IEC 62109-1

Edition 1.0 2010-04

INTERNATIONAL STANDARD

colour inside

Safety of power converters for use in photovoltaic power systems – Part 1: General requirements

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE XG

ICS 27.160

ISBN 978-2-88910-621-9

® Registered trademark of the International Electrotechnical Commission

CONTENTS

FOREWORD 8
INTRODUCTION 10
1 Scope and object 11
1.1 Scope 11
1.1.1 Equipment included in scope 11
1.1.2 Equipment for which other requirements may apply 11
1.2 Object 11
1.2.1 Aspects included in scope 11
1.2.2 Aspects excluded from scope 12
2 Normative references 12
3 Terms and definitions 15
4 General testing requirements 25
4.1 General 25
4.2 General conditions for testing 25
4.2.1 Sequence of tests 25
4.2.2 Reference test conditions 25
4.3 Thermal testing 28
4.3.1 General 28
4.3.2 Maximum temperatures 28
4.4 Testing in single fault condition 31
4.4.1 General 31
4.4.2 Test conditions and duration for testing under fault conditions 31
4.4.3 Pass/fail criteria for testing under fault conditions 32
4.4.4 Single fault conditions to be applied 33
4.5 Humidity preconditioning 36
4.5.1 General 36
4.5.2 Conditions 36
4.6 Backfeed voltage protection 36
4.6.1 Backfeed tests under normal conditions 37
4.6.2 Backfeed tests under single-fault conditions 37
4.6.3 Compliance with backfeed tests 37
4.7 Electrical ratings tests 37
4.7.1 Input ratings 37
4.7.2 Output ratings 37
5 Marking and documentation 37
5.1 Marking 37
5.1.1 General 37
5.1.2 Durability of markings 38
5.1.3 Identification 38
5.1.4 Equipment ratings 38
5.1.5 Fuse identification 38
5.1.6 Terminals, connections and controls 39
5.1.7 Switches and circuit-breakers 39
5.1.8 Class II equipment 39
5.1.9 Terminal boxes for external connections 40
5.2 Warning markings 40

5.2.1 Visibility and legibility requirements for warning markings 40
5.2.2 Content for warning markings 40
5.2.3 Sonic hazard markings and instructions 41
5.2.4 Equipment with multiple sources of supply 41
5.2.5 Excessive touch current 41
5.3 Documentation 42
5.3.1 General 42
5.3.2 Information related to installation 42
5.3.3 Information related to operation 43
5.3.4 Information related to maintenance 44
6 Environmental requirements and conditions 44
6.1 Environmental categories and minimum environmental conditions 45
6.1.1 Outdoor 45
6.1.2 Indoor, unconditioned 45
6.1.3 Indoor, conditioned 45
6.2 Pollution degree 46
6.3 Ingress protection 47
6.4 UV exposure 47
6.5 Temperature and humidity 47
7 Protection against electric shock and energy hazards 47
7.1 General 47
7.2 Fault conditions 47
7.3 Protection against electric shock 48
7.3.1 General 48
7.3.2 Decisive voltage classification 48
7.3.3 Protective separation 52
7.3.4 Protection against direct contact 52
7.3.5 Protection in case of direct contact 57
7.3.6 Protection against indirect contact 60
7.3.7 Insulation including clearance and creepage distances 68
7.3.8 Residual Current Detection (RCD) or Monitoring (RCM) device compatibility 79
7.3.9 Protection against shock hazard due to stored energy 80
7.4 Protection against energy hazards 80
7.4.1 Determination of hazardous energy level 80
7.4.2 Operator access areas 81
7.4.3 Service access areas 81
7.5 Electrical tests related to shock hazard 81
7.5.1 Impulse voltage test (type test) 81
7.5.2 Voltage test (dielectric strength test) (type test and routine test) 83
7.5.3 Partial discharge test (type test or sample test) 87
7.5.4 Touch current measurement (type test) 88
7.5.5 Equipment with multiple sources of supply 89
8 Protection against mechanical hazards 89
8.1 General 89
8.2 Moving parts 90
8.2.1 Protection of service persons 90
8.3 Stability 90
8.4 Provisions for lifting and carrying 91

