INTERNATIONAL STANDARD

IEC 61965

Second edition
2003-07

Mechanical safety of cathode ray tubes

Sécurité mécanique des tubes cathodiques

Reference number
IEC 61965:2003(E)

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

Consolidated editions

The IEC is now publishing consolidated versions of its publications. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

Further information on IEC publications

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology. Information relating to this publication, including its validity, is available in the IEC Catalogue of publications (see below) in addition to new editions, amendments and corrigenda. Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is also available from the following:

- **IEC Web Site (www.iec.ch)**

- **Catalogue of IEC publications**

  The on-line catalogue on the IEC web site (www.iec.ch/searchpub) enables you to search by a variety of criteria including text searches, technical committees and date of publication. On-line information is also available on recently issued publications, withdrawn and replaced publications, as well as corrigenda.

- **IEC Just Published**

  This summary of recently issued publications (www.iec.ch/online_news/ justpub) is also available by email. Please contact the Customer Service Centre (see below) for further information.

- **Customer Service Centre**

  If you have any questions regarding this publication or need further assistance, please contact the Customer Service Centre:

  Email: custserv@iec.ch
  Tel: +41 22 919 02 11
  Fax: +41 22 919 03 00

INTERNATIONAL STANDARD

IEC 61965

Second edition
2003-07

Mechanical safety of cathode ray tubes

Sécurité mécanique des tubes cathodiques

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE XA

For price, see current catalogue

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

MECHANICAL SAFETY OF CATHODE RAY TUBES

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61965 has been prepared by IEC technical committee 39: Electronic tubes.

This second edition cancels and replaces the first edition published in 2000. This second edition constitutes a technical revision.

The main change with respect to the previous edition is the inclusion of the requirements for cathode ray tubes with film attached to the face plate.

The text of this standard is based on the following documents:

FDIS	Report on voting
39/264/FDIS	39/265/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

INTRODUCTION

This International Standard sets forth test methods and limits for cathode ray tubes (CRTs). Originally, the only IEC standard for the mechanical safety of CRTs had been contained within Clause 18 of the equipment standard IEC 60065. Whereas that standard had been accepted and used by many countries, many others were not able to implement its requirements because of differing local needs. IEC 61965 was therefore published in 2000 with the aim of providing the basis for wider acceptance and use and reflecting the current IEC policy of producing separate component standards to which equipment standards can refer.

This 2nd edition covers the requirements for the CRTs with film attached to the faceplate as part of the safety implosion protection system.

Many years of experience had been built up in the use of both the IEC 60065 test and the other commonly used national alternatives. During the development of IEC 61965, extensive test programmes and ballistic and statistical calculations were carried out to verify that the requirements of the standard give protection for users of CRTs when the tubes are mounted in the equipment for which they are intended. This was also done to ensure that IEC 61965 maintains the stringent requirements of both IEC 60065 and the alternative tests in common use. These tests and calculations also confirmed

a) the acceptability of one standard ball for the mechanical strength test, and

b) the need for the implosion test where it is not always possible to induce rapid devacuation using the ball impact test.

As the impact tests in this standard are overstress tests, only the effect of rapid devacuation is evaluated and not subsequent relaxation of mechanical stresses in the CRT from the implosion protection system.

MECHANICAL SAFETY OF CATHODE RAY TUBES

1 Scope

This International Standard is applicable to cathode ray tubes and cathode ray tube assemblies (hereinafter referred to as CRTs) which are intended for use as components in apparatus and which have integral protection with respect to the effects of implosion.

These requirements apply to CRTs intended for use in apparatus including electrical and electronic measuring and testing equipment, information technology equipment, medical equipment, telephone equipment, television equipment and other similar electronic apparatus.

This standard is intended to apply only to those CRTs in which the face of the CRT forms part of the enclosure for the apparatus. The test methods do not apply to CRTs which are protected by separate safety screens.

A CRT covered by this standard is intended to be installed in an enclosure designed both to protect the rear of the CRT against mechanical or other damage under normal conditions of operation and to protect the user against particles expelled in a backwards direction from the CRT face in the event of implosion.

This standard contains requirements for CRTs of 76 mm diagonal and larger that incorporate implosion protection systems providing protection against the hazards of particles expelled forwards beyond the face. There is no intended protection against particles expelled in other directions.

Compliance is tested by subjecting CRTs to the test procedures and criteria, which are given in Clauses 8 (large CRTs), 9 (small CRTs) and 10 (CRTs with protective film) of this standard. The definitions of large and small CRTs are given in Clause 3.

