Machine Guards

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EN 349

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Explaining the requirements for minimum gaps to avoid crush hazards

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 the requirements in EN 349, *Safety of Machinery. Minimum gaps to avoid crushing of parts of the human body*.

Introduction

EN 349 *Safety of machinery. Minimum gaps to avoid crushing of parts of the human body* (and BS EN 349 as published by BSI in the UK) has been with us since 1993 and has proven to be a very useful standard for machine builders and engineers designing or specifying guards, particularly perimeter guarding. At the time of writing, the current version of the standard is BS EN 349:1993+A1:2008, with the 2008 amendment just adding a pair of appendices referencing the old and new Machinery Directives. EN 349 is Harmonised to the Machinery Directive 2006/42/EC and provides a presumption of conformity with certain essential health and safety requirements (EHSRs). Compared with some other machinery safety standards, EN 349 is uncontroversial, simple to understand and straightforward to use, though care has to be taken in its application.

Risk assessment

Before reaching for a copy of EN 349 and designing or specifying machine guards it is important to conduct a risk assessment, ideally in line with the requirements of EN ISO 12100:2010 *Safety of machinery. General principles for design. Risk assessment and risk reduction* (with the equivalent in the UK being BS EN ISO 12100:2010). If possible, the machine should be designed to be inherently safe so that it does not need measures such as guarding. In fact EN 349 can help in this respect because if gaps are sufficiently large, then they do not need to be guarded to prevent crush injuries. Nevertheless, a risk assessment should be the first step taken.

An EN ISO 12100:2010 risk assessment should cover all aspects of the machine's lifecycle, including assembly, maintenance, disassembly and so on. Although it may not seem obvious when reading EN 349, there is an implication that needs to be considered: it is easy to imagine situations where fingers could be crushed while handling heavy components during assembly, maintenance and disassembly. Although the formal risk assessment may show the likelihood of occurrence to be small, the severity of the injury (finger amputation) is serious enough that the designer should take *reasonably practicable* steps to eliminate the risk. In reality, it would be impossible to design-out all potential finger-crushing gaps, so there will be residual risks for which the appropriate action could be to state in the machine instructions that care must be taken when handling heavy parts (using appropriate lifting equipment if necessary) so as to avoid fingers being crushed.

The risk assessment also needs to take into account the people who are likely to be using the machinery because the anthropomorphic data used to determine the 'safe' gaps stated in EN 349 will not cover 100 per cent of the population or those wearing bulky clothing or PPE (personal protective equipment). Furthermore, EN 349 refers to children (if they are in the 'population at risk') whereas EN ISO 13857, relating to safety distances (see Normative references below), applies only to people of 14 years and older for upper and lower limbs, and children older than three years where the designer needs to address reaching through openings.

Normative references

Because EN 349 is a simple and stable standard, it has not been updated as frequently as some others. One of the results of this is that the Normative references are now out of date. In fact only three Normative references are listed (EN 292-1:1991, EN 292-2 and EN 294) and these have all been superseded. The equivalent standards today are:

- EN ISO 12100:2010 *Safety of machinery. General principles for design. Risk assessment and risk reduction*
- EN ISO 13857:2008 *Safety of machinery. Safety distances to prevent hazard zones being reached by upper and lower limbs*

Because some machinery safety standards have been merged in recent years, EN ISO 12100:2010 covers risk assessment (none of the three Normative references listed in EN 349 relate directly to risk assessments) and EN ISO 13857 covers both upper and lower limbs (EN 294 only covered upper limbs, whereas the then-current standard for lower limbs is not in the EN 349 list of Normative references).

Minimum gaps

EN 349 clause 4, *Minimum gaps*, contains key information about how to apply the standard, as well as the all-important minimum gaps to avoid crushing parts of the human body. A table shows clearly the minimum gaps for the body, head, leg, foot, toes, arm, hand/wrist/fist and finger. However, the designer should treat this table with caution, as a risk assessment might show that there is a foreseeable risk of misuse of the machine. For example, it might be thought that a minimum gap for a hand would be appropriate but, if it is foreseeable that an operator or maintenance technician might place his or her head in the gap to obtain a better view of the process, the minimum gap for the head will be required – and this is significantly larger.

Other factors to consider

Type-C standards

If the machine is covered by a Type-C machine-specific standard then this might specify minimum gaps that differ from those in EN 349. If so, remember that the Type-C machinery safety standard will take precedence. Designers should always check whether the machine they are working on is covered by a Type-C standard.

Other hazards

EN 349 applies only to risks from crushing hazards, whether the gap is created between two parts of a machine moving together or a part moving towards a fixed object (which may be a fixed part of the machine, an adjacent machine, a wall or a

perimeter guard, for example). If one or other part of the machine is moving quickly then it may be appropriate to consider the risks from an impact hazard, whether or not the gap is close to the minimum specified in EN 349.

Similarly, if one or other moving part of the machine is relatively sharp, then a puncture, cut or severing injury could be the dominant risk, rather than crushing.

New hazards

Whenever a measure is introduced to reduce risk, such as installing a perimeter guard to prevent access to hazardous parts of a machine, a reassessment must be undertaken to check whether any new hazards have been introduced. In the case of perimeter guarding, EN 349 is important in this step, as it is possible that installing fixed perimeter guarding could introduce a new crushing hazard that was not present previously if, for example, part of the machine moves towards the guarding.

Furthermore, opening a gap to eliminate a crushing hazard for one part of the body could potentially make the gap wide enough that it creates a new crushing hazard for another part of the body; for example, the difference between the minimum gaps for the hand/wrist/fist and the arm is only 20mm.

Conclusion

Compliance with EN 349 is relatively straightforward but, as with any other aspect of machine design, a degree of intelligence is required when applying the standard. A risk assessment is essential, and all relevant standards should be applied.

Procter Machine Guarding is the UK's leading machinery guarding specialist. The company has published numerous guides, calculators 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. These downloads include a Risk Assessment Calculator based on EN ISO 12100:2010 and a Safety Distance Calculator based on EN ISO 13857. 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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