



UL 1778

STANDARD FOR SAFETY

Uninterruptible Power Systems

UL Standard for Safety for Uninterruptible Power Systems, UL 1778

Fifth Edition, Dated June 13, 2014

Summary of Topics

This revision of ANSI/UL 1778 dated April 28, 2023 is being issued to include reference to UL 1973 for battery requirements; [4.3.8.101.0](#), [5.3.102](#), [HHH.7A](#), [HHH.8](#) and Annex [III](#)

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated December 2, 2022.

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CSA Group
CSA C22.2 No. 107.3-14
Third Edition



ULSE Inc.
UL 1778
Fifth Edition

Uninterruptible Power Systems

June 13, 2014

(Title Page Reprinted: April 28, 2023)



ANSI/UL 1778-2023

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This ANSI/UL Standard for Safety consists of the Fifth Edition including revisions through April 28, 2023. The most recent designation of ANSI/UL 1778 as an American National Standard (ANSI) occurred on April 28, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

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Preface

This is the harmonized CSA Group and ULSE standard for Uninterruptible Power Systems (UPS). It is the third edition of CSA C22.2 No. 107.3 and the fifth edition of UL 1778. This harmonized standard has been jointly revised on April 28, 2023. For this purpose, CSA Group and ULSE are issuing revision pages dated April 28, 2023.

This harmonized Standard was prepared by CSA Group and ULSE Inc. (ULSE). The efforts and support of the National Electrical Manufacturers Association (NEMA) and Electro-Federation Canada (EFC) are gratefully acknowledged.

This standard is considered suitable for use for conformity assessment within the stated scope of the standard.

This Standard was reviewed by the CSA Subcommittee on Uninterruptible Power Systems, under the jurisdiction of the CSA Technical Committee on Industrial Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee.

Application of Standard

Where reference is made to a specific number of samples to be tested, the specified number is to be considered a minimum quantity.

Note: Although the intended primary application of this standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.

The Standard is intended to be used in conjunction with the applicable requirements of CAN/CSA-C22.2 No. 60950-1-07 and UL 60950-1, March 2007, second edition, which is referred to in this Standard as the Reference Document (RD). Compliance will be determined by the requirements located in CAN/CSA-C22.2 No. 60950-1-07 and UL 60950-1, March 2007, second edition, with deviations presented in the third edition of CSA C22.2 No. 107.3 and the fifth edition of UL 1778.

Level of Harmonization

This Standard is published as an equivalent standard for CSA Group and ULSE. An equivalent standard is a standard that is substantially the same in technical content, except as follows: Technical national differences are allowed for codes and governmental regulations as well as those recognized as being in accordance with NAFTA Article 905, for example, because of fundamental climatic, geographical, technological, or infrastructural factors, scientific justification, or the level of protection that the country considers appropriate. Presentation is word for word except for editorial changes.

Interpretations

The interpretation by the standards development organization of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

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Uninterruptible Power Systems

1 General

1.1 Scope

Replace this clause of the RD with the following:

1.1.1 Equipment covered by this Standard

This Standard applies to UNINTERRUPTIBLE POWER SYSTEMS (UPS). The primary function of the UPS for this Standard is to ensure continuity of an alternating power source. The UNINTERRUPTIBLE POWER SYSTEM may also serve to improve the quality of the power source by keeping it within specified characteristics. This Standard is applicable to movable, stationary, fixed, and built-in UPS for distribution systems up to 600 V a.c. This equipment is designed to be installed in accordance with the Canadian Electrical Code, Part I, CSA C22.1, or the National Electrical Code, ANSI/NFPA 70, and, unless otherwise identified, the Standard for the Protection of Electronic Computer Data-Processing Equipment, ANSI/NFPA 75.

This Standard specifies requirements intended to ensure safety for the OPERATOR and, where specifically stated, for SERVICE PERSONNEL.

This Standard is intended to reduce the risk of fire, electric shock, or injury to persons from installed equipment, both as a single unit or as a system of interconnected units, subject to installing, operating, and maintaining the equipment in the manner prescribed by the manufacturer.

1.1.2 Additional requirements

In addition to the requirements in this Standard, a UPS is to comply with the UPS-relevant requirements of CAN/CSA-C22.2 No. 60950-1/UL 60950-1, March 2007, second edition, *Information Technology Equipment – Safety – Part 1: General requirements* (RD), as applicable for the country where the product will be used. Wherever there is a conflict between the requirements of this Standard and the RD, the requirements of this Standard will prevail.

Engine-driven d.c. power generators intended to provide backup power for the battery supply circuit of UPS units are investigated for compliance with the requirements of UL 2200, and CSA C22.2 No. 100.

UPS that employ hospital grade components identified by the markings "Hospital Only", "Hospital Grade", or a green dot on the BODY of the component, or otherwise implying suitability for medical use, are evaluated to the requirements of this Standard and CAN/CSA-C22.2 No. 60601-1/UL 60601-1.

Requirements additional to those specified in this Standard may be necessary for equipment intended for use where ingress of water is possible; for guidance on such requirements and on relevant testing, see Annex [LLL](#) and Annex T/RD.

1.1.3 Exclusions

These requirements do not cover UPS units for use as legally required standby systems, described in Article 701 of the *National Electrical Code*, ANSI/NFPA 70, and emergency power supply described in Section 46 of the *Canadian Electrical Code, Part I*, CSA C22.1. See Annex [LLL](#).

Where considered appropriate, revision of requirements will be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this Standard.

NOTE 1: For equipment subject to transient overvoltages exceeding those for Category II according to IEC 60664, additional protection might be necessary. Such additional protection may be located in the AC MAINS SUPPLY to the equipment or in the equipment as an integral design feature.

NOTE 2 Where the additional protection is an integral part of the equipment insulation requirements, CREEPAGE DISTANCES and CLEARANCE distances from the mains through to the load side of the additional protection may be judged as Category III or IV as required. All insulation requirements, CREEPAGE DISTANCES, and CLEARANCE distances on the load side of the additional protection may be judged as Category I or II as required.

1.1.4 Additional applications

This Standard does not cover all types of UPS, but it may be taken as a guide for such equipment. Requirements additional to those specified in this Standard are in some cases necessary for specific applications, e.g.,

- a) equipment intended for operation while exposed to conditions such as extremes of temperature; excessive dust, moisture, or vibration; flammable gases; or corrosive or explosive atmospheres;
- b) UPS equipment based on rotary machinery;
- c) UPS equipment meeting emergency lighting and power requirements as specified in UL 924; and central power system described in CSA C22.2 No 141-10.

Additional subclause:

1.1.101 Normative references

Any undated reference to a code or standard appearing in the requirements of this Standard shall be interpreted as referring to the latest edition of that code or standard.