NOTE This set of requirements replaces the current requirements for the mechanical safety of cathode ray tubes (CRTs) as described in IEC 60065 (Clause 18), which will be modified accordingly.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60065:2001, *Audio, video and similar electronic apparatus – Safety requirements*

IEC 60068-1:1988, *Environmental testing – Part 1: General and guidance*
Amendment 1 (1992)

IEC 60216-1:2001, *Electrical insulating materials – Properties of thermal endurance – Part 1: Ageing procedures and evaluation of test results*

ISO 527-1:1993, *Plastics – Determination of tensile properties – Part 1: General principles*

ISO 527-3:1995, *Plastics – Determination of tensile properties – Part 3: Test conditions for films and sheets*

ISO 8510-1:1990, *Adhesives – Peel test for a flexible-bonded-to-rigid test specimen assembly – Part 1: 90 degree peel*

3 Definitions

For the purposes of this document the following definitions apply.

3.1
bonded frame
system employing a preformed metal frame that covers the periphery of the CRT rim area. The space or void between the CRT rim and the metal frame is filled with resin or equivalent

3.2
CRT diagonal
nominal diagonal of the glass envelope at its maximum dimension (for example, mould-match line) excluding any hardware

3.3
CRT envelope
structure consisting of a face or faceplate, funnel and neck assembly

3.4
devacuation
equalization of the pressure in a CRT relative to the ambient pressure

3.5
fracture
one or more cracks in the faceplate or funnel causing a rapid or slow devacuation of the CRT envelope

3.6
glass particle
piece of glass that exceeds 0,025 g in weight

3.7
implosion
devacuation due to the rapid and sudden inward collapse of a CRT envelope, usually accompanied by a loud report

3.8
laminated CRT
system that provides a separate external safety panel bonded to the face of the CRT

3.9
prestressed banded CRT
system that employs a metal tension band (located over the CRT rim area) that is tightened by thermal shrinking, or other means, to a tensile load. The system may also include a metal rim band located between the tension band and the CRT rim. The tension band or the rim band or both may have an interlayer of tape, resin or the equivalent placed between the mating parts

3.10
prestressed banded CRTs with protective film
system employing a prestressed banded construction (see 3.9) that also includes a layer of film adhered to the CRT face as an integral component of the protection system

3.11
shaling
condition where the glassware splits into thin layers

3.12
test cabinet
enclosure, which is used to accommodate the CRT during tests

3.13
useful phosphor screen
a) colour CRT: the visible phosphored area of the CRT as viewed from the front

b) monochrome CRT: specified maximum useful phosphored area of the CRT

3.14
large CRT
CRT with diagonal dimension exceeding 160 mm

3.15
small CRT
rectangular CRT with a minor face dimension of at least 50 mm, a minimum diagonal dimension of 76 mm and a maximum diagonal dimension of 160 mm; a round CRT of a minimum diameter of 76 mm and a maximum diameter of 160 mm

3.16
common quality management system

quality management system described in documentation which is identical with systems used in two or more plants and under one central control and management

4 General requirements

4.1 Corrosion protection

If corrosion of a metal part will contribute to a failure to meet the requirements of this standard, then the part shall be adequately protected against corrosion.

4.2 Mechanical damage

To improve repeatability and reproducibility of test results, it should be verified that samples submitted for test have no external visible scratching on the surface of the faceplates.

4.3 Handling

Safety precautions should be addressed when handling test samples prior to and after testing.

4.4 Film-coated CRTs

In the case of CRTs with film, which is not an integral part of the implosion protection system, the product must be tested without film in accordance with Tables 1 and 2 and 6 to 9.

5 Environmental conditioning

5.1 Standard atmospheric conditions for testing

Unless otherwise specified, all tests and measurements shall be made under standard atmospheric conditions for testing as given in 5.3 of IEC 60068-1:

– temperature: 15 °C to 35 °C;
– relative humidity: 25 % to 75 %;
– air pressure: 86 kPa to 106 kPa

5.2 Preconditioning

Before CRTs are subjected to thermal conditioning or to testing they will be allowed to stabilize at standard atmospheric conditions for testing (see 5.1) for a minimum period of 16 h.

5.3 Thermal conditioning

Details of thermal conditioning are given in Tables 1 to 9. After thermal conditioning has been completed, the CRTs will be allowed to stabilize at standard atmospheric conditions for testing (see 5.1) for a minimum period of 24 h.

6 Sampling

6.1 Sampling plans

Details are given in Tables 1 to 9.