8.5 Wall mounting 91
8.6 Expelled parts 92
9 Protection against fire hazards 92
9.1 Resistance to fire 92
9.1.1 Reducing the risk of ignition and spread of flame 92
9.1.2 Conditions for a fire enclosure 93
9.1.3 Materials requirements for protection against fire hazard 93
9.1.4 Openings in fire enclosures 96
9.2 Limited power sources 100
9.2.1 General 100
9.2.2 Limited power source tests 100
9.3 Short-circuit and overcurrent protection 101
9.3.1 General 101
9.3.2 Number and location of overcurrent protective devices 101
9.3.3 Short-circuit co-ordination (backup protection) 102
10 Protection against sonic pressure hazards 102
10.1 General 102
10.2 Sonic pressure and sound level 102
10.2.1 Hazardous noise levels 102
11 Protection against liquid hazards 103
11.1 Liquid containment, pressure and leakage 103
11.2 Fluid pressure and leakage 103
11.2.1 Maximum pressure 103
11.2.2 Leakage from parts 104
11.2.3 Overpressure safety device 104
11.3 Oil and grease 104
12 Chemical hazards 104
12.1 General 104
13 Physical requirements 105
13.1 Handles and manual controls 105
13.1.1 Adjustable controls 105
13.2 Securing of parts 105
13.3 Provisions for external connections 105
13.3.1 General 105
13.3.2 Connection to an a.c. mains supply 106
13.3.3 Wiring terminals for connection of external conductors 110
13.3.4 Supply wiring space 111
13.3.5 Wire bending space for wires 10 mm^2 and greater 112
13.3.6 Disconnection from supply sources 112
13.3.7 Connectors, plugs and sockets 112
13.3.8 Direct plug-in equipment 113
13.4 Internal wiring and connections 113
13.4.1 General 113
13.4.2 Routing 113
13.4.3 Colour coding 113
13.4.4 Splices and connections 114
13.4.5 Interconnections between parts of the PCE 114
13.5 Openings in enclosures 114

13.5.1 Top and side openings 114
13.6 Polymeric materials 116
13.6.1 General 116
13.6.2 Polymers serving as enclosures or barriers preventing access to hazards 117
13.6.3 Polymers serving as solid insulation 117
13.6.4 UV resistance 118
13.7 Mechanical resistance to deflection, impact, or drop 118
13.7.1 General 118
13.7.2 250 N deflection test for metal enclosures 119
13.7.3 7 J impact test for polymeric enclosures 119
13.7.4 Drop test 119
13.8 Thickness requirements for metal enclosures 120
13.8.1 General 120
13.8.2 Cast metal 120
13.8.3 Sheet metal 120
14 Components 122
14.1 General 122
14.2 Motor overtemperature protection 124
14.3 Overtemperature protection devices 124
14.4 Fuse holders 124
14.5 Mains voltage selecting devices 124
14.6 Printed circuit boards 124
14.7 Circuits or components used as transient overvoltage limiting devices 125
14.8 Batteries 125
14.8.1 Battery enclosure ventilation 125
14.8.2 Battery mounting 126
14.8.3 Electrolyte spillage 126
14.8.4 Battery connections 127
14.8.5 Battery maintenance instructions 127
14.8.6 Battery accessibility and maintainability 127
15 Software and firmware performing safety functions 127
Annex A (normative) Measurement of clearances and creepage distances 128
Annex B (normative) Programmable equipment 133
Annex C (normative) Symbols to be used in equipment markings 134
Annex D (informative) Test probes for determining access 136
Annex E (informative) RCDs 138
Annex F (informative) Altitude correction for clearances 140
Annex G (informative) Clearance and creepage distance determination for frequencies greater than 30 kHz 141
Annex H (informative) Measuring instrument for touch current measurements (see 7.5.4) 144
Annex I (informative) Examples of protection, insulation, and overvoltage category requirements for PCE 146
Annex J (normative) Ultraviolet light conditioning test 150

Figure 1 – Functional summary of protective measures against electric shock 48
Figure 2 – Typical waveform for a.c. working voltage 51

