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Edition 2.2 2022-11
CONSOLIDATED VERSION

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Uninterruptible power systems (UPS) – Part 1: Safety requirements

Alimentations sans interruption (ASI) – Partie 1: Exigences de sécurité



IEC 62040-1:2017-07+AMD1:2021-05+AMD2:2022-11 CSV(en-fr)



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Uninterruptible power systems (UPS) – Part 1: Safety requirements

Alimentations sans interruption (ASI) – Partie 1: Exigences de sécurité

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

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Alimentations sans interruption (ASI) – Partie 1: Exigences de sécurité



IEC 62040-1:2017-07+AMD1:2021-05+AMD2:2022-11 CSV(en-fr)

CONTENTS

FOREWORD 4
INTRODUCTION 6
1 Scope 7
2 Normative references 7
3 Terms and definitions 8
4 Protection against hazards 15
5 Test requirements 29
6 Information and marking requirements 42
Annexes 49
Annex A (normative) Additional information for protection against electric shock 50
Annex M (informative) Test probes for determining access 51
Annex AA (informative) Minimum and maximum cross-section of copper conductors suitable for connection to terminals for external conductor 52
Annex BB (normative) Reference loads 54
Annex CC (normative) Ventilation of lead-acid battery compartments 58
Annex DD (informative) Guidance for disconnection of batteries during shipment 61
Annex EE (informative) Short-time withstand current test procedure – Guidance and typical values 63
Annex FF (informative) Maximum heating effect in transformer tests 67
Annex GG (normative) Requirements for the mounting means of rack-mounted equipment 69
Bibliography 71

Figure 101 – Examples of design of openings preventing vertical access 18
Figure 102 – Test circuit for load-induced change of reference potential – Single-phase output 35
Figure 103 – Test circuit for load-induced change of reference potential – Three-phase output 35
Figure 104 – Voltage backfeed warning label 45
Figure M.101 – Jointed test finger (IP2X) 52
Figure BB.1 – Reference resistive load 54
Figure BB.2 – Reference inductive-resistive load (series) 55
Figure BB.3 – Reference inductive-resistive load (parallel) 55
Figure BB.4 – Reference capacitive-resistive load (series) 55
Figure BB.5 – Reference capacitive-resistive load (parallel) 55
Figure BB.6 – Reference non-linear load 56
Figure DD.1 – Precautionary label for products shipped with the battery disconnected 61
Figure DD.2 – Precautionary label for products shipped with the battery connected 62
Figure EE.1 – 3-wire test circuit for UPS short-time withstand current 63
Figure EE.2 – 4-wire test circuit for UPS short-time withstand current 64
Figure EE.3 – 2-wire test circuit for single phase UPS short-time withstand current 65

Table 1 – Alphabetical list of terms 9

Table 101 – UPS input port configuration 16
Table 102 – Overvoltage categories 19
Table 103 – Maximum temperature limits for magnetic components during stored energy mode of operation 22
Table 22 – Test overview 29
Table 104 – Short-time withstand current 37
Table 105 – Temperature limits for transformer windings 40
Table A.101 – Comparison of limits of working voltage 50
Table AA.1 – Conductor cross-sections (extract from IEC 61439-1:2011) 53
Table FF.1 – Test steps 67

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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UNINTERRUPTIBLE POWER SYSTEMS (UPS) –

Part 1: Safety requirements

FOREWORD

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This consolidated version of the official IEC Standard and its amendments has been prepared for user convenience.

IEC 62040-1 edition 2.2 contains the second edition (2017-07) [documents 22H/217/FDIS and 22H/218/RVD] and its corrigendum (2019-10), its amendment 1 (2021-05) [documents 22H/269/FDIS and 22H/271/RVD] and its amendment 2 (2022-11) [documents 22H/288/CDV and 22H/298/RVC].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendments 1 and 2. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

International Standard IEC 62040-1 has been prepared by subcommittee 22H: Uninterruptible power systems (UPS), of IEC technical committee 22: Power electronic systems and equipment.

This second edition constitutes a technical revision.

This edition includes the following significant technical change with respect to the previous edition: the reference document has been changed from IEC 60950-1:2005 (safety for IT equipment) to IEC 62477-1 (group safety standard for power electronic converters).

