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British Standard

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19 March 2003

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BRITISH STANDARD

BS EN
12198-3:2002

Safety of machinery — Assessment and reduction of risks arising from radiation emitted by machinery —

Part 3: Reduction of radiation by attenuation or screening

The European Standard EN 12198-3:2002 has the status of a British Standard

ICS 13.110; 13.280

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National foreword

This British Standard is the official English language version of EN 12198-3:2002.

The UK participation in its preparation was entrusted to Technical Committee MCE/3, Safeguarding of machinery, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

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This British Standard, having been prepared under the direction of the Engineering Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 6 December 2002

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12198-3

November 2002

ICS 13.110; 13.280

English version

Safety of machinery - Assessment and reduction of risks arising from radiation emitted by machinery - Part 3: Reduction of radiation by attenuation or screening

Sécurité des machines - Estimation et réduction des risques engendrés par les rayonnements émis par les machines - Partie 3: Réduction du rayonnement par atténuation ou par écrans

Sicherheit von Maschinen - Bewertung und Verminderung des Risikos der von Maschinen emittierten Strahlung - Teil 3: Verminderung der Strahlung durch Abschwächung oder Abschirmung

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Contents

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Foreword

This document EN 12198-3:2002 has been prepared by Technical Committee CEN /TC 114 "Safety of machinery", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2003, and conflicting national standards shall be withdrawn at the latest by May 2003.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EC Directive(s).

For relationship with EC Directives, see informative annex ZA, which is an integral part of this document.

This European Standard deals with the essential requirement "Radiation" (see EN 292-2:1991, annex A, paragraph 1.5.10).

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard : Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

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Introduction

Machinery supplied by electrical power or containing radiation sources may emit radiation or generate electric and/or magnetic fields. The radiation emissions will vary in frequency and magnitude.

It does not deal with other strategies concerning reduction of radiation risk by substitution with a smaller source, increasing the distance or reducing exposure time.

This document is a type B standard as stated in EN 1070.

The provisions of this document may be supplemented or modified by a type C standard.

NOTE For machines which are covered by the scope of a type C standard and which have been designed and built according to the provisions of that standard, the provisions of that type C standard take precedence over the provisions of this type B standard.

1 Scope

The purpose of this European standard is to provide means to enable manufacturers of machinery concerned by a radiation hazard to design and manufacture efficient safeguards against radiations.

Specific technical details of the design of shields for the different types of radiation and machines will be provided in other standards.

This European standard applies to machinery as defined by EN 292.

Part 1 of this standard contains the general principles of risk assessment of radiation emission by machinery. Details of the measurement of the radiation emission are given in Part 2 of this standard.

This standard deals with a design strategy for reducing the radiation flux by attenuation or screening.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 292-1:1991, *Safety of machinery - Basic concepts, general principles for design - Part 1: Basic terminology, methodology.*

EN 292-2:1991, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles and specifications.*

EN 294:1992, *Safety of machinery - Safety distance to prevent danger zones being reached by the upper limbs.*

EN 953:1997, *Safety of machinery – Guards - General requirements for the design and construction of fixed and movable guards.*

EN 1050:1996, *Safety of machinery - Principles for risk assessment.*

EN 1070:1998, *Safety of machinery – Terminology.*

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EN 1088:1995, *Safety of machinery - Interlocking devices associated with guards - Principles for design and selection.*

EN 12198-1:2000, *Safety of machinery – Assessment and reduction of risks arising from radiation emitted by machinery – Part 1: General principles.*

EN 12198-2:2002, *Safety of machinery – Assessment and reduction of risks arising from radiation emitted by machinery – Part 2 : Radiation emission measurement procedure.*

IEC 60050-111:1996, *International Electrotechnical Vocabulary - Chapter 111: Physics and chemistry.*

IEC 60050-121:1998, *International Electrotechnical Vocabulary - Part 121: Electromagnetism*.

IEC 60050-161:1990, *International Electrotechnical Vocabulary - Chapter 161: Electromagnetic compatibility.*

IEC 60050-881:1983, *International Electrotechnical Vocabulary – Chapter 881 : Radiology and radiological physics.*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 1070:1998 and the following apply. Additional definitions specifically needed for this standard are contained in EN 12198-1:2000.

The terms and definitions given in IEC 60050-111:1996, IEC 60050-121:1998, IEC 60050-161:1990 and IEC 60050-881:1983, are also applicable.

3.1
shield (general definition)
component designed to reduce, select or absorb radiations. The purpose of the component may be for radiation protection or in order to select particular radiations

NOTE Shields are also know as attenuators, screens or filters .

3.2
protection shield
shield used for the radiation protection of people and/or equipment

3.3
selective shield
shield used to filter the radiations, selecting their kind or their energy

3.4
shadow shield
shield arranged in such a way that the radiation source is not totally enclosed, but which prevents free passage of radiation in certain directions

4 Classification of radiation

Classification of radiation is given in clause 4 of EN 12198-1:2000.

