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Mechanical safety of cathode ray tubes

Sécurité mécanique des tubes cathodiques

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- **IEC web site***
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For general terminology, readers are referred to IEC 60050: *International Electrotechnical Vocabulary* (IEV).

For graphical symbols, and letter symbols and signs approved by the IEC for general use, readers are referred to publications IEC 60027: *Letter symbols to be used in electrical technology*, IEC 60417: *Graphical symbols for use on equipment. Index, survey and compilation of the single sheets* and IEC 60617: *Graphical symbols for diagrams.*

* See web site address on title page.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MECHANICAL SAFETY OF CATHODE RAY TUBES

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The 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.

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

FDIS	Report on voting
39/252/FDIS	39/255/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 3.

Annexes A and B are for information only.

The committee has decided that the contents of this publication will remain unchanged until 2004. At this date, the publication will be

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- withdrawn;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

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

This International Standard sets forth test methods and limits for cathode ray tubes (CRTs). Hitherto, the only IEC standard for the mechanical safety of CRTs has been contained within clause 18 of the equipment standard IEC 60065. Whereas that standard has been accepted and used by many countries, many others have not been able to implement its requirements because of differing local needs. This new standard aims to provide the basis for wider acceptance and use, and reflects the current IEC policy of producing separate component standards to which equipment standards can refer.

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 this new standard, 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 the new standard 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) and 9 (small CRTs) 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 normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60065:1998, *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, *Guide for the determination of thermal endurance properties of electrical insulating materials. Part 1: General guidelines for ageing procedures and evaluation of test results*

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
shaling
condition where the glassware splits into thin layers

3.11
test cabinet
enclosure which is used to accommodate the CRT during tests

3.12
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

3.13
large CRT
CRT with diagonal dimension exceeding 160 mm

3.14
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

3.15
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 face plates.

4.3 Handling

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

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 6. 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 6.

6.2 Sample numbers

The numbers of CRTs and the test programmes for prestressed banded CRTs are given in tables 1 and 2, for bonded frame CRTs in tables 3 and 4 and for laminated CRTs in tables 5 and 6.

NOTE In addition to the quantities specified in the tables, additional samples shall 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 glass cutter 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 10) 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.