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

This International Standard is to be read in conjunction with IEC 62477-1:2012.

The provisions of the general rules dealt within IEC 62477-1:2012 are only applicable to this document insofar as they are specifically cited. Clauses and subclauses of IEC 62477-1:2012 that are applicable in this document are identified by reference to IEC 62477-1:2012, for example, "Clause 4 of IEC 62477-1:2012 applies, except as follows".

The exceptions are then listed. The exceptions can take the form of a deletion, a replacement or an addition of subclauses, tables, figures or annexes.

Subclauses, tables and figures that are additional to those in IEC 62477-1:2012 are, in this document, identified by a suffix in the format of X.10x, for example 4.3.101.

Annexes that are additional to those in IEC 62477-1:2012 are, in this document, lettered AA, BB, etc.

In this document, the following print types are used:

- requirements and normative annexes: roman type
- compliance statements and test specifications: *italic type*
- notes and other informative matter: smaller roman type
- normative conditions within tables: smaller roman type
- terms that are defined in Clause 3: **bold**

A list of all parts in the IEC 62040 series, published under the general title *Uninterruptible Power Systems (UPS)*, can be found on the IEC website.

The committee has decided that the contents of the base publication and its amendments 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.

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

IEC technical sub-committee 22H: Uninterruptible power systems (UPS) carefully considered the relevance of each paragraph of IEC 62477-1:2012 in UPS applications. This part of IEC 62040 utilizes IEC 62477-1:2012 as a reference document and references, adds, replaces or modifies requirements as relevant. This is because product-specific topics not covered by the reference document are the responsibility of the technical committee using the reference document.

IEC 62477-1:2012 relates to products that include power electronic converters, with a rated system voltage not exceeding 1 000 V AC or 1 500 V DC. It specifies requirements to reduce risks of fire, electric shock, thermal, energy and mechanical hazards, except functional safety as defined in IEC 61508 (all parts). The objectives of this document are to establish a common terminology and basis for the safety requirements of products that contain power electronic converters across several IEC technical committees.

IEC 62477-1:2012 was developed with the intention:

- to be used as a reference document for product committees inside IEC technical committee 22: Power electronic systems and equipment in the development of product standards for power electronic converter systems and equipment;
- to replace IEC 62103 as a product family standard providing minimum requirements for safety aspects of power electronic converter systems and equipment in apparatus for which no product standard exists; and

  NOTE The scope of IEC 62103 contains reliability aspects, which are not covered by this document.

- to be used as a reference document for product committees outside TC 22 in the development of product standards of power electronic converter systems and equipment intended for renewable energy sources. TC 82, TC 88, TC 105 and TC 114, in particular, have been identified as relevant technical committees at the time of publication.

The reference document, being a group safety standard, will not take precedence over this product-specific standard according to IEC Guide 104. IEC Guide 104 provides information about the responsibility of product committees to use group safety standards for the development of their own product standards.

UNINTERRUPTIBLE POWER SYSTEMS (UPS) –

Part 1: Safety requirements

1 Scope

This part of IEC 62040 applies to movable, stationary, fixed or built-in **UPS** for use in low-voltage distribution systems and that are intended to be installed in an area accessible by an **ordinary person** or in a restricted access area as applicable, that deliver fixed frequency AC output voltage with port voltages not exceeding 1 000 V AC or 1 500 V DC and that include an energy storage device. It applies to pluggable and to permanently connected **UPS**, whether consisting of a system of interconnected units or of independent units, subject to installing, operating and maintaining the **UPS** in the manner prescribed by the manufacturer.

NOTE 1 Typical **UPS** configurations, including voltage and/or frequency converters and other topologies, are described in IEC 62040-3, the test and performance product standard for **UPS**.

NOTE 2 **UPS** generally connect to their energy storage device through a DC link. A chemical battery is used throughout the standard as an example of an energy storage device. Alternative devices exist, and as such, where "battery" appears in the text of this document, this is to be understood as "energy storage device".