Products covered by this Standard are to comply with the reference installation codes and standards as noted (in Annex III) as appropriate for the country where the product is to be used. When the product is intended for use in more than one country, the product is to comply with the installation codes and standards for all countries where it is intended to be used.

For products intended for use in Canada, general requirements are given in CAN/CSA-C22.2 No. 0.

1.2 Definitions

The provisions of 1.2/RD apply, together with the following:

Addition:

For the purpose of this Standard, the following definitions apply. Where the terms “voltage” and “current” are used, they imply the rms values, unless otherwise specified.

NOTE: Care should be taken that measuring instruments give a true rms reading in the presence of non-sinusoidal signals.

Definitions in alphabetical order

Accessory equipment, field-installable	1.2.1.113
Active output power, rated	1.2.1.109
Active power	1.2.1.106

Apparent output power	1.2.1.105
Apparent output power, rated	1.2.1.108
Backfeed	1.2.1.110
Backfeed protection	1.2.1.111
Battery, valve-regulated	1.2.2.104
Battery, vented	1.2.2.105
Brace	1.2.13.103
Branch circuit	1.2.8.101
Bypass	1.2.1.102
Controlled environment	1.2.13.101
Electronic backfeed protection	1.2.1.112
Load, linear	1.2.2.101
Load, non-linear	1.2.2.102
Load, normal	1.2.2.1
Power factor	1.2.1.107
Power failure	1.2.1.103
Primary power	1.2.1.104
Short-circuit withstand rating	1.2.13.102
Stored energy mode	1.2.2.103
Support	1.2.13.104
Uninterruptible power system (UPS)	1.2.1.101

1.2.1 Equipment electrical ratings

Additional definitions:

1.2.1.101 UNINTERRUPTIBLE POWER SYSTEM (UPS) : Combination of converters, switches, and energy storage devices (such as batteries), constituting a power system for maintaining continuity of power to load in case of input POWER FAILURE.

1.2.1.102 BYPASS : Power path alternative, either internal or external, to the UPS.

1.2.1.103 POWER FAILURE : Any variation in power supply that can cause unacceptable performance of the load equipment.

1.2.1.104 PRIMARY POWER : Power that is normally available, as supplied by an electrical utility company or by a USER'S generator.

1.2.1.105 APPARENT OUTPUT POWER : The product of the rms output voltage and rms current. It is given for a load in VA or kVA, with a specified POWER FACTOR.

1.2.1.106 ACTIVE POWER : Sum of the electrical power at the fundamental frequency and the powers of each harmonic component from the output terminals, in W or kW.

1.2.1.107 POWER FACTOR: Characteristic of an a.c. load expressed as the ratio of ACTIVE POWER to apparent power.

1.2.1.108 RATED APPARENT OUTPUT POWER : Apparent output power as declared by the manufacturer.

1.2.1.109 RATED ACTIVE OUTPUT POWER : Active output power as declared by the manufacturer.

1.2.1.110 BACKFEED : The condition in which HAZARDOUS VOLTAGE or energy available within the UPS is fed back to any of the input terminals, either directly or by a leakage path, when operating in the STORED ENERGY MODE with PRIMARY POWER disconnected.

1.2.1.111 BACKFEED PROTECTION : The method used to reduce the risk of electric shock due to BACKFEED.

1.2.1.112 ELECTRONIC BACKFEED PROTECTION : BACKFEED PROTECTION that does not employ an air gap.

1.2.1.113 FIELD-INSTALLABLE ACCESSORY EQUIPMENT : Equipment intended to modify the UPS construction or function. Such equipment is typically installed in the field by service personnel.

1.2.2 Operating conditions

Replace this definition of the RD with the following:

1.2.2.1 NORMAL LOAD : The mode of operation that approximates as closely as possible the rated conditions of normal use in accordance with the manufacturer's operating instructions.

NOTE For examples of NORMAL LOAD conditions for UPS equipment, see Annex [BBB](#).

Delete this definition in the RD:

1.2.2.3 RATED RESTING TIME

This definition is not applicable. Any reference to RATED RESTING TIME in the RD is not applicable.

Additional definitions:

1.2.2.101 LINEAR LOAD : A load in which the current drawn from the supply is defined by the following relationship:

$$I = U/Z$$

where:

I = load current

U = supply voltage

Z = load impedance

1.2.2.102 NON-LINEAR LOAD : A load in which the parameter Z (load impedance) is no longer a constant but is a variable dependent on other parameters, such as voltage or time (see Annex [BBB](#)).

1.2.2.103 STORED ENERGY MODE : The operation of the UPS when supplied by the following conditions:

- a) PRIMARY POWER is disconnected or is out of a given tolerance;
- b) battery stored energy source being discharged;

- c) load is within the given range; and
- d) output voltage is within the given tolerance.

1.2.2.104 BATTERY, VALVE-REGULATED : A battery in which the venting of the products of electrolysis is controlled by a reclosing pressure-sensitive valve.

1.2.2.105 BATTERY, VENTED : A battery in which the products of electrolysis and evaporation are allowed to escape freely to the atmosphere. Also known as "flooded" or "wet".

1.2.8 Circuits and circuit characteristics

Additional definitions:

1.2.8.101 BRANCH CIRCUIT : The portion of the building wiring system beyond the final overcurrent protective device on the power-distribution panel that protects the circuit to the field-wiring terminals of PERMANENTLY CONNECTED EQUIPMENT or the receptacle outlet of PLUGGABLE EQUIPMENT TYPE A or PLUGGABLE EQUIPMENT TYPE B.

1.2.13 Miscellaneous

Additional definitions:

1.2.13.101 CONTROLLED ENVIRONMENT : An environment that is an indoor, temperature-regulated location such as a computer room, office, or factory floor that is relatively free of conductive contaminants such as carbon dust and the like.

1.2.13.102 SHORT-CIRCUIT WITHSTAND RATING : The highest current at rated voltage that a device is intended to interrupt under standard test conditions.

NOTE: Equipment intended to interrupt current at other than fault levels may have its interrupting rating implied in other ratings, such as horsepower or locked rotor current.

1.2.13.103 BRACE : A mechanical assembly that is secured to bus bars to restrict relative motion between the bus bars.

1.2.13.104 SUPPORT : A mechanical assembly that is secured to bus bars and that is further secured to a rigid structural member such as the enclosure or a separate member secured to the framework.

1.3 General requirements

The provisions of 1.3/RD apply, together with the following:

Additional subclause:

1.3.101 The frame or chassis of the equipment shall not be used to carry current other than the allowable touch current as determined in the test specified in 5.101/RD.

NOTE The frame or chassis connected to protective earth may carry current during the abnormal operating and fault conditions described in [5.3](#) and the abnormal tests in Annexes B/RD and C/RD and Annex [AAA](#) of this Standard.

