use of the guard in a specific application are made by the machine designer.

Annex C, Example of pendulum test method for mechanically testing guards

Annex C is another new informative annex relating to testing of guards and guard materials. Note that the test method described is optional but, if used, has to be followed as given. The pendulum test methods described are applicable only to guards where an impact hazard exists, whether that impact comes from inside or outside the guarded area. This annex applies to both guard materials and complete guards (such as perimeter fencing) and refers to soft and hard pendulums for simulating impacts from the human body and moving machinery. Like Annex B, Annex C makes it clear that test results are valid only for the test object and the conclusions for use of the guard in a specific application are made by the machine designer.

Bibliography

Numerous changes have been made to the bibliography (international standards and technical reports, and European standards). In general, the standards that were listed in the EN 953 bibliography that have not been carried across to ISO 14120 include those covering vibration, integral lighting of machines, degrees of protection for enclosures, and acoustics. In contrast, the standards listed in the ISO 14120 bibliography that were not listed in EN 953 cover ergonomics, minimum gaps to avoid crushing of parts of the human body, prevention of unexpected startup, hygiene requirements, fire prevention and protection, explosion prevention and protection, and screens for protection when using welding and lasers.

In conclusion

Engineers familiar with EN 953 will find it easy to adapt to using ISO 14120 because the two are very similar in terms of content, even though some subclauses has been moved. Nevertheless, there are significant changes as outlined above, the results of which could be more use of movable guards instead of fixed guards (hence higher costs) and a more onerous validation/verification procedure to be followed. Also, where some fixed guards had previously been held in place by quick-release fasteners, if those fixed guards are not now redesigned as movable guards, the choice of fasteners may have to be reconsidered. There could be a transition period during which EN 953 remains valid even after ISO 14120 has been published and Harmonised to the Machinery Directive, but machine guard designers are strongly advised to check their designs now in case they have to be modified to comply with the ISO 14120.

Procter Machine Guarding is the UK's leading machinery guarding specialist. The company has published numerous guides and White Papers relating to machine guarding and machinery safety standards, all of which can be downloaded free of charge from the website at www.machinesafety.co.uk. Alternatively, contact Procter Machine Guarding to discuss specific machine guarding requirements by telephoning 02920 855758 or emailing guards@procterbedwas.co.uk

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