This document specifies requirements to ensure safety for the **ordinary person** who comes into contact with the **UPS** and, where specifically stated, for the **skilled person**. The objective is to reduce risks of fire, electric shock, thermal, energy and mechanical hazards during use and operation and, where specifically stated, during service and maintenance.

This product standard is harmonized with the applicable parts of group safety publication IEC 62477-1:2012 for power electronic converter systems and contains additional requirements relevant to **UPS**.

This document does not cover:

- UPS that have a DC output;
- systems for operation on moving platforms including, but not limited to, aircrafts, ships and motor vehicles;
- external AC or DC input and output distribution boards covered by their specific product standard;
- stand-alone static transfer systems (STS) covered by IEC 62310-1;
- systems wherein the output voltage is directly derived from a rotating machine;
- telecommunications apparatus other than **UPS** for such apparatus;
- functional safety aspects covered by IEC 61508 (all parts).

NOTE 3 Even if this document does not cover the applications listed above, it is commonly taken as a guide for such applications.

NOTE 4 Specialized **UPS** applications are generally governed by additional requirements covered elsewhere, for example **UPS** for medical applications.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

Clause 2 of IEC 62477-1:2012 applies, except as follows:

Add the following normative references:

IEC 60364-4-42, *Low-voltage electrical installations – Part 4-42: Protection for safety – Protection against thermal effects*

IEC 60384-14, *Fixed capacitors for use in electronic equipment – Part 14: Sectional specification – Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*

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

IEC 60947-2:2006*, Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*[1]

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

IEC 61000-2-2:2002, *Electromagnetic compatibility (EMC) – Part 2-2: Environment – Compatibility levels for low-frequency conducted disturbances and signaling in public low-voltage power supply systems*

IEC 61008-1, *Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) – Part 1: General rules*

IEC 61009-1, *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) – Part 1: General rules*

IEC 62040-2:2005, *Uninterruptible power systems (UPS) – Part 2: Electromagnetic compatibility (EMC) requirements*[2]

IEC 62477-1:2012, *Safety requirements for power electronic converter systems and equipment – Part 1: General*

3 Terms and definitions

Clause 3 of IEC 62477-1:2012 applies, except as follows:

Add the following new terms and definitions, and new notes:

---

1 4th edition (2006). This 4th edition has been replaced in 2016 by a 5th edition IEC 60947-2:2016, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*.

2 2nd edition (2005). This 2 nd edition has been replaced in 2016 by a 3rd edition IEC 62040-2:2016, *Uninterruptible power systems (UPS) – Part 2: Electromagnetic compatibility (EMC) requirements*.

Table 1 – Alphabetical list of terms

Terms	Term number		Terms	Term number	
	62040-1	62477-1		62040-1	62477-1
adjacent circuit		3.1	power semiconductor device		3.34
active power	3.111		primary power	3.108	
apparent power	3.112		prospective short-circuit current	3.122	
backfeed	3.127		protective equipotential bonding		3.36
backfeed protection	3.128		protective class I		3.37
basic insulation		3.2	protective class II		3.38
basic protection		3.3	protective class III		3.39
bypass	3.110		protective earthing (PE)		3.40
commissioning test		3.4	PE conductor		3.41
cord	3.109		protective impedance		3.42
decisive voltage class (*DVC*)		3.5	(electrically) protective screening		3.43
double insulation		3.6	protective separation		3.44
DVC As		3.7	PEC		3.45
DVC Ax		3.8	PECS		3.46
earth fault	3.131		rated conditional short-circuit current	3.120	
electrical breakdown		3.9	rated current	3.117	
(electrical) insulation		3.10	rated load	3.115	
(electronic) (power) conversion		3.11	rated peak withstand current	3.118	
enclosure		3.12	rated short-time withstand current	3.119	
enhanced protection		3.13	rating	3.113	
expected lifetime		3.14	rated value	3.114	
Extra Low Voltage (ELV)		3.15	rated voltage	3.116	
fault protection		3.16	reference non-linear load	3.126	
field wiring terminal		3.17	reference test load	3.125	
fire enclosure		3.18	reinforced insulation		3.47
functional insulation		3.19	restricted access area		3.48
hazardous energy	3.107		routine test		3.49
hazardous live part		3.20	sample test		3.50
hazardous voltage	3.106		SELV (systems)		3.51
installation		3.21	short-circuit backup protection		3.52
instructed person	3.103		service acces area	3.105	
linear load	3.123		short-circuit protective device (SCPD)	3.130	
live part		3.22	simple separation		3.53
low impedance path	3.121		single fault condition		3.54
low voltage		3.23	skilled person	3.102	
mains supply		3.24	startle reaction		3.55
muscular reaction (inability to let go)		3.25	supplementary insulation		3.56

