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 is being issued to include the following changes:

Addition of dated reference to UL 60950 RD

Update to references to the component requirements of the RD

Update to Table 4.5.3.101A for temperature limits

Revision to bus bar temperature limits

Addition of symbol for no telecommunication network

Corrections in Annex NNN for short-circuit withstand rating

Addition of requirements and figure for short circuit withstand and short circuit closing test port location

Updates to References

Text that has been changed in any manner or impacted by UL'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 November 25, 2016, March 24, 2017, and August 11, 2017.

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Third Edition

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Uninterruptible Power Systems

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Commitment for Amendments

This standard is issued jointly by the Canadian Standards Association (operating as "CSA Group") and Underwriters Laboratories Inc. (UL). Comments or proposals for revisions on any part of the standard may be submitted to CSA Group or UL at anytime. Revisions to this standard will be made only after processing according to the standards development procedures of CSA Group and UL. CSA Group and UL will issue revisions to this standard by means of a new edition or revised or additional pages bearing their date of issue.

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This Standard is subject to review five years from the date of publication, and suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquires@csagroup.org and include "Proposal for change" in the subject line: Standard designation (number); relevant clause, table, and/or figure number; wording of the proposed change; and rationale for the change.

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This ANSI/UL Standard for Safety consists of the Fifth Edition including revisions through October 12, 2017. The most recent designation of ANSI/UL 1778 as an American National Standard (ANSI) occurred on October 10, 2017. 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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CONTENTS

Preface

This is the harmonized CSA Group and UL 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 October 12, 2017.

This harmonized Standard was prepared by CSA Group and Underwriters Laboratories Inc. (UL). 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.

This Standard has been approved by the American National Standards Institute (ANSI) as an American National Standard.

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 UL. 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.

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 mm^2) 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 mm^2).

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.