6.2 Sample numbers

The numbers of CRTs and the test programmes for prestressed banded CRTs are given in Tables 1, 2, 3 and 4, for bonded frame CRTs in Tables 6 and 7 and for laminated CRTs in Tables 8 and 9.

NOTE 1 Additionally, the number of samples for film-adhesion testing are given in Table 5.

NOTE 2 In addition to the quantities specified in the tables, additional samples should be made available for use in case of retest to satisfy the intent of the requirement.

6.3 Compliance

All CRTs in a test group shall comply with the test requirements for that group, except that, if only one CRT from all the test groups does not comply with the requirements, acceptability may be determined by subjecting a second test group to the set of tests during which unacceptable results occurred. The construction is acceptable if all CRTs in the second test group comply with the requirements.

7 Test preparation and set-up

7.1 Scratch patterns

As the form and depth of the scratch patterns may affect the force which is needed to obtain implosion or devacuation of the CRT, it is recommended that the scratches be made using a diamond- or carbide-tipped stylus, a glasscutter with a wheel of hardened steel or other similar tools.

7.2 Barriers

Barriers as specified in the test procedures, each made of 10 mm to 20 mm thick material, $250\ ^{0}_{-3}$ mm high and (2,00 ± 0,01) m long, shall be placed on the floor in front of the test cabinet at the specified locations, measured horizontally from the vertical plane of the centre of the front surface of the CRT to the near surface of the barrier closest to the tube face. The tolerance on the position of the barrier shall be ±10 mm, unless otherwise stated. The barriers may be less than 2 m long provided that they extend to the walls of the test room (see Figures 2 and 5). A non-skid surface such as a blanket or rug may be placed on the floor.

NOTE A particle travelling past the plane of the front surface of the barrier shall be considered to have passed the barrier.

7.3 Mounting

The CRT shall be mounted in a test cabinet of rigid construction and of suitable dimensions that does not permit a gap or opening wider than 6 mm around the CRT (see Figure 1). The mounting of the CRT in front of, or behind, the front panel of the test cabinet shall be in accordance with the CRT manufacturer's specifications or intended application. When mounting specifications are not available, the preferred mounting method shall be behind the front panel unless design features do not allow this condition.

A hole of suitable area shall be provided at the top of the cabinet to allow access to the funnel. This hole shall be covered during the impact test.

An opening having an area of not less than one-quarter of the area of the face of the CRT or 0,02 m^2, whichever is the smaller, shall also be provided in the bottom or rear of the cabinet for air intake in the event of an implosion.

The cabinet shall be firmly supported so as to prevent movement during the test.

7.4 Mounting position

The centre of the CRT shall be (1,00 ± 0,05) m above the floor.

8 Testing of large CRTs

8.1 Mechanical strength (ball impact test)

8.1.1 Test procedure

A solid smooth steel ball of (40 ± 1) mm diameter and mass of (260 ± 15) g, including the hook, and a minimum C scale Rockwell hardness of 60, shall be suspended by suitable means such as a fine wire or chain with a mass not exceeding 10 % of the mass of the ball and the hook. It shall be allowed to fall freely as a pendulum from a calculated height and strike the face of the CRT with an energy of (5,5 ± 0,1) J. The CRT shall be placed so that the face is vertical and in the same vertical plane as the point of support of the pendulum. A single impact shall be applied to any point on the CRT face at a distance of 40 mm or greater from the edge of the useful phosphor screen.

NOTE The test laboratory should consider all their test set-up uncertainties to ensure this 40 mm minimum position of the point of impact.

The barrier shall be placed 1,5 m from the plane of the centre of the face of the CRT (see Figure 2).

8.1.2 Glass throw criteria

A CRT is in compliance if the expulsion of glass within 5 s of the initial impact meets the following requirements:

a) there shall be no glass particle (a single piece of glass having a mass greater than 0,025 g) past the 1,5 m barrier;

b) the total mass of all pieces of glass past the 1,5 m barrier shall not exceed 0,1 g.

8.2 Implosion test (missile)

8.2.1 Test procedure

The face of the CRT at the top and bottom shall be scratched (3 ± 1) mm from the screen or phosphor edge into the viewing area. The scratches shall be horizontal lines (100 ± 5) mm long.

The impact object shall be a steel missile (see example in Figure 3) with a mass of (2,3 ± 0,1) kg, a minimum C scale Rockwell hardness of 60 and having one end rounded on a radius of (25 ± 0,5) mm.