Figure 3 – Typical waveform for d.c. working voltage 51
Figure 4 – Typical waveform for pulsating working voltage 52
Figure 5 – Examples for protection against direct contact for DVC-C circuits 56
Figure 6 – Protection by DCV A with protective separation 57
Figure 7 – Protection by means of protective impedance 58
Figure 8 – Protection by limitation of discharge energy 59
Figure 9 – Protection by means of voltage limitation 60
Figure 10 – Examples of protective bonding and earthing 61
Figure 11 – Protective bonding impedance test for separate unit with power fed from the PCE with overcurrent protection for the power cable 63
Figure 12 – Protective bonding impedance test for separate unit with accessible parts and with power fed from the PCE without overcurrent protection 64
Figure 13 – Voltage test procedures 85
Figure 14 – Fire enclosure bottom openings below an unenclosed or partially enclosed component 97
Figure 15 – Fire enclosure baffle construction 98
Figure 16 – Examples of cross-sections of designs of openings preventing vertical access 115
Figure 17 – Examples of louver design 115
Figure 18 – Enclosure openings 116
Figure 19 – Methods of compliance verification 123
Figure A.1 – Narrow groove 128
Figure A.2 – Wide groove 129
Figure A.3 – V-shaped groove 129
Figure A.4 – Rib 129
Figure A.5 – Uncemented joint with narrow groove 129
Figure A.6 – Uncemented joint with wide groove 130
Figure A.7 – Uncemented joint with narrow and wide grooves 130
Figure A.8 – Narrow recess 130
Figure A.9 – Wide recess 131
Figure A.10 – Intervening, unconnected conductive part 131
Figure A.11 – Distance for multilayer PWBs 132
Figure D.1 – Test finger 136
Figure D.2 – Test pin 137
Figure D.3 – Straight unjointed test finger 137
Figure E.1 – Flow chart leading to selection of the RCD/RCM type upstream of a PCE 138
Figure G.1 – Clearance distance determination for frequencies greater than 30 kHz 141
Figure G.2 – Creepage distance determination for frequencies greater than 30 kHz 142
Figure H.1 – Measuring instrument 144
Figure H.2 – Alternative measuring instrument 145
Figure I.1 – Transformer (basic) isolated PV inverter 147
Figure I.2 – Transformer (basic) isolated PV inverter with SPD to reduce impulse voltage for functional insulation 147
Figure I.3 – Isolated PV inverter with SPD to reduce impulse voltage for basic insulation 148

Figure I.4 – Transformer isolated auxiliary circuit with reinforced insulation 148
Figure I.5 – Transformerless PV inverter 149

Table 1 – Total temperature limits for transformers, inductors, and other coils and their insulation systems 30
Table 2 – Total temperature limits for materials and components where manufacturer's ratings and component standards do not exist (see 4.3.2.1) 30
Table 3 – Total touch temperature limits for accessible surfaces 31
Table 4 – Environmental categories, environmental conditions, and test requirements 45
Table 5 – Reduction of the pollution degree of internal environment through the use of additional protection 46
Table 6 – Summary of the limits of the decisive voltage classes 49
Table 7 – Examples of application of insulation and separation 50
Table 8 – Insulation between accessible unearthed parts and DVC-A or -B circuits adjacent to DVC-B or -C circuits 55
Table 9 – Values of accessible capacitance and charging voltage (threshold of pain) 59
Table 10 – Test duration for protective bonding test 65
Table 11 – External protective earthing conductor cross-section 66
Table 12 – Insulation voltage for low voltage circuits 71
Table 13 – Clearance distances 73
Table 14 – Creepage distances (mm) 75
Table 15 – Impulse voltage test 82
Table 16 – Impulse test voltage 83
Table 17 – AC or DC test voltage for circuits connected directly to the mains 84
Table 18 – a.c. or d.c. test voltage for circuits not connected directly to the mains 84
Table 19 – Partial discharge test 88
Table 20 – Summary of material flammability requirements 96
Table 21 – Allowable openings in fire enclosure bottoms 98
Table 22 – Limits for inherently limited power sources 101
Table 23 – Limits for power sources not inherently limited 101
Table 24 – Sizes of conductors 108
Table 25 – Physical tests on power supply cords 109
Table 26 – Wire bending space from terminals to obstructions 112
Table 27 – Minimum property retention limits after UV exposure 118
Table 28 – Thickness of sheet metal for enclosures: Carbon steel or stainless steel 121
Table 29 – Thickness of sheet metal for enclosures: aluminium, copper or brass 122
Table A.1 – Value of X 128
Table C.1 – Symbols 134
Table F.1 – Correction factor for clearances at altitudes above 2 000 m (see 7.3.7.4.1) 140
Table F.2 – Test voltages for verifying clearances at different altitudes 140
Table G.1 – Minimum values of clearances in air at atmospheric pressure for inhomogeneous field conditions (Table 1 of IEC 60664-4) 142
Table G.2 – Minimum values of creepage distances for different frequency ranges (Table 2 of IEC 60664-4) 143