Terms	Term number		Terms	Term number	
	62040-1	62477-1		62040-1	62477-1
non-linear load	3.124		surge protective device (SPD)		3.57
non-mains supply		3.26	system		3.58
open type		3.27	system voltage		3.59
ordinary person	3.104		stored energy mode	3.129	
output short-circuit current		3.28	temporary overvoltage		3.60
PELV (systems)		3.29	touch current		3.61
Permanently connected		3.30	type test		3.62
pluggable equipment type A		3.31	ventricular fibrillation		3.63
pluggable equipment type B		3.32	working voltage		3.64
port		3.33	uninterruptible power system (UPS)	3.101	
			zone of equipotential bonding		3.65

Note 1 to entry: Where the terms "voltage" and "current" are used, RMS values are implied unless otherwise specified.

Note 2 to entry: Non-sinusoidal signals are measured with appropriate true RMS measuring instruments.

3.101
uninterruptible power system
UPS
combination of convertors, switches and energy storage devices (such as batteries), constituting a power system for maintaining continuity of load power in case of input power failure

Note 1 to entry: Continuity of load power occurs when voltage and frequency are within rated steady-state and transient tolerance bands, and with distortion and interruptions within the limits specified for the output port. Input power failure occurs when voltage and frequency are outside rated steady-state and transient tolerance bands, or with distortion or interruptions outside the limits specified for the **UPS**.

3.102
skilled person
person with relevant education and experience to enable him or her to perceive risks and to avoid hazards which the equipment can create

Note 1 to entry: Such person has access to restricted access areas.

[SOURCE: IEC 60050-195:1998, 195-04-01, modified – The word "(electrically)" has been deleted from the term, and "electricity" has been replaced by "the equipment" in the definition. The note has been added.]

3.103
instructed person
person adequately advised or supervised by **skilled persons** to enable him or her to perceive risks and to avoid hazards which the equipment can create

Note 1 to entry: Such person has access to restricted access areas.

Note 2 to entry: Examples of activities performed by an **instructed person** can be found in IEC 61140:2001, Clause 8.

[SOURCE: IEC 60050-195:1998, 195-04-02, modified – The word "(electrically)" has been deleted from the term, and the notes have been added.]

3.104
ordinary person
person who is neither a **skilled person** nor an **instructed person**

Note 1 to entry: Such person does not have access to a restricted access area and is not trained to identify hazards. Such person may otherwise have access to the equipment or may be in the vicinity of the equipment. An ordinary person will not intentionally create hazards nor have access to hazardous parts under normal and **single fault conditions**.

[SOURCE: IEC 60050-195:1998, 195-04-03, modified – The note has been added.]

3.105
service access area
area accessible by **skilled person**s by the use of a tool, where it is necessary for **skilled person** to have access regardless of the equipment being energized

3.106
hazardous voltage
voltage exceeding 42,4 V peak, or 60 V DC, existing in a circuit that does not meet the requirements for either a limited current circuit or a TNV-1 circuit

Note 1 to entry: A limited current circuit is understood in the context of "protection by means of protective impedance" as described in IEC 62477-1:2012, 4.4.5.4.

[SOURCE: IEC 60950-1:2005, 1.2.8.6 modified – TNV has been replaced by TNV-1.]

3.107
hazardous energy
available power level of 240 VA or more, having a duration of 60 s or more, or a stored energy level of 20 J or more (for example, from one or more capacitors), at a potential of 2 V or more

Note 1 to entry: See IEC 62477-1:2012, 4.5.1.2.