1.4 General conditions for tests

The provisions of 1.4.1/RD, 1.4.2/RD, 1.4.3/RD, 1.4.4/RD, 1.4.5/RD, 1.4.6/RD, 1.4.7/RD, 1.4.8/RD, 1.4.10/RD, 1.4.11/RD, 1.4.12/RD, 1.4.13/RD, 1.4.14/RD and 1.4.15/RD apply, together with the following:

1.4.1 Application of tests

Addition:

Only the leakage current (TOUCH CURRENT) and heating tests shall be performed at input tolerances. Except as noted in other clauses of the Standard, tests shall be conducted at nominal input voltages.

1.4.10 Loading configuration of the EUT

Addition to first paragraph:

- loads due to recharging batteries;

Additional subclause:

1.4.15.101 Routine tests

Each production unit shall be subjected to the test requirements specified in Annex [PPP](#).

1.5 Components

The provisions of 1.5.1/RD, 1.5.2/RD, 1.5.3/RD, 1.5.4/RD, 1.5.5/RD, 1.5.6/RD, 1.5.7/RD, 1.5.7.1/RD, 1.5.7.2/RD, 1.5.7.3/RD, and 1.5.8/RD apply, together with the following:

1.5.1 General

Add the following text to the last paragraph of this subclause:

Except as indicated in [1.5](#), a component of a product covered by this Standard shall comply with the requirements for that component. See Annex [III](#) for a list of Standards covering components generally used in the products covered by this Standard. A component shall comply with CSA Group or Underwriters Laboratories Inc. Standards, as appropriate for the country where the product is to be used.

Additional subclauses:

1.5.101 Oil-filled and inverter storage capacitors shall comply with the requirements of Annex [AAA](#).

1.5.102 Batteries shall comply with the requirements of [4.3.8.101](#).

1.5.103 Power switching devices shall comply with the requirements of Annex [AAA](#).

1.5.104 Relays shall comply with the requirements of Annex [AAA](#).

1.5.105 Static transfer devices shall comply with the requirements of Annex [AAA](#).

1.5.106 BYPASS/maintenance BYPASS devices shall comply with the requirements of Annex [AAA](#).

1.5.107 Capacitors or EMI filters connected across the AC MAINS SUPPLY shall comply with the requirements for across-the-line capacitors in UL 60384-14 or CSA E60384-14 , UL 810 or CSA C22.2 No. 190, and UL 1283 or CSA C22.2 No. 8, or the test specified in [5.2.101](#) of this Standard.

1.5.108 FIELD-INSTALLABLE ACCESSORY EQUIPMENT

1.5.108.1 FIELD-INSTALLABLE ACCESSORY EQUIPMENT shall be constructed so that it does not present any hazard specified in this Standard. FIELD-INSTALLABLE ACCESSORY EQUIPMENT shall be installed per manufacturer instructions and, once installed, shall not present any hazard specified in this Standard.

1.5.108.2 The installation of FIELD-INSTALLABLE ACCESSORY EQUIPMENT by an operator shall be restricted to an arrangement that can be accomplished mechanically a tool not provided by the manufacturer and electrically by means of plug-in connections to receptacles available on the basic unit or as a part of the building wiring.

1.5.108.3 The installation of FIELD-INSTALLABLE ACCESSORY EQUIPMENT by qualified service personnel shall be such that:

- a) The mechanical positioning can be accomplished by means of regular tools normally available at installation or by means of special tools provided as a part of the installation kit by the organization responsible for the product; and
- b) The electrical connections can be readily accomplished by making use of existing terminals and connections in the unit wherever possible.

1.5.108.4 The requirement in [1.5.108.3](#) does not preclude the addition or removal of components or insulated conductors or rerouting of insulated conductors to accomplish the desired change as long as the alterations in the unit wiring:

- a) Can be accomplished by the use of materials and reference to instructions, both of which are furnished as part of the accessory-equipment kit and conversion-unit kit; and
- b) Do not require the use of makeshift or substitute parts not used in the basic construction of the system.

1.5.108.5 All wiring provided as a part of an item of FIELD-INSTALLABLE ACCESSORY EQUIPMENT or related to its installation shall be acceptable for use at the highest voltage and temperature that can be encountered in the area in which the wire is to be installed.

1.5.108.6 FIELD-INSTALLABLE ACCESSORY EQUIPMENT shall meet the applicable construction and performance requirements of this Standard.

1.5.108.7 FIELD-INSTALLABLE ACCESSORY EQUIPMENT marking

1.5.108.7.1 Each piece of FIELD-INSTALLABLE ACCESSORY EQUIPMENT shall be marked with the manufacturer's name, trademark, or other descriptive marking by means of which the organization responsible for the product can readily be identified and with a distinctive catalogue number or equivalent identification. Alternatively, the marking for a piece of FIELD-INSTALLABLE ACCESSORY EQUIPMENT may be on the package.

1.5.108.7.2 FIELD-INSTALLABLE ACCESSORY EQUIPMENT intended to be installed by an operator shall be marked to indicate the unit for which it is intended or shall be marked with a reference to an instruction manual that tabulates the units for which it is intended. Additionally, FIELD-INSTALLABLE ACCESSORY EQUIPMENT shall include instructions on or packed with the equipment such that the FIELD-INSTALLABLE ACCESSORY EQUIPMENT can be properly mounted on and interconnected with the basic unit.

1.5.108.7.3 FIELD-INSTALLABLE ACCESSORY EQUIPMENT intended to be installed by service personnel and FIELD-INSTALLABLE ACCESSORY EQUIPMENT shall include instructions either on or packed with each piece of FIELD-INSTALLABLE ACCESSORY EQUIPMENT. The instructions shall provide a detailed sequence of the mechanical and electrical steps that are necessary for proper installation and operation.

1.6 Power interface

The provisions of 1.6.1/RD, 1.6.2/RD, and 1.6.4/RD apply, together with the following:

Additional subclause:

1.6.1.101 Telecommunication UPS intended for either permanent or cord connection to single or polyphase 600 V nominal or less ac supply

1.6.1.101.1 All pole-mounted CATV UPS enclosures shall have provision for connecting three 6 AWG copper bonding or grounding conductors as follows:

- a) bonding to the cable suspension strand or support wire on the pole;
- b) bonding to the ac input power-system grounded neutral; and
- c) grounding to the ground rod.

1.6.1.101.2 All pedestal-mounted CATV UPS enclosures shall have provision for connecting two 6 AWG copper bonding or grounding conductors as follows:

- a) bonding to the ac input power-system grounded neutral; and
- b) grounding to the ground rod.