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

SAFETY OF POWER CONVERTERS FOR USE IN PHOTOVOLTAIC POWER SYSTEMS –

Part 1: General requirements

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, Publicly Available Specifications (PAS) 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 itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
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 62109-1 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

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

FDIS	Report on voting
82/593/FDIS	82/597/RVD

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

A list of all parts of IEC 62109 series, under the general title, *Safety of power converters for use in photovoltaic power systems*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. 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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This Part of IEC 62109 specifies the safety requirements that are generally applicable to all equipment within its scope. For certain types of equipment, these requirements will be supplemented or modified by the special requirements of one or more subsequent parts (for example IEC 62109-2, IEC 62109-3, etc.) of the standard which must be read in conjunction with the Part 1 requirements.

SAFETY OF POWER CONVERTERS FOR USE IN PHOTOVOLTAIC POWER SYSTEMS –

Part 1: General requirements

1 Scope and object

1.1 Scope

This part of IEC 62109 applies to the power conversion equipment (PCE) for use in Photovoltaic (PV) systems where a uniform technical level with respect to safety is necessary. This standard defines the minimum requirements for the design and manufacture of PCE for protection against electric shock, energy, fire, mechanical and other hazards.

This standard provides general requirements applicable to all types of PV PCE. There are additional parts of this standard that provide specific requirements for the different types of power converters, such as Part 2 - inverters. Additional parts may be published as new products and technologies are commercialised.

1.1.1 Equipment included in scope

This standard covers PCE connected to systems not exceeding maximum PV source circuit voltage of 1 500 V d.c. The equipment may also be connected to systems not exceeding 1 000 V a.c. at the a.c. mains circuits, non-mains a.c. load circuits, and to other DC source or load circuits such as batteries. This standard may be used for accessories for use with PCE, except where more appropriate standards exist.

Evaluation of PCE to this standard includes evaluation of all features and functions incorporated in or available for the PCE, or referred to in the documentation provided with the PCE, if such features or functions can affect compliance with the requirements of this standard.

1.1.2 Equipment for which other requirements may apply

This standard has not been written to address characteristics of power sources other than photovoltaic systems, such as wind turbines, fuel cells, rotating machine sources, etc.

NOTE 1 Requirements for other sources may be incorporated in the IEC 62109 series in the future.

Additional or other requirements are necessary for equipment intended for use in explosive atmospheres (see IEC 60079), aircraft, marine installations, electromedical applications (see IEC 60601) or at elevations above 2 000 m.

NOTE 2 Requirements are included for adjustment of clearance distances for higher elevations, but not for other factors related to elevation, such as thermal considerations

1.2 Object

1.2.1 Aspects included in scope

The purpose of the requirements of this part of IEC 62109 is to ensure that the design and methods of construction used provide adequate protection for the operator and the surrounding area against:

a) electric shock and energy hazards;

b) mechanical hazards;

c) excessive temperature hazards;

d) spread of fire from the equipment;

e) chemical hazards;

f) sonic pressure hazards;

g) liberated fluids, gases and explosion hazards.

NOTE Servicing personnel are expected to have the necessary knowledge and skill to use reasonable care in dealing with hazards associated with the operation, repair and maintenance of this equipment. Based upon this premise, this standard provides only limited requirements (for example markings or guarding) intended to protect service personnel from hazards that may not be apparent even to trained personnel.

1.2.2 Aspects excluded from scope

Aspects not covered by this standard include, but are not limited to, the following:

a) functional reliability, performance or other properties of the equipment not related to safety;

b) effectiveness of transport packaging;

c) EMC requirements;

d) installation requirements, which are covered by local and national installation codes.

NOTE This standard does provide requirements for PCE intended to ensure that the PCE can be installed in a safe manner, including requirements for installation instructions provided with the product.