3.108
primary power
power supplied by an electrical utility company or by a local generator

3.109
cord
flexible cable with a limited number of conductors of small cross-sectional area

[SOURCE: IEC 60050-461:2008, 461-06-15.]

3.110
bypass
alternative power path, either internal or external to the **UPS**

3.111
active power
under periodic conditions, mean value, taken over one period T, of the instantaneous power p

$$P = \frac{1}{T}\int_0^T p\,\mathrm{d}t$$

Note 1 to entry: Under sinusoidal conditions, the **active power** is the real part of the complex power $\underline{S}$, thus $\underline{P}$ = Re $\underline{S}$

Note 2 to entry: The coherent SI unit for **active power** is watt, W.

Note 3 to entry: DC, fundamental and harmonic voltages and currents contribute to the magnitude of the **active power**. Where applicable, instruments used to measure **active power** should therefore present sufficient bandwidth and be capable of measuring any significant non-symmetrical and harmonic power components.

[SOURCE: IEC 60050-131: 2013, 131-11-42, modified – A third note to entry has been added.]

3.112
apparent power
product of the RMS voltage and RMS current

3.113
rating
set of **rated values** and operating conditions of a machine, a device or equipment

[SOURCE: IEC 60050-151:2001, 151-16-11, modified – The words "of a machine, a device or equipment" have been added.]

3.114
rated value
value of a quantity used for specification purposes, generally established by a manufacturer for a specified set of operating conditions of a component, device, equipment, or system

[SOURCE: IEC 60050-151:2001, 151-16-08, modified – The word "established" has been expanded to read "generally established by a manufacturer".]

3.115
rated load
load or condition in which the output of the **UPS** delivers the power for which the **UPS** is rated

Note 1 to entry: The **rated load** is expressed in **apparent power** (VA) and **active power** (W) resulting in a (rated) power factor that includes the effect of any applicable combination of **linear** and of **non-linear load** as prescribed in Annex BB.

Note 2 to entry: **Rated load** is a value of load used for specification purposes, generally established by a manufacturer for a specified set of operating conditions of a component, device, equipment, or system

3.116
rated voltage
input or output voltage as declared by the manufacturer

Note 1 to entry: For a three-phase supply, the rated voltage corresponds to the phase-to-phase voltage.

3.117
rated current
input or output current of the **UPS** as declared by the manufacturer

3.118
rated peak withstand current
I_{pk}
value of peak short-circuit current, declared by the **UPS** manufacturer, that can be withstood under specified conditions

Note 1 to entry: For the purpose of this document, I_{pk} refers to the initial asymmetric peak value of the prospective test current listed in Table 104.

3.119
rated short-time withstand current
I_{cw}
RMS value of short-time current, declared by the **UPS** manufacturer, that can be carried under specified conditions, defined in terms of current and time

[SOURCE: IEC 61439-1:2011, 3.8.10.3, modified – The definition has been rephrased and the word "assembly" has been replaced by "**UPS**".]

3.120
rated conditional short-circuit current
I_{cc}
RMS value of **prospective short-circuit current**, declared by the **UPS** manufacturer, that can be withstood for the total operating time (clearing time) of the **short-circuit protective device** (**SCPD**) under specified conditions

Note 1 to entry: The **short-circuit protective device** does not necessarily form an integral part of the **UPS**.

[SOURCE: IEC 61439-1:2011, 3.8.10.4, modified – The word "RMS" has been added to "value", the word "assembly" has been replaced by "**UPS**", and the note has been rephrased.]

3.121
low impedance path
path containing devices that for **UPS** load purposes present negligible impedance, such as cabling, switching devices, protecting devices and filtering devices

Note 1 to entry: The devices in a **low impedance path** generally present current limiting characteristics under short-circuit conditions.

Note 2 to entry: Examples include current limiting fuses, current limiting circuit-breakers, transformers and inductors.

3.122
prospective short-circuit current
I_{cp}
RMS value of the current which would flow if the supply conductors to the circuit are short-circuited by a conductor of negligible impedance located as near as practicable to the supply terminals of the **UPS**

[SOURCE: IEC 61439-1:2011, 3.8.7, modified – The word "assembly" has been replaced by "**UPS**".]