Machinery shall be so designed and constructed that any emission of radiation is limited to the extent necessary for its operation and that the effects on exposed persons are non-existent or reduced to non-dangerous proportions (See EN 292-2:1991, annex A).

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5 Procedure for reducing radiation emission levels by design

The procedure for reducing radiation by attenuation or screening shall include the following steps:

1) Specify the design target according to 7.2 of EN 12198-1:2000, by defining a radiation emission level not to be exceeded, lowest possible.

2) Characterize all the radiation sources (see clause 4 and 6.2 of EN 12198-1:2000).

3) Define intended directions, intensity of radiation fields and access to the irradiated area.

4) Review attenuating or screening materials available.

5) Assess environmental conditions and their effects on the source and shields.

6) Make design decisions.

7) Manufacture prototype.

8) Measure in accordance with EN 12198-2 and clause 6 of EN 12198-1:2000.

9) Compare with desired levels set in step 1 (see clause 7 of EN 12198-1:2000).

10) If necessary, modify design and repeat steps 6 to 10.

11) Prepare documentation for users.

These steps will be described in detail in clause 6.

6 Strategy for design of shield

6.1 Design target

The design target defined in 5.1) is set by the manufacturer according to clause 7 of EN 12198-1:2000.

6.1.1 It is essential that manufacturers take the risk from radiation into account when they design machines. This can be achieved by assigning desired maximum emission levels of functional radiation emissions and undesirable radiation emissions, according to 7.2 of EN 12198-1:2000.

6.1.2 Numerical values for maximum emission levels may be set by other bodies in documents such as national legislation or international recommendations. Where there is no legislation or recommendation then the manufacturer shall decide what safety criteria the design has to satisfy. These criteria may differ during different phases of a machine's use (see 3.11 and 5.1 of EN 292-1:1991), (see also EN 1050).

6.1.3 The manufacturer shall also consider the possible alteration of radiation emissions caused by changes in environmental operating conditions or in duty cycles of the machine.

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6.2 Characterization of all the radiation sources

The following points shall be taken into consideration :

— number of sources ;

— radiation characteristics : spectrum, intensity etc. (see clause 4 of EN 12198-1:2000) ;

— construction characteristics of each source ;

  — geometry (point, linear, cylindrical, spherical...) including dimensions ;

  — open or enclosed radiation sources ;

  — radiation generator (removal of electrical power will terminate radiation emission) ;

  — physical state : (solid, liquid, gas, plasma...) ;

— chemical composition (s).

Special care shall be taken :

— when different types of radiation are emitted by the same source ;

— when the source manufacturer has defined a functional life time or safe working life time for the source.

6.3 Radiation fields, beam geometry access and enclosure

The manufacturers shall take account of the following considerations.

6.3.1 Radiation field or beam geometry

a) The field or beams size should be as small as possible considering such factors as the area of the interaction between radiation and material and the uniformity needed across that area.

b) The distance which the intended field or beam has to traverse should be minimized. This will be after taking account of the divergence and any access required to the field.

6.3.2 Access to the irradiated area

Wherever possible the field or beam should be enclosed to prevent inadvertent access to levels of radiation above the design target level.

As part of the routine maintenance or setting of a machine, it may be necessary to measure the field or beam profiles or intensity. The position of beams may also need to be adjusted.

If there is a need for access to the field or beam then access points should be included during the design stage.

The construction of access points shall not create leakage of radiation above the level specified in the design targets.

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6.3.3 Design of guards

Guards enclosing fields or beam may be required to exhibit attenuation properties or only prevent access to the beam. If the guard is to be a shield then its design shall also follow the steps listed in 5. If it is only to prevent human access then any openings shall be as small as possible and comply with Table 3, 4 or 5 of EN 294:1992 as appropriate.

Manufacturers should be aware that reflectors may be inserted accidentally even through small openings. If it is possible to reflect significant proportions of the beam which would cause the design target to be exceeded then the guard shall be without opening.

6.4 Review available of attenuating material

6.4.1 The manufacturer shall review materials, considering factors such as absorbing, attenuating and other properties.

In particular, consideration shall be given to the following properties :

— chemical composition ;

— stability after lifetime of irradiation ;

— availability ;

— size and weight (or mass), manual or mechanical handling ;

— rigidity and shock resistance - is it self supporting ;

— durability - will it withstand the mechanical demands placed on it ;

— toxicity - during machining, use or disposal ;

— machinability - how easy, safe, cheap is it to machine ;

— electrical conductivity - earthing and electrical continuity of conducting parts ;

— flammability - fire resistance or use of machine in flammable atmospheres ;

— thermal conductivity - can it remove any heat generated safely.

NOTE Waste disposal authorities can impose conditions on the use of certain materials.