1.6.2 Input current

Additional subclauses:

1.6.2.101 While supplying rated output under each of the conditions described in Items (a) to (d), the input current shall not be more than 110 % of the rated value:

- a) Recharging mode: The UPS shall receive power from the PRIMARY POWER source while delivering maximum rated alternating current power and the battery charging current.
- b) Stored energy mode: For a UPS used with a remote battery, while simulating PRIMARY POWER outage, the inverter portion of the UPS shall receive power from either a fully charged battery bank or an external dc source of supply and shall be allowed to deliver maximum rated alternating current power. The input dc current shall be measured.
- c) BYPASS mode: The transfer switch shall be positioned to allow the PRIMARY POWER for the output load to bypass the rectifier/charger and inverter sections of the UPS and be delivered directly to the load adjusted to draw maximum rated alternating current power.
- d) Normal mode: With a fully charged battery, the UPS shall receive power from the PRIMARY POWER source and deliver maximum rated alternating current power.

1.6.2.102 With reference to [1.6.2.101](#) (a), the battery charging circuit shall be connected to one of the following:

- a) a resistive-capacitive (RC) load having capacitance of 1000 microfarads per output dc ampere rating of the battery supply;
- b) a battery supplemented with a resistive load bank; or
- c) a battery having an ampere-hour (watt or kilowatt) and voltage rating corresponding to that which is intended to be used with the UPS.

1.6.2.103 If a battery load is used as described in [1.6.2.102](#) (c), the battery shall be prepared for charging by first connecting it to the proper load and then discharging it to the low-voltage disconnect (LVD) potential, or 80 % of the float charging voltage rating of the battery for a UPS having a low-voltage disconnect lockout, at a rate not exceeding the discharge rate assigned by the battery manufacturer.

1.7 Markings and instructions

The provisions of 1.7.1/RD, 1.7.2/RD, 1.7.4/RD, 1.7.5/RD, 1.7.6/RD, 1.7.7/RD, 1.7.8/RD, 1.7.9/RD, 1.7.10/RD, 1.7.11/RD, 1.7.12/RD, 1.7.13/RD, and 1.7.14/RD apply, together with the following:

Additional Note:

NOTE 101 In Canada, there are two official languages: English and French. Annex [JJJ](#) provides examples of French translations of the on-product markings specified in this Standard. Markings required by this Standard may have to be provided in other languages to conform with the language requirements of the country where the product is to be used.

1.7.1 Power rating

Additional paragraph:

The marking shall include the following:

- a) number of phases, unless intended for single phase only;
- b) RATED ACTIVE OUTPUT POWER, in W or kW;
- c) RATED APPARENT OUTPUT POWER, in VA or kVA;
- d) rated output voltage;
- e) rated output current;
- f) rated output frequency;
- g) where applicable, short-circuit withstand rating (see [5.101](#)); and
- h) if appropriate, the unbalanced load capability.

New subclauses:

1.7.1.101 One of the following markings shall be placed on units that exceed the maximum output voltage harmonics when measured in accordance with Annex [DDD](#):

- a) NOTICE: The output of this device is not purely sinusoidal. It has a nominal total voltage harmonic distortion of ____ percent, with the nominal value of the largest single voltage harmonic of ____ percent.
- b) NOTICE: For use with _____ loads.

c) NOTICE: Only for use with manufacturer: _____; model: _____.

For the marking in item (b), the generic type of load shall be inserted in the blank space provided. Examples of such generic load types include computer loads and information processing loads.

1.7.1.102 For units designed with additional separate automatic BYPASS/maintenance BYPASS, additional input a.c. supply, or external batteries, relevant supply ratings shall be allowed to be specified in the accompanying installation instructions. Where this is done, the following instruction shall appear on or near the point of connection:

SEE INSTALLATION INSTRUCTIONS BEFORE CONNECTING TO THE SUPPLY

Compliance is determined by inspection.

1.7.1.103 Industrial-type output receptacles with standard configurations according to the CEC, Part I and the NEC may have output voltage, frequency, or types of current different from the rating of the receptacles, provided that a highly visible marking indicating the voltage, frequency, and current is permanently applied adjacent to each output receptacle or group of output receptacles, such that no hazard will result from a misunderstanding of the intended output rating. See Annex [LLL](#).

1.7.1.104 The date of manufacture shall be plainly and permanently marked on a unit such that the date is readily visible after installation of the unit. This date may be abbreviated, or in a code affirmed by the manufacturer, provided that the code does not

a) repeat in less than 20 years; and

b) require reference to the production records of the manufacturer to determine when the unit was manufactured.

1.7.1.105 In Canada, when a CATV UPS is used by public utilities, the following marking or equivalent shall appear on the UPS:

“This UPS is for use with telephone equipment in accordance with section 60 of the *Canadian Electrical Code, Part I*, and is subject to inspection by an inspector”.

The following marking shall appear on all CATV UPS:

“This unit is intended for connection to pole-mounted or underground amplifiers”.

CATV UPS that are not provided with a separate enclosed service switch or circuit breaker complying with CSA C22.2 No. 4 or CSA C22.2 No. 5 shall be marked with the following or equivalent:

“In order to comply with the *Canadian Electrical Code, Part I*, disconnecting means for the CATV UPS shall be marked as being suitable for use as service equipment”.

1.7.1.106 Terminals intended for connection of batteries shall indicate the polarity according to IEC 60417, or be so constructed as to prevent improper connection.

1.7.2 Safety instructions and marking

Additional subclauses:

1.7.2.101 Ambient temperature

The maximum ambient operating temperature shall be indicated in the instruction manual.

1.7.2.102 Signalling circuits

Information shall be provided in the installation instructions as to the purpose and connection of any signalling circuits, relay contacts, emergency power off (EPO) circuits, etc. Attention should be drawn to the necessity of maintaining the security of any SELV CIRCUIT when connected to other equipment.

1.7.2.103 Internal circuit configuration

Installation instructions shall carry sufficient information, including the basic internal circuit configuration of the UPS, to emphasize its compatibility with power distribution systems (see Annex V/RD).

Special attention shall be given to compatibility with the relevant wiring rules and to BYPASS circuits.

1.7.2.104 General instructions

The information in items (a) – (s), as appropriate, shall be provided for a UPS, a remote battery supply/cabinet assembly, and a maintenance BYPASS cabinet assembly. A single installation manual may be used for a UPS investigated in combination with a remote battery supply/cabinet or maintenance BYPASS cabinet assembly. The information in items (c) – (s) may be marked on the unit in lieu of providing it in the instruction manual.