The CRT shall be subjected to a single impact, intending to cause rapid devacuation using the minimum energy within the range. The impact object shall be swung through an arc of a pendulum to obtain an impact of not less than 7,0 J and not more than 14,0 J to cause rapid devacuation of the samples in the test group.

The impact area shall be the area bounded by two concentric circles where the radius of one circle is one-sixth of the height of the useful phosphor screen and the second circle radius is one-half of the height of the useful phosphor screen less 50 mm (see Figure 4). In Figure 4, if R_2 is less than R_1 then the impact shall be applied to the circle specified in R_1.

NOTE Previous testing experience on a particular CRT design (obtained from the CRT manufacturer or the test laboratory) should be considered when selecting the energy level within the range and the impact location.

The impact object travel shall be restricted so that the rounded end of the missile penetrates the CRT face equal to, or less than, 25 mm (see Figure 5).

Barriers shall be placed 1,0 m and 1,5 m from the vertical plane of the centre of the face of the CRT (see Figure 5).

If no CRTs devacuate as a result of this test then the alternative implosion test (missile) described in 8.2.3 shall be carried out.

8.2.2 Glass throw criteria

A CRT is in compliance if the expulsion of glass within 5 s of the initial impact meets the following requirements:

a) there shall be no single piece of glass having a mass greater than 15 g between the 1,0 m and 1,5 m barriers;

b) the total mass of all pieces of glass between the 1,0 m and 1,5 m barriers shall not exceed 45 g;

c) there shall be no single piece of glass having a mass greater than 1,5 g beyond the 1,5 m barrier.

8.2.3 Alternative implosion test (missile)

This alternative test shall be used as an additional test when the test in 8.2.1 has devacuated no CRTs, or may be used as an alternative to the test in 8.2.1 when it can be shown that the 8.2.1 test is unlikely to devacuate at least one CRT of the sample group.

8.2.3.1 Test procedure

As in 8.2.1, except that the impact object will be a steel missile (see example in Figure 11) with a mass of (1,4 ± 0,1) kg, a minimum C scale Rockwell hardness of 60 and one end rounded on a radius of (15 ± 0,5) mm.

8.2.3.2 Glass throw criteria

As in 8.2.2. If no CRTs devacuate as a result of the test in 8.2.3.1, then the glass throw requirements of 8.2.2 are deemed to have been satisfied.

8.3 Implosion test (thermal shock)

8.3.1 Test procedure

The CRT shall be mounted in the test cabinet, which is described in 7.3 and 7.4. The barrier shall be placed at (150 ± 2) mm from the vertical plane of the centre of the face of the CRT. An area shall be scratched on the faceplate sidewall or face of the CRT using one of the patterns illustrated in Figure 6.

A thermal shock shall be applied using one of the following methods.

a) Liquid nitrogen

The scratched area shall be cooled using liquid nitrogen until a fracture occurs. A dam of modelling clay or equivalent may be used to contain the liquid nitrogen.

b) Hot rod

The end of an ordinary flint glass rod, of suitable diameter (for example, 10 mm) shall be heated until it is red hot and nearly fluid. The heated end of the rod shall be pressed firmly on the scratched area of the CRT. If devacuation of the CRT does not occur within 10 s then the rod shall be withdrawn and cold water poured slowly on the scratched area. If a devacuation cannot be induced by repeated applications of the hot rod then the test shall be carried out using liquid nitrogen (see 8.3.1a).

8.3.2 Glass throw criteria

A CRT is in compliance if, within 5 s of the initial fracture, no glass particle is expelled through the plane of the face beyond the 150 mm barrier.

8.4 High-energy impact test

CRTs, which have a laminated implosion protection system, shall be subjected to the following high-energy impact test.

8.4.1 Test procedure

A (25 ± 1) mm diameter steel pin (see Figure 9) shall be inserted through the hole at the top of the test cabinet and placed on the CRT envelope (3 ± 1) mm behind the seal of the faceplate and funnel. If the hardware extends back from the seal more than 3 mm so as to interfere with the placement of the pin, then the pin shall be placed as close as possible to the hardware without touching it. A weight (see Figure 10), having a mass of (4,5 ± 0,1) kg, shall be caused to fall from a height so as to impact the pin at the end of its fall.

The height of the test mass shall be adjusted to limit the amount of energy to the minimum required to produce fracturing of the glassware, but not less than 7 J.

If fracturing of the glass does not occur, the impact energy shall be increased in 7 J increments to a maximum of 63 J using a new test sample each time until all the CRTs in the test group have suffered rapid devacuation.