6.4.2 The manufacturer shall consider how components are to be used including whether they will :

— be removable or fixed ;

— require maintenance.

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6.5 Assess of environmental conditions

The machine and the materials and devices used for the attenuation of radiation shall withstand the effects of the foreseeable environmental and operating conditions. Special consideration shall be given at least to the following factors :

— permissible location of machinery ;

— humidity : limits max and min ;

— temperature : maximum and minimum ambient temperature
(European Economic Area : - 40 °C in North, to + 40 °C in South) ;

— pressure ;

— acidity (pH) ;

— dusts : periodic cleaning ;

— flammability or explosivity of the atmosphere ;

— vibrations ;

— lubrication materials ;

— cooling water quality.

6.6 Design requirements

Manufacturers shall review all the information gathered from the considerations in 6.1 to 6.5 and decide on the following details, when designing a machine. decide on the detailed design, in the following manner

6.6.1 To achieve a safe shielding design, the manufacturer shall consider :

— the source position and its mount,

— the mounting penetrations through, and movements of a shield, and

— the interlocking between the radiation source and any guard.

6.6.2 When applicable, the following requirements shall be fulfilled :

— the source shall be positioned so that its housing can not be damaged by normal operation or any single fault condition which would lead to a change in the emission characteristics. If necessary, further mechanical protection shall be provided in order to achieve this ;

— any further mechanical protection shall not increase the radiation emission hazard or other hazards by virtue of its presence or location ;

— where the further mechanical protection would interfere with the intended emissions, then it may be omitted on the condition that any change in emission characteristics is detected and indicated automatically ;

— if the opening of a guard gives an automatic "stop" command, the closing of the guard shall not reactivate the emission without a further operation (see 3.22.4 of EN 292-1:1991, see also EN 953 and EN 1088) ;

— the source or its housing shall be securely mounted. Normal operation or single fault conditions shall not cause it to be dislodged. The design of the housing and mount shall facilitate source replacement without significant exposure to the operator ;

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— any detectors, indicators, source power, or shutter, interlocks shall operate in a "fail to safety" mode (see EN 292).

NOTE 1 As far as possible, initially, design decisions can be made on the predicted performance of the considered design.

NOTE 2 Many of the factors considered will impose conflicting demands on the design of the shield and manufacturers will have to follow an iterative process until a compromise is reached which still satisfies their specified design target.

6.6.3 Joints and service penetrations in the shields shall provide the same level of attenuation as the body of the material.

6.6.4 If attenuators will be degraded during normal operation, then the manufacturers shall :

— specify the frequency which a shield shall be replaced, and

— install devices which detect the degradation of performance and indicate it automatically.

If the degradation in performance of a shield is such that the radiation emissions exceed the design target level then :

— the source shall be switched off, or

— mechanical shutters or other means shall restrict emissions.

6.6.5 Shields must be positioned and mounted so that they will not be damaged during normal operation nor under any single fault condition which would lead to a degradation of their attenuation performance.

If shields cannot be positioned so that they are safe from damage, then further mechanical protection must be provided. In general for isotropic emitters, the nearer the shield is to the source the smaller it will physically need to be.

If shields, or parts of them, are designed to be removed for maintenance or servicing, then the arrangement of fasteners shall ensure correct replacement.

6.6.6 If the design target levels will be exceeded when shields are removed, then :

— the source must be automatically switched off, or

— mechanical shutters or other means used to restrict the emissions to the design target levels.

If this is not possible, then the shield shall :

— have fastenings which require a tool to release them, and

— suitable permanent warnings signs shall be fixed to them.

6.6.7 If a change in emissions is such that the design target levels are exceeded, then :

— the source must be automatically switched off, or

— mechanical shutters or other means shall restrict emissions.

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6.7 Manufacture prototype

In many cases it is impossible to accurately predict the performance of a shield because of the complex interrelationship of the factors considered above. The performance will need to be verified empirically.

Manufacture of a prototype will allow the adequacy of the radiation protection design to be demonstrated.

6.8 Determination of the effectiveness of the shielding

The effectiveness of the shielding of a machine, against the radiation hazard, shall be determined.

— on radiation measurements of prototypes or models in accordance with EN 12198-2 ;

— on theoretical calculation.

6.9 Compare with desired levels set in step 1 and if necessary, modify design

If the results of measurements exceed the design target levels, it is necessary to modify the design and repeat steps 6 to 9 of clause 5.

6.10 Prepare documentation for users

In addition to clause 5 of EN 292-2:1991, the information for use shall include a full description of the radiation protection aspects of the machine.

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Annex ZA
(informative)

Relationship of this document with EC Directives

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EC Directive(s):

Machinery Directive 98/37/EC, amended by Directive 98/79/EC.

Compliance with this document provides one means of conforming with the specific essential requirements of the Directive concerned and associated EFTA regulations.

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