IMPORTANT SAFETY INSTRUCTIONS

a) SAVE THESE INSTRUCTIONS – This manual contains important instructions for Models _____ that should be followed during installation and maintenance of the UPS and batteries. (*Blank space is to be filled in with appropriate model numbers.*)

NOTE: If the instructions are exactly the same for all models, specific model numbers need not be specified.

b) If pressure terminal connectors or the fastening hardware is not provided on the UPS as shipped, the instruction manual shall indicate which pressure terminal connector or component terminal assemblies are for use with the UPS.

c) With reference to item (b), the terminal assembly packages and the instruction manual shall include information identifying wire size and manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product can be identified.

d) If a pressure terminal connector provided in the unit or in a terminal assembly for a field installed conductor requires the use of other than an ordinary tool for securing the conductor, identification of the tool and any necessary instructions for using the tool shall be included in the instruction manual.

e) A unit provided with a wire connector for field installed wiring shall be provided with instructions specifying that the connector provided is to be used in making the field connection.

f) A unit employing pressure terminal connectors for field wiring connections shall be provided with instructions specifying a range of values or a nominal value of tightening torque to be applied to the clamping screws of the terminal connectors.

NOTE: The torque range of connectors investigated to the following standards are assumed to apply:

i) UL 486A-486B and CSA C22.2 No. 65; or

ii) UL 486E or CSA C22.2 No. 65.

g) The instruction manual for stationary and portable units having multiple input voltage ratings shall include information indicating the type of attachment plug that is to be used for connection to a voltage supply other than what the UPS is set for when it is shipped from the factory.

h) The instruction manual for a UPS that exceeds the temperature limits of Table 4C/RD shall specify that the unit is to be installed so that it is not likely to be contacted by people.

i) The instruction manual for a UPS shall contain complete instructions concerning proper selection of the power supply cord when the UPS is intended for use with an appliance coupler and is not provided with a detachable power cord.

j) Instructions for field assembly of modules of a modular unit, including an interconnection wiring diagram, shall be either

1) packaged with the modules; or

2) contained in the instruction manual, provided that the marking on the module makes reference to the instruction manual.

k) Remote dc sources, including batteries, not provided with overcurrent protection, shall include a statement in the installation instruction manual indicating that overcurrent protection is to be provided by others. See [2.7.101](#).

l) UPS with permanently connected ac outputs, not provided with overcurrent protection, shall include a statement in the installation instruction manual indicating that overcurrent protection is to be provided by others.

m) The instruction manual shall include information identifying the number of conductors and range of conductor sizes for a unit having a single equipment field-wiring terminal that is intended for connection of more than one conductor.

n) For a unit provided with field-wiring terminals or leads, the instruction manual shall include the information indicated in Row 1, 2, 3, or 4 of [Table 1.7.2.104](#), or with equivalent wording, if it is

1) intended for use on a supply circuit rated 110 A or less; or

2) intended for field connection with 1 AWG (42.4 mm²) or smaller conductors.

Table 1.7.2.104
Termination markings

Temperature rating of wire that is intended to be used for connection of the unit	Copper conductors only	Aluminum conductors or copper-clad conductors
60 or 75 °C	"Use either ____ AWG, 60 °C or ____ AWG, 75 °C copper wire "	Row 1
		"Use 60 °C wire, either ____ AWG copper or ____ AWG aluminum; or 75 °C wire, either ____ AWG copper or ____ AWG aluminum"
60 °C	"Use ____ AWG, 60 °C copper wire "	Row 2
		"Use 60 °C wire, either ____ AWG copper or ____ AWG aluminum"
75 °C	"Use ____ AWG, 75 °C copper wire "	Row 3
		"Use 75 °C wire, either ____ AWG copper or ____ AWG aluminum"
90 °C	"Use ____ AWG, 90 °C copper wire"	Row 4
		"Use 90 °C wire, either ____ AWG copper or ____ AWG aluminum "

o) For a unit provided with field-wiring terminals or leads, the instruction manual shall include the information indicated in Row 3 or 4 of [Table 1.7.2.104](#), or with equivalent wording, if it is

1) intended for use on a supply circuit rated more than 110 A; or

2) intended for field connection with conductors larger than 1 AWG (42.4 mm²).

p) If applicable, the instruction manual shall include a statement indicating that Class 1 wiring methods are to be used for field wiring connections to terminals of a Class 2 circuit.

q) the instruction manual for a unit investigated for use in a CONTROLLED ENVIRONMENT shall indicate that the unit is intended for installation in a temperature-regulated, indoor area that is relatively free of conductive contaminants.

r) If an abnormal test is terminated by operation of the intended BRANCH CIRCUIT overcurrent protective device; or if the a.c. input overcurrent protection is relied upon for protection of an a.c. output receptacle, the instruction manual for a unit thus described shall include the word "CAUTION" and the following or equivalent: "To reduce the risk of fire, connect only to a circuit provided with ____ A maximum branch circuit overcurrent protection in accordance with the *National Electrical Code*, ANSI/NFPA 70 and the *Canadian Electrical Code, Part I*, C22.1". (The blank space is to be filled in with the appropriate ampere rating of BRANCH CIRCUIT overcurrent protection).

s) Instructions shall be provided that explain how to install a remote shunt-trip circuit breaker for a unit that is intended to be used with this type of breaker.

t) The instruction manual for a UPS intended to be used with a remote battery supply that is not provided with the UPS shall make reference to the battery manufacturer's installation manual for battery installation and maintenance instructions.

1.7.2.105 Installation instructions for CATV UPS

The instruction manual for a UPS intended to supply power to cable TV equipment shall include the instructions for proper installation. The text of these instructions shall appear under the heading "Installation Instructions".

1.7.2.106 Installation instructions for modular units

Individual modules of a modular unit may be of the open construction type – either no enclosure or a partial enclosure is supplied – provided that when the modules are assembled together in the field as intended, the unit enclosure complies with the requirements in this Standard and in the RD. Identification of the modules and instructions for assembling shall be provided.

1.7.8 Controls and indicators

1.7.8.3 Symbols

Additional paragraph:

Safety symbols and their meanings are shown in Annex [CCC](#).

1.7.13 Replaceable batteries

Additional subclauses:

1.7.13.101 Marking requirements for batteries located in a SERVICE ACCESS AREA

Battery cabinets or compartments shall be provided with the following clearly legible information, fixed upon the battery cabinet or compartment of stationary batteries, in such a position that it can be clearly seen by SERVICE PERSONNEL before accessing the battery compartment:

- a) battery manufacturer name, catalogue number, and number of batteries;
- b) nominal voltage of total battery string;
- c) nominal capacity of total battery string;
- d) a caution label denoting an energy and chemical hazard and reference to the maintenance handling and disposal instructions for the safety of SERVICE PERSONNEL;
- e) for a UPS having a battery supply without transformer isolation, a label containing the word "CAUTION" and the following warning or equivalent: "Risk of Electric Shock – Battery Circuit is not isolated from ac input, hazardous voltage may exist between battery terminals and ground. Test before touching."

1.7.13.102 Instructions

1.7.13.102.1 Internally mounted battery

Instructions shall carry sufficient information to enable the replacement of the battery with a suitable manufacturer and catalogue number.

