INTERNATIONAL STANDARD

IEC 61965

Second edition
2003-07

Mechanical safety of cathode ray tubes

Sécurité mécanique des tubes cathodiques

© IEC 2003 — Copyright - all rights reserved

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

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

FOREWORD 5
INTRODUCTION 6
1 Scope 7
2 Normative references 7
3 Definitions 8
4 General requirements 9
4.1 Corrosion protection 9
4.2 Mechanical damage 9
4.3 Handling 9
4.4 Film-coated CRTs 9
5 Environmental conditioning 10
5.1 Standard atmospheric conditions for testing 10
5.2 Preconditioning 10
5.3 Thermal conditioning 10
6 Sampling 10
6.1 Sampling plans 10
6.2 Sample numbers 10
6.3 Compliance 10
7 Test preparation and set-up 10
7.1 Scratch patterns 10
7.2 Barriers 11
7.3 Mounting 11
7.4 Mounting position 11
8 Testing of large CRTs 11
8.1 Mechanical strength (ball impact test) 11
8.2 Implosion test (missile) 12
8.3 Implosion test (thermal shock) 13
8.4 High-energy impact test 13
9 Testing of small CRTs 14
9.1 Mechanical strength (ball impact test) 14
9.2 Implosion test (high ball) 15
9.3 Implosion test (thermal shock) 15
9.4 High-energy impact test 15
10 Testing of prestressed banded CRTs with protective film 16
10.1 General 16
10.2 Film scoring pattern for CRTs with protective film 16
10.3 Peel test 17
10.4 Immersion test 17
11 Marking 17
12 Application notes for pre-stressed banded CRTs with protective film 18
13 Normative requirements for the use of Tables 1 and 2 (prestressed banded CRTs) 18
13.1 Sampling plan I: New construction 18
13.2 Sampling plan II: New construction with known resin or tape 19
13.3 Sampling plan III: Tension band and alternative tension band 19
13.4 Sampling plan IV: Alternative construction 20

14 Normative requirements for the use of Tables 3 and 4 (prestressed banded with protective film) 21
14.1 Sampling plan I: New construction 21
14.2 Sampling plan II: New construction with known resin, tape, film or adhesive 22
14.3 Sampling plan III: Alternative tension band 22
14.4 Sampling plan IV: Alternative construction 23
15 Alternative thermal conditioning for use with Tables 3 and 4 (prestressed banded with protective film) 24
15.1 Additional peel force requirements where alternative thermal conditioning is to be performed 24
15.2 Tensile strength test where alternative thermal conditioning is to be performed 24
16 Normative requirements for the use of Tables 6 and 7 (bonded frame CRTs) 25
16.1 Sampling plan I: New construction 25
16.2 Sampling plan II: Alternative construction 26
17 Normative requirements for the use of Tables 8 and 9 (laminated CRTs) 26
17.1 Sampling plan I: New construction 26
17.2 Sampling plan II: Alternative construction 26

Annex A (informative) Background to the development of this standard 46
A.1 Mechanical strength test 47
A.2 Implosion test 47
A.3 Small CRTs (76 mm to 160 mm diagonal) 47
A.4 Evaluation time 47

Annex B (informative) Velocity and potential force of glass particles expelled from a CRT subjected to a ball impact – Ballistic and statistical calculations 48
B.1 Introduction 48
B.2 Analysis without friction 48
B.3 Analysis with friction 54
B.4 Potential threat 57
B.5 Conclusions 57

Figure 1 – Example of a test cabinet 35
Figure 2 – Example of a ball impact test 36
Figure 3 – Example of a 2,3 kg steel missile 37
Figure 4 – Missile impact area on a typical CRT 38
Figure 5 – Example of a missile impact test 39
Figure 6 – Options for scratch patterns for implosions by the thermal shock method 40
Figure 7 – Film scoring tool 41
Figure 8 – Example of high-energy impact test set-up 42
Figure 9 – Steel pins used in high-energy impact test 43
Figure 10 –Weights used in high-energy impact test 44
Figure 11 – Example of 1,4 kg steel missile 45
Figure B.1 – Height of the barriers and distances from the CRT face 48

Figure B.2 – Example of the parabolic trajectory of a glass particle and the definition of the distances 49

Figure B.3 – Definition of the initial angle and initial velocity and the forces acting on a particle 50

Figure B.4 – Initial velocity required to pass over barriers at $x = l_1$ (solid line) or $x = l_2$ (dashed line) as a function of the initial angle β 52

Figure B.5 – Trajectories for a glass particle for different initial angles and an initial velocity of 4 m/s 52

Figure B.6 – Definition of the forces acting on a particle 54

Figure B.7 – Measurements of a typical glass particle 55

Figure B.8 – Trajectory of a glass particle with an initial velocity of 2 m/s and an initial angle of 45° without friction (dashed line) and with friction (solid line) 56

Figure B.9 – Trajectories of a glass particle with an initial velocity of 2 m/s and an initial angle of 45° for different values of the cross-sectional area 57

Table 1 – Sampling and test programme for prestressed banded CRTs exceeding 160 mm diagonal 27

Table 2 – Sampling and test programme for prestressed banded CRTs from 76 mm to 160 mm diagonal 28

Table 3 – Sampling and test programme for prestressed banded CRTs with protective film exceeding 160 mm diagonal 29

Table 4 – Sampling and test programme for prestressed banded CRTs with protective film from 76 mm to 160 mm diagonal 30

Table 5 – Sampling and test programme for adhesion of film used in CRTs with protective film (tested according to Tables 3 and 4) 31

Table 6 – Sampling and test programme for bonded frame CRTs exceeding 160 mm diagonal 32

Table 7 – Sampling and test programme for bonded frame CRTs from 76 mm to 160 mm diagonal 32

Table 8 – Sampling and test programme for laminated CRTs exceeding 160 mm diagonal 33

Table 9 – Sampling and test programme for laminated CRTs from 76 mm to 160 mm diagonal 33

Table 10 – CRT size and deflection angle ranges 34

Table B.1 – Values of the distances 49

Table B.2 – Upper and lower boundary values of the initial angle 51

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*