3.123
linear load
load where the current drawn from the supply is defined by the relationship:

$$I = U/Z$$

where

I is the load current;

U is the supply voltage;

Z is the constant load impedance

Note 1 to entry: Application of a **linear load** to a sinusoidal voltage results in a sinusoidal current.

[SOURCE: IEC 62040-3:2011, 3.2.4]

3.124
non-linear load
load where the parameter Z (load impedance) is no longer a constant but is a variable dependent on other parameters, such as voltage or time

[SOURCE: IEC 62040-3:2011, 3.2.5]

3.125
reference test load
load or condition in which the output of the **UPS** delivers the **active power** (W) for which the **UPS** is rated

Note 1 to entry: This definition permits, when in test mode and subject to local regulations, the **UPS** output to be injected into the input AC supply.

[SOURCE: IEC 62040-3:2011, 3.3.5]

3.126
reference non-linear load
non-linear load that when connected to a **UPS**, consumes the **apparent power** at which the **UPS** shall be tested

Note 1 to entry: Refer to Clause BB.5 for test details.

[SOURCE: IEC 62040-3:2011, 3.3.6, modified – The expression "the apparent and active power for which the UPS is rated in accordance with Annex E" has been replaced by "the apparent power at which the **UPS** shall be tested", and the note has been added.]

3.127
backfeed
condition in which a voltage or energy available within the **UPS** is fed back to any of the input terminals, either directly or by a leakage path while operating in the **stored energy mode** and with **primary power** not available

[SOURCE: IEC 62040-3:2011, 3.2.3, modified – The words "while AC input power is" have been replaced by "with **primary power**".]

3.128
backfeed protection
control scheme that reduces the risk of electric shock due to **backfeed**

3.129
stored energy mode
stable mode of operation that the **UPS** attains under the following conditions:

a) AC input power is disconnected or is out of required tolerance;

b) all power is derived from the energy storage device;

c) the load is within the specified **rating** of the **UPS**

[SOURCE: IEC 62040-3:2011, 3.2.10, modified – The words "of UPS operation" have been deleted in the term, and the word "system" has been replaced by "device" in b).]

3.130
short-circuit protective device
SCPD
device intended to protect a circuit or parts of a circuit against short-circuit currents by interrupting them

[SOURCE: IEC 60947-1:2007, 2.2.21]

3.131
earth fault
occurrence of an accidental conductive path between a live conductor and the earth

[SOURCE: IEC 60050-826:2004, 826-04-14, modified – The second preferred term "ground fault" has been deleted, as well as the notes.]

3.132
movable UPS
UPS that is either

- 18 kg or less in mass and not fixed in place, or
- provided with wheels, casters, or other means to facilitate movement by an **ordinary person** as required to perform its intended use

4 Protection against hazards

Clause 4 of IEC 62477-1:2012 applies, except as follows:

4.2 Fault and abnormal conditions

Subclause 4.2 in IEC 62477-1:2012 applies, except as follows:

Replace the fourth paragraph of IEC 62477-1:2012, 4.2 by the following:

Compliance is checked by analysis or by test according to 5.2.4.6 of IEC 62477-1:2012.

Compliance through analysis only is permitted when such analysis conclusively shows that no hazard will result from failure of the component.

4.3 Short-circuit and overload protection

Subclause 4.3 in IEC 62477-1:2012 applies except as follows:

Add the following:

4.3.101 AC input current

The input current to the **UPS** shall not exceed that declared by the **UPS** manufacturer – see 6.2 a).

In determining the steady state input current, the consumption due to optional features offered or provided by the manufacturer for inclusion in or with the **UPS** shall be considered and adjusted to give the most unfavourable result.

NOTE Transient input current arising from dynamic occurences, for example inrush or overload current, is not considered.

Compliance is checked when highest current measured or calculated (as applicable) when performing the test described in 5.2.3.102 does not exceed the input current declared by the manufacturer (see 6.2).

4.3.102 Transformer protection

Transformers shall be protected against overtemperature.

NOTE Means of protection include:

- overcurrent protection,
- internal thermal cut-outs,
- use of current limiting devices.

Compliance is checked by the applicable tests of 5.2.3.104.