Safety instructions to allow access by SERVICE PERSONNEL shall be stated in the installation/service handbook.

If batteries are to be installed by SERVICE PERSONNEL, instructions for interconnections, including terminal torque, shall be provided.

1.7.13.102.2 Externally mounted battery

Installation instructions shall state voltage, ampere-hour (watt or kilowatt) rating, charging information, method of protection, and maximum fault current required on installation to coordinate with UPS protective devices.

Where the battery is not provided by the UPS manufacturer, the installation and maintenance instructions shall be provided by the battery manufacturer.

1.7.13.103 External battery cabinets

External battery cabinets supplied with the UPS shall have adequate installation instructions to define cable sizes for connection to the UPS. Installation instructions for the battery shall be provided by the UPS battery manufacturer.

1.7.13.104 Installation or replacement of batteries located in an OPERATOR ACCESS AREA

The batteries shall be of a sealed or valve-regulated type.

Reverse connection of the terminals shall be prevented if reverse connection could result in a hazard within the meaning of this Standard.

The OPERATOR manual shall include the following instructions for battery replacement and disposal:

When replacing batteries, replace with the same number of the following battery: _____ (*The blank space shall be filled with the manufacturer's name and the model number of the batteries used with the equipment.*)

CAUTION: Risk of energy hazard, _____ V, _____ Ampere-hour (watt or kilowatt) battery. Before replacing batteries, remove conductive jewelry such as chains, wrist watches, and rings. High energy through conductive materials could cause severe burns.

CAUTION: Do not dispose of batteries in a fire. The batteries may explode.

CAUTION: Do not open or mutilate batteries. Released material is harmful to the skin and eyes. It may be toxic.

1.7.13.105 Installation or replacement of batteries located in a SERVICE ACCESS AREA

Bare parts that involve an energy hazard shall be located, enclosed, guarded, or provided with a barrier to take into account the unintentional bridging by conductive materials that might be present during service operations.

Bare parts operating at a HAZARDOUS VOLTAGE level shall be located or guarded such that unintentional contact with such parts is unlikely during servicing operations involving other parts of the equipment.

The service manual shall include the following instructions for battery replacement and disposal:

Servicing of batteries should be performed or supervised by personnel knowledgeable about batteries and the required precautions.

When replacing batteries, replace with the same type and number of batteries or battery packs.

CAUTION: Do not dispose of batteries in a fire. The batteries may explode.

CAUTION: Do not open or mutilate batteries. Released electrolyte is harmful to the skin and eyes. It may be toxic.

CAUTION: A battery can present a risk of electrical shock and high short-circuit current. Contact with any part of a grounded battery can result in electrical shock. The following precautions should be observed when working on batteries:

- a) Remove watches, rings, or other metal objects.
- b) Use tools with insulated handles.
- c) Wear rubber gloves and boots.
- d) Do not lay tools or metal parts on top of batteries.
- e) Disconnect charging source and load prior to installing or maintaining the battery.
- f) Remove battery grounds during installation and maintenance to reduce likelihood of shock. Remove the connection from ground if any part of the battery is determined to be grounded.

1.7.13.106 VENTED BATTERIES

UPS having VENTED BATTERIES shall have an additional caution in the manual describing the safe methods of handling VENTED BATTERIES.

2 Protection from hazards

The provisions of 2/RD apply, together with the following.

2.1 Protection from electric shock and energy hazards

The provisions of 2.1.1/RD, 2.1.1.1/RD, 2.1.1.2/RD, 2.1.1.3/RD, 2.1.1.4/RD, 2.1.1.5/RD, 2.1.1.6/RD, 2.1.1.7/RD, 2.1.1.8/RD, 2.1.2/RD, and 2.1.3/RD apply, together with the following additions.

Additional subclauses:

2.1.101 BACKFEED PROTECTION

HAZARDOUS VOLTAGE and/or energy shall not appear on the a.c. input terminals under the condition of a single fault on a component (such as in the control circuit) upon loss of the a.c. input voltage.

For fixed-installation UPS, BACKFEED PROTECTION may be provided internally or externally to the UPS in the a.c. input line.

When a BACKFEED PROTECTION isolator is external to the UPS, the supplier shall specify in the installation instructions the suitable isolating device to be used.

The UPS shall be tested as specified in [2.1.102](#). No shock hazard shall exist at the a.c. input when measured 1 s after de-energization of the a.c. input line if the equipment is PLUGGABLE TYPE A, or 15 s if permanently connected or PLUGGABLE TYPE B.

2.1.102 The UPS shall be operated with an a.c. power output current at no load and full load and with a single fault applied to the component being investigated. The fault placed on the component shall simulate the failure mode of that component. The a.c. input line shall then be disconnected and any BACKFEED measured.

Compliance is checked by inspection of the equipment and relevant circuit diagram and by simulating fault conditions according to 5.3.7/RD and other sections of this Standard, such as Annex [FFF](#).

2.1.103 In the United States the following applies:

A UPS provided with a marking indicating that it is suitable for use in a computer room shall comply with Annex NAE 3.4.11/RD.

2.6 Provisions for earthing and bonding

2.6.3 Protective earthing conductors and protective bonding conductors

2.6.3.3 Size of protective bonding conductors

Replace Table 2D/RD with the following:

Table 2.6.3.3
Minimum size of conductors for bonding

Ampacity of largest ungrounded conductor in the circuit or equivalent for multiple parallel conductors, A	Size of bonding conductor	
	Copper wire, AWG or kcmil	Aluminum wire, AWG or kcmil
20	14	12
30	12	10
40	10	8
60	10	8
100	8	6
200	6	4
300	4	2
400	3	1
500	2	1/0
600	1	2/0
800	1/0	3/0
1000	2/0	4/0
1200	3/0	250 kcmil
1600	4/0	350 kcmil
2000	250 kcmil	400 kcmil
2500	350 kcmil	500 kcmil
3000	400 kcmil	600 kcmil
4000	500 kcmil	800 kcmil
5000	700 kcmil	1000 kcmil
6000	800 kcmil	1250 kcmil

NOTE: Refer to Annex [EEE](#) and Annex V/RD for grounding supplied from separately derived a.c. sources.

2.6.3.4 Resistance of earthing conductors and their terminations

Replace item b) of the RD with the following:

- b) For equipment powered an AC MAINS SUPPLY, if the PROTECTIVE CURRENT RATING of the circuit under test exceeds 16 A, the test current is 200% of the PROTECTIVE CURRENT RATING, up to a maximum test current of 500 A, and the duration of the test is as shown in Table 2E.