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 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60085, *Electrical insulation – Thermal evaluation and designation*

IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

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

IEC 60216-2, *Electrical insulating materials – Thermal endurance properties – Part 2: Determination of thermal endurance properties of electrical insulating materials – Choice of test criteria*

IEC 60216-3, *Electrical insulating materials – Thermal endurance properties – Part 3: Instructions for calculating thermal endurance characteristics*

IEC 60216-4-1, *Electrical insulating materials – Thermal endurance properties – Part 4-1: Ageing ovens – Section 1: Single-chamber ovens*

IEC 60216-5, *Electrical insulating materials – Thermal endurance properties – Part 5: Determination of relative thermal endurance index (RTE) of an insulating material*

IEC 60216-6, *Electrical insulating materials – Thermal endurance properties – Part 6: Determination of thermal endurance indices (TI and RTE) of an insulating material using the fixed time frame method*

IEC 60227-1:2007, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V - Part 1: General requirements*

IEC 60245-1:2003, *Rubber insulated cables – Rated voltages up to and including 450/750 V – Part 1: General requirements*

IEC 60309 (all parts), *Plugs, socket-outlets and couplers for industrial purposes*

IEC 60320 (all parts), *Appliances couplers for household and similar general purposes*

IEC 60364-1:2005, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions*

IEC 60364-5-54, *Electrical installations of buildings – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements, protective conductors and protective bonding conductors*

IEC 60417, *Graphical symbols for use on equipment*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60664 (all parts), *Insulation coordination for equipment within low-voltage systems*

IEC 60664-3:2003, *Insulation coordination for equipment within low-voltage systems – Part 3: Use of coating, potting or moulding for protection against pollution*

IEC 60664-4:2005, *Insulation coordination for equipment within low-voltage systems – Part 4: Consideration of high-frequency voltage stress*

IEC 60695-2-11, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products*

IEC 60695-2-20, *Fire hazard testing – Part 2-20: Glowing/hot wire based test methods – Hot-wire coil ignitability – Apparatus, test method and guidance*

IEC 60695-11-5, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

IEC 60695-11-10, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC 60695-11-20, *Fire hazard testing – Part 11- 20: Test flames – 500 W flame test methods*

IEC 60730-1:2010, *Automatic electrical controls for household and similar use – Part 1: General requirements*

IEC 60755, *General requirements for residual current operated protective devices*

IEC 60950-1:2005, *Information technology equipment – Safety – Part 1: General requirements*

IEC 60990:1999, *Methods of measurement of touch current and protective conductor current*

IEC 61032*, Protection of persons and equipment by enclosures – Probes for verification*

IEC 61180-1, *High-voltage test techniques for low voltage equipment – Part 1: Definitions, test and procedure requirements*

IEC 62020, *Electrical accessories – Residual current monitors for household and similar uses (RCMs)*

ISO 178, *Plastics – Determination of flexural properties*

ISO 179 (all parts), *Plastics – Determination of Charpy impact properties*

ISO 180, *Plastics – Determination of Izod impact strength*

ISO 261, *ISO general purpose metric screw threads – General plan*

ISO 262, *ISO general purpose metric screw threads – Selected sizes for screws, bolts and nuts*

ISO 527 (all parts*), Plastics – Determination of tensile properties*

ISO 3746, *Acoustics – Determination of sound power levels of noise sources using sound pressure – Survey method using an enveloping measurement surface over a reflecting plane*

ISO 4892-1, *Plastics – Methods of exposure to laboratory light sources – Part 1: General guidance*

ISO 4892-2, *Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps*

ISO 4892-4, *Plastics – Methods of exposure to laboratory light sources – Part 4: Open-flame carbon-arc lamps*

ISO 7000, *Graphical symbols for use on equipment – Index and synopsis*

ISO 8256, *Plastics – Determination of tensile-impact strength*

ISO 9614-1, *Acoustics – Determination of sound power levels of noise sources using sound intensity – Part 1: Measurement at discrete points*

ISO 9614-2, *Acoustics – Determination of sound power levels of noise sources using sound intensity – Part 2: Measurement by scanning*

ISO 9614-3, *Acoustics – Determination of sound power levels of noise sources using sound intensity – Part 3: Precision method for measurement by scanning*

ANSI/ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*

ANSI UL 746B, *Polymeric Materials – Long Term Property Evaluations*

ANSI UL 746C, *Polymeric Materials – Use in Electrical Equipment Evaluations*

ASTM E162, *Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source*