Additional subclause:

2.6.101 Bonding

For Class I PLUGGABLE EQUIPMENT TYPE A, the UPS shall provide sufficient terminals, earthed socket-outlets, or other means to permit, in the final installed system configuration, equipotential protective bonding to the UPS from other Class I equipment, including external UPS battery cabinets, irrespective of whether the UPS primary protective conductor is disconnected from its source. Any special bonding instructions shall be stated in the user's instructions.

Refer to Annex [EEE](#) for grounding supplied from separately derived a.c. sources.

A UPS having a separately derived output that is intended to be grounded in the field shall be marked with the following or equivalent words:

"The output a.c. circuit is considered as a separately derived source".

If local codes require grounding of this circuit, use terminal (identify terminal) for bonding this circuit to the ENCLOSURE. Ground the ENCLOSURE to a suitable grounding electrode in accordance with local code requirements.

2.7 Overcurrent and earth fault protection in primary circuits

2.7.1 Basic requirements

Additional paragraphs:

For components in series with the AC MAINS SUPPLY to the equipment, such as the supply cord, appliance coupler, EMI filter, and switch, short-circuit and earth fault protection may be provided by protective devices in the building installation. See Annex [LLL](#).

AC output overcurrent protection shall be provided. Overcurrent protection need not be provided for permanently connected equipment when the overcurrent protection is provided by others in the final installation.

If reliance is placed on protection in the building installation, the installation instructions shall comply with 2.7.1/RD, except that for PLUGGABLE EQUIPMENT TYPE A, the buildings installation shall be regarded as providing protection in accordance with the rating of the wall outlet, and 2.7.1/RD does not apply.

NOTE: Building overcurrent protection is an acceptable method for protecting PLUGGABLE TYPE A UPS.

If the protection against electric shock of the UPS (see [2.1](#)) relies on residual current devices in the building installation circuit and the design of the UPS is such that in any normal or abnormal operating condition a fault current to earth with d.c. component is possible, the installation instructions shall define (an) appropriate building residual current device(s).

Compliance is checked by inspection and functional test.

Additional subclause:

2.7.101 Battery supply circuit overcurrent protection

A battery supply circuit shall be provided with overcurrent and short-circuit protection as follows:

Where the batteries are installed inside the UPS, the battery supply circuit shall be provided with a protective device located adjacent to the battery connecting means before any component that may fail short-circuited, such as capacitors, solid-state devices, or similar components.

Where the batteries are installed outside the UPS, the location of the overcurrent-protective device shall be as indicated above, within the separate cabinet.

The rating of the overcurrent-protective device located internally shall be such as to protect against conditions described in 5.3/RD.

For a UPS to be used with a separated battery supply, the rating of the overcurrent-protective device shall be indicated in the instruction manual.

NOTE: The current rating of the conductors to be connected between the UPS and battery supply is determined from the requirements given in 3.2/RD.

When the overcurrent-protective device is not provided by the manufacturer, suitable installation instructions shall be provided for installation of an overcurrent-protective device.

Compliance is checked by inspection and tests.

2.7.102 Rating of protective device

The rating of the overcurrent protective device located internally shall be such as to protect against conditions described in 5.3.1/RD.

Compliance is checked by inspection and tests

2.7.103 Type and location of overcurrent protective devices

Overcurrent protection located within the UPS or stationary remote battery cabinet may be a supplementary overcurrent protective device or branch circuit protective device. Overcurrent devices in permanently connected battery cabinets shall be branch circuit protective devices.

2.8 Safety interlocks

Additional subclause:

2.8.101 Protection of service personnel

2.8.101.1 General

In addition to the requirements of 2.8/RD, clauses [2.8.101.2](#) to [2.8.101.8](#) apply to SERVICE PERSONS who find it necessary to reach over, under, across, and around an uninsulated electrical part or moving part to make adjustments or measurements while the UPS is energized.

2.8.101.2 Covers

Parts at HAZARDOUS VOLTAGE or energy level shall be so arranged and covers so located as to reduce the risk of electric shock or high current levels while covers are being removed and replaced.

2.8.101.3 Location and guarding of parts

Parts at HAZARDOUS VOLTAGE or energy level and moving parts that involve a risk of injury to persons shall be located, guarded, or enclosed so as to reduce the likelihood of unintentional contact by a SERVICE PERSON adjusting or resetting controls, or the like, or performing mechanical functions that may be performed with the UPS energized, such as lubricating a motor, adjusting the setting of a control with or without marked dial settings, resetting a trip mechanism, or operating a manual switch.

2.8.101.4 Parts on doors

Parts at HAZARDOUS VOLTAGE or energy level, located on the rear side of a door, shall be guarded or insulated to reduce the likelihood of unintentional contact of the live parts by a SERVICE PERSON.

Compliance with [2.8.101.2](#) to [2.8.101.4](#) is checked by inspection, measurement, and use of the test finger (Figure 2A/RD).

2.8.101.5 Component access

A component that requires inspection, resetting, adjustment, servicing, or maintenance while energized shall be so located and mounted with respect to other components and with respect to grounded metal parts that it is accessible for electrical service functions without subjecting the SERVICE PERSON to the risk of electric shock, HAZARDOUS ENERGY LEVEL, high current, or injury to person by adjacent moving parts. Access to a component shall not be impeded by other components or wiring.

For an adjustment that is to be made with a screwdriver or similar TOOL when the UPS is energized, the requirement in 2.8.3/RD necessitates that protection be provided so that inadvertent contact with adjacent uninsulated hazardous live parts involving a risk of electric shock or HAZARDOUS ENERGY LEVEL is unlikely, taking into consideration that misalignment of the TOOL with the adjustment can result when an adjustment is attempted.

This protection shall be provided by

- a) location of the adjustment means away from uninsulated hazardous live parts; or
- b) a guard to reduce the likelihood that the TOOL will contact with uninsulated live parts.

Compliance is checked by inspection and, where necessary, by fault simulation.

2.8.101.6 Moving parts

Moving parts that can cause injury to persons during service operations shall be located or protected so that unintentional contact with the moving parts is not likely.

2.8.101.7 Capacitor banks

Capacitor banks shall be fitted with a means of discharge for protection of SERVICE PERSONS. A warning label shall be added if discharge time exceeds 10 s, stating the time taken to reduce the hazard to a safe level (not greater than 5 min) (see 1.2.8.5/RD and 1.2.8.8/RD).

2.8.101.8 Internal batteries

Internal batteries shall be so arranged as to minimize risk of electric shock from inadvertent contact with terminals, and the interconnection method shall be such as to minimize risk of short-circuiting and electric shock during servicing and replacement. See [1.7.13.105](#).

Compliance with [2.8.101.5](#) to [2.8.101.8](#) is checked by inspection.

2.9 Electrical insulation

2.9.1 Properties of insulating materials

Additional subclauses:

2.9.1.101 For PLUGGABLE EQUIPMENT TYPE B or permanently connected equipment intended to be installed by SERVICE PERSONNEL only, and marked as noted in [2.9.1.102](#), the humidity test in 2.9.2/RD is optional.

2.9.1.102 Equipment on which the humidity test has not been performed shall be labelled "Intended for a CONTROLLED ENVIRONMENT". See [1.7.2.104](#) (q) for instruction manual requirements.

3 Wiring, connections, and supply

The provisions of 3/RD apply, together with the following:

3.1 General

3.1.4 Insulation of conductors

Additional subclause:

3.1.4.101 Insulated conductors of different circuits within a UPS, including wires in a terminal box or compartment, shall be either separated by barriers or segregated and shall be so separated or segregated from uninsulated live parts connected to different circuits.

NOTE: For insulated conductors of different circuits, if each conductor is provided with insulation acceptable for the highest of the circuit voltages, no barriers or segregation is necessary.

3.2.5 Power supply cords

Additional subclause:

3.2.5.101 Cord-connected power supplies

Power supplies intended to be cord-connected shall be provided with a suitable length of cord having an additional conductor for grounding non-current-carrying conductive parts. The cord shall have an ampacity equal to or greater than the marked input in amperes, and shall be of the hard-usage type except:

- a) as required by other clauses of this Standard;
- b) a cord for a table-mounted power supply having a mass of 5 kg or less may be Type **SV** (or equivalent) provided that the cord is not longer than 1 m.

3.4 Disconnection from the mains supply

Additional subclause:

3.4.101 Disconnect device – General

A disconnect device shall be provided for the d.c. supply circuits and a.c. power output circuits of a permanently connected UPS and/or a remote supply/cabinet assembly. This disconnect device shall:

- a) open all ungrounded conductors;
- b) consist of either a manually operated switch or circuit breaker; and
- c) employ an operating handle that is either accessible from outside of the enclosure or located under a hinged cover not requiring a tool for opening.

3.4.102 Constructions without additional disconnect means

The following constructions may be provided without additional disconnect means:

- a) a UPS or battery supply having either a cord-and-plug or receptacle for connection to the output a.c. or d.c. circuit; and
- b) a permanently connected UPS or battery supply provided with an instruction manual indicating that the disconnection means is to be provided by others and the function of the disconnect device marked for its function. See Annex [LLL](#).

3.4.103 Disconnect device installed in a restricted access location

A disconnect device installed in a restricted access location as defined in 1.2.7.3/RD is considered accessible and shall either

- a) be marked "This equipment is only to be installed either in a restricted area or an information technology equipment room"; or
- b) have the equivalent cautionary statement included in the installation manual.

NOTE: Examples of a restricted access location are

- an electrical equipment room with locked doors accessible only to qualified personnel; and
- an enclosure housing electrical apparatus utilizing removable or sealable covers or bolted doors.

Compliance is checked by inspection.

3.5 Interconnection of equipment

Additional subclause:

3.5.101 Telecommunication connectors

Telecommunication-type connectors and terminals not intended for connection to the telecommunication network may be marked "Not for telecommunication (telephone) network" or an equivalent wording, or with the symbol shown in Annex [CCC](#). The marking shall be located in a readily visible location adjacent to the connector.

4 Physical requirements

The provisions of 4/RD apply, together with the following:

4.1 Stability

Additional paragraph:

This test shall be applied to the unit with and without batteries.

4.3 Design and construction

4.3.8 Batteries

Additional subclause:

4.3.8.101 Battery requirements

4.3.8.101.0 General

Batteries shall comply with the following:

- a) UL 1973, the Standard for Batteries for Use in Stationary and Motive Auxiliary Power Applications; or
- b) UL 1989, the Standard for Standby Batteries, for lead acid batteries for UPS less than 70 kWhs.

4.3.8.101.1 Location

Vented batteries shall be contained in a separate enclosure or compartment from the power conversion portion of the UPS. This requirement does not apply to valve-regulated batteries and other sealed cell battery types. Vented batteries may be contained in the overall enclosure of the UPS, provided that a barrier, partition, or the equivalent is used to inhibit the passage of hydrogen gas from the battery area to the area of the enclosure containing the electronic components, switches, contactors, and controls used in the power conversion portion of the UPS.

4.3.8.101.2 General requirements for installation

4.3.8.101.2.1 Accessibility and maintainability

Battery poles (terminals) and battery connectors shall be accessible so that their fixings (hardware) can be tightened with the correct TOOLS. Batteries with liquid electrolyte shall be so located that the battery cell (vent) caps are accessible for electrolyte tests and readjusting of electrolyte levels.

Compliance is checked by inspection and application of the TOOLS and measuring equipment supplied or recommended by the battery manufacturer.

4.3.8.101.2.2 Insulation

Batteries in conductive casings shall be provided with adequate insulation between each other and from cabinets or compartments. Such insulation shall meet the requirements of 2.9/RD.

Compliance is checked by measurement and/or test.

4.3.8.101.2.3 Electrolyte spillage

VENTED BATTERY trays and cabinets shall have an electrolyte-resistive coating.

The ENCLOSURE or compartment housing a VENTED BATTERY shall be constructed so that spillage or leakage of the electrolyte from one battery will be contained within the ENCLOSURE and be prevented from

- a) reaching the outer surfaces of the UPS, where contact with the USER is possible;
- b) contaminating adjacent electrical components or materials; and
- c) bridging required electrical distances.

Compliance is checked by inspection.

4.3.8.101.2.4 Ventilation

The ENCLOSURE or compartment housing a VENTED BATTERY shall be provided with proper ventilation so that any potentially explosive mixtures of hydrogen and oxygen are dispersed safely below non-hazardous levels.

For battery compartments (separate or combined), the method for determining the necessary airflow to ensure adequate dissolution levels is given in Annex [HHH](#).

In combined apparatus of battery and electrical components, attention shall be given to prevent ignition of local concentrations of hydrogen and oxygen by adjacent operational arcing parts, such as contactors and switches close to battery vents/valves. This shall be achieved by the use of fully enclosed components, separation of battery compartments, or adequate ventilation, depending on the technical construction of the UPS and battery.

For battery rooms, proper information on the required flow of air shall be provided in the installation instructions if the battery installation is supplied with the UPS.

NOTE: Valve-regulated batteries require ventilation, although it may be considerably less than that for a vented cell. The battery manufacturer should be consulted for the frequency/rate of gas release in both normal and abnormal operating conditions.

Compliance is checked by inspection, calculation, and measurement.

4.3.8.101.2.5 Charging voltages

Batteries shall be protected against excessive charging voltages under any normal or single fault condition.

Compliance is checked by the tests described in 5.3/RD and [5.3.102](#) of this Standard.

4.5 Thermal requirements

4.5.3 Temperature limits for materials

Replace Table 4B/RD with the following: