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Uninterruptible Power Systems (UPS) —– Part 1-1:

General and Safety Requirements for UPS used in Operator Access Areas

(IEC 62040-1-1: 2002, MOD)

(Draft for Approval)

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Contents

Preface

GB 7260 “Uninterruptible power systems (**UPS**)” is divided into several parts as follows:

- Part 1-1: General and safety requirements for UPS used in operator access areas;
- Part 1-2: General and safety requirements for UPS used in restricted access locations;
- Part 2: Electromagnetic compatibility (EMC) requirements;
- Part 3: Method of specifying the performance and test requirements.

This is Part 1-1 of GB 7260. All technical content of this Part is mandatory.

The amendment of this Part adopts IEC 62040-1-1: 2002 “Uninterruptible power systems (UPS) - Part 1-1: General and safety requirements for UPS used in operator access areas.”

Compared with IEC 62040-1-1: 2002, this Part has the following technical differences:

Subsection 4.5.15 of this Part is modified to “Unless otherwise specified, in the documents provided to the end user, the man-machine interface and all labels should be all printed in standard Chinese.”

In this Part, Appendices A, B, C, D, E, F, G, K, L, M and N are specification appendices, while Appendices H, J and X are Informative Appendices.

This Part was proposed by the China Electrical Equipment Industrial Association.

The Standardisation Administration of China/Technical Committee (SAC/TC 60) implemented this standard under centralised management.

The units responsible for drafting this Part are Emerson Network Power Co., Ltd. and Forward Group.

The units involving in the drafting of this Part were: Delta-CIMIC Electronics Co., Ltd., Qingdao Rectifier Manufacturing Co., Ltd., Xian Power Electronics Research Institute, and QED Gomatech International Development Ltd.

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This is the first issue of this Part.

Uninterruptible power systems (UPS) — Part 1-1: General and safety requirements for UPS used in operator access areas

1 Scope and special application

1.1 Scope

This Part of GB 7260 applies to direct-current (DC)-based electronic uninterruptible power systems with energy storage devices. This Part adopts the related contents of GB 4943-2001 and IEC 60950-1: 2001.

The main function of uninterruptible power systems (UPS) included in this Part is to guarantee the continuity of alternating-current (AC) power output. UPS can also maintain power at specified characteristics, and hence enhance power quality. The annotations about regional difference indicated in the related chapters of GB 4943-2001 and IEC 60950-1: 2001 also apply to this Part.

This Part applies to mobile, vertical, fixed or embedded UPS of low-voltage power distribution designed for installation in operator access areas. This Part specifies the requirements for ensuring the safety of operators and laymen who may have access to the equipment. Where particularly specified, it also applies to maintenance staff.

This Part aims at ensuring the safe installation, operation and maintenance of UPS devices in accordance with the methods specified by the manufacturers. UPS means either single UPS units or internally interconnected UPS systems.

This Part does not include DC power-supplied electronic ballasts (IEC 60924 and IEC 60925) or rotating-machine-based UPS.

With regards to the general and safety requirements of UPS for installation in areas of restricted access, please refer to GB 7260.4. Please refer to GB 7260.2 for the requirements for and definitions of electromagnetic compatibility (EMC).

1.2 Special application

Although this Part does not include every type of UPS, it may still serve as a basic instructive document: for some UPS with special purposes, certain requirements may need to be added to this Part. Said special purposes are:

— UPS devices designed to be exposed to the following: extreme temperatures, excessive powder and dust, humidity or vibration, flammable gases, corrosive or explosive atmosphere;

—UPS-equipped electronic medical devices situated within 1.5 meters of the patient's body;

— When over-voltage borne by the UPS when at transient state exceeds the over-voltage of Class II as specified in GB/T 16935.1, the UPS power supply part may require additional protective measures;

— Additional requirements are needed for UPS devices that may have to be immersed in water or overrun by foreign matter. The guide rules for these requirements and related tests are indicated in Appendix H;

— UPS for long-time (exceeding 30 minutes) square wave output functioning should meet the fuzzy test requirements for voltage wave shapes as set out in Subsection 5.3.12 of GB/T 7260.3 to verify the compatibility of the load.

Note: UPS for use in vehicles, vessels or flights or in tropical regions, or UPS for use in areas at over 1,000m above sea level may be subject to different requirements.

2 Normative references

The provisions of the following documents become provisions of this Part of GB 7260 after being referenced. For dated reference documents, all later amendments (excluding corrigenda) and versions do not apply to this standard; however, any parties that come to an agreement under this standard are encouraged to consider adopting the latest versions of these documents. For undated reference documents, the latest versions apply to this standard:

GB 4208 Degrees of protection provided by enclosure (IP code) (GB 4208 – 1993, eqv. IEC 60529: 1989);

GB 4943-2001 Safety of information technology equipment (eqv. IEC 60950: 1999);

GB/T 5465.2 Graphical symbols for use on electrical equipment (GB/T 5465.2 – 1996, idt. IEC 60417: 1994);

GB 6829 – 1995 General requirements for residual current operated protective devices (eqv. IEC 60755 and its amendment 1: 1986 and amendment 2: 1992);

GB 7260.2 Uninterruptible power systems (UPS) Part 2: Electromagnetic compatibility (EMC) requirements (GB 7260.2 – 2003, IEC 62040-2: 1999, MOD);

GB/T 7260.3 Uninterruptible power systems (UPS) Part 3: Method of specifying the performance and test requirements (GB/T 7260.3 – 2003, IEC 62040-3: 1999, MOD);

GB 7260.4 Uninterruptible power systems (UPS) Part 1-2: General and safety requirements for UPS used in restricted access locations (GB 7260.4 – 200×, IEC 62040-1-2: 2002, MOD);

GB 16916.1 – 2003 Residual current operated circuit breakers without integral overcurrent protection for household and similar uses (RCCB) Part 1: General rules (IEC 61008-1: 1996, MOD);

GB 16917.1 – 2003 Residual current operated circuit breakers with integral overcurrent protection for household and similar uses (RCBO) Part 1: General rules (IEC 61009-1: 1996, MOD);

GB/T 16935.1 – 1997 Insulation coordination for equipment within low-voltage systems Part 1: Principles, requirements and tests (idt. IEC 60664-1: 1992);

GB/T 17045 – 2006 Protection against electric shock – Common aspects for installation and equipment (IEC 61140: 2001, IDT);

IEC 60950-1: 2001 Information technology equipment – Safety Part 1: General requirements;

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

3 Definitions

3.1 General rules

This part adopts the following definitions. The related definitions of GB 4943-2001 and IEC 60950-1: 2001 also apply to this Part.

Unless otherwise specified, the terms “voltage” and “current” used in this Part shall be the root mean square (R.M.S.) values.

Note: When a non-sine wave signal exists, the measurement instrument to be used should be able to give real R.M.S. reading.

3.1.1 Uninterruptible Power System (UPS)

An Uninterruptible Power System (UPS) comprises a converter, switch and energy storage device (e.g. storage battery) and is a power system that is able to maintain the continuity of loaded electric power when input power fails to function correctly.

3.1.2 Bypass

Internal or external power supply route replacing indirect UPS.

3.1.3 Primary power

Electric power provided by the generator of a public power supply system or user.

3.1.4 Backfeed

A part of the voltage or energy inside UPS that directly connects or reversely feeds to any input terminal through the leakage route under the circumstances that the stored energy mode and primary power cannot be used.

3.1.5 Backfeed protection

A control measure for diminishing the risk of electric shock caused by backfeed.

3.1.6 Stored energy mode

UPS function under the following power supply circumstances:

— the primary power is cut or exceeds the given tolerance;

— the storage battery is discharging;

— the load is within the given range;

— the output voltage is within the given tolerance.

3.2 Electrical parameters of UPS

3.2.1 Rated voltage

Input or output voltage as specified by the manufacturer (3-phase power supply system refers to line voltage).

3.2.2 Rated voltage range

Input or output voltage range as specified by the manufacturer, and expressed by the lower limit value and upper limit value of rated voltage.

3.2.3 Rated current

Maximum input or output current of UPS announced by the manufacturer.

3.3 Load types

3.3.1 Normal load

Try to adopt the mode closest to the strictest conditions of normal use as specified in the manufacturer's operation manual. However, when the actual application conditions are observably stricter than the maximum load conditions recommended by the manufacturer, the maximum load available for application should be used.

Note: Examples of the standard normal load conditions of UPS are shown in Appendix M.

3.3.2 Linear load

The load of current out of power described by the following relational expression:

$$I = U/Z$$

Where:

I — loaded current;

U — power voltage;

Z — loaded impedance.

3.3.3 Non-linear load

The load with the parameter of loaded impedance (*Z*) no longer being an invariable constant, but varying with such parameters as voltage, time or others (see Appendix M).

3.4 Power connections

The definitions set out in Subsection 1.2.5 of GB 4943-2001 and the following clauses are apply.

3.4.1 Power cord

Flexible cord or multiple-core leads to be used for the purpose of interconnection.

3.5 Circuits and circuit characteristics

The definition in Subsection 1.2.8 of IEC 60950-1: 2001 applies.

3.5.1 Hazardous voltage

The definition set out in Subsection 1.2.8.4 of GB 4943-2001 applies.

3.6 Insulation

The definition set out in Subsection 1.2.9 of GB 4943-2001 applies.

3.7 Equipment mobility

The definition set out in Subsection 1.2.3 of GB 4943-2001 applies.

3.8 Insulation classes for UPS

The definition set out in Subsection 1.2.4 of GB 4943-2001 applies.

3.9 Enclosures

The definition set out in Subsection 1.2.6 of GB 4943-2001 applies.

3.10 Accessibility

The definition set out in Subsection 1.2.7 of GB 4943-2001 applies.

3.11 Components

The definition set out in Subsection 1.2.11 of IEC 60950-1: 2001 applies.

3.12 Power distribution

The definition set out in Subsection 1.2.8 of GB 4943-2001 applies.

3.13 Flammability

The definition set out in Subsection 1.2.12 of IEC 60950-1: 2001 applies.

3.14 Miscellaneous

The definition set out in Subsection 1.2.13 of GB 4943-2001 and the following clauses apply.

3.14.1 Type test

The definition set out in Subsection 1.4.2 of GB 4943-2001 and the following contents apply.

Within the scope of this Part, if materials, parts and components are checked for compliance through inspections / tests of product characteristics, these may replace

the specified type test by any related inspection data or previous applicable test results.

Note: For large-sized or high-power equipment, the appropriate test facilities may not be available for carrying out certain type tests.

3.15 Telecommunication networks

The definitions set out in the following subsections apply: Subsections 1.2.8.9, 1.2.8.10, 12..8.11, 1.2.8.12 and 1.2.13.8 of GB 4943-2001.

4 General test conditions

Subsections 1.4.1, 1.4.2, 1.4.3, 1.4.6, 1.4.7, 1.4.10, 1.4.11, 1.4.13 and 1.4.14 of GB 4943-2001, Subsection 1.4.8 and 1.4.12 of IEC 60950-1: 2001, and the following clauses apply.

Only current leakage and exotherm tests should be carried out within the tolerance of input voltage. All other tests should be carried out under the nominal input voltage.

4.1 Working parameters when testing

Testing should be carried out within the functioning area of the manufacturer when the following parameters are found to be in the most critical combinations, unless special test conditions that would have an obvious significant influence on the test results are specified in other clauses of this Part:

— Power supply voltage;
— No power at the power supply voltage;
— Power supply frequency;
— Charging conditions of the storage battery;
— Installation of the whole UPS machine and positioning of components that may be dismantled;
— Function mode;
— The temperature control device, adjustment device or the adjustment of similar control in the operator access areas, including:
  a) no reliance on tool adjustment; or
  b) through adjustment by key or tool intentionally allocated for use by the operator.

4.2 Test load

When it is confirmed that the input current and other test results may be affected, the following factors should be considered and should be adjusted so as to produce the most critical results:

— The recharged load of the storage battery;
— The load of an optional object inside the equipment under test (EUT) or attached to the equipment as proposed or indicated by the manufacturer;

— The load of other units scheduled to be allocated by the manufacturer and supplied with power by the EUT;

— The load of equipment that can be connected to any standard power socket in the operator access area that does not exceed the declared numerical value specified in Subsection 4.5.2.

When testing, a manual load can be used to simulate the above loads.

4.3 Components

Subsections 1.5.1, 1.5.2, 1.5.4, 1.5.5, 1.5.6, 1.5.7 and 1.5.8 of IEC 60950-1: 2001 apply

4.4 Power interface

Subsections 1.6.1, 1.6.2 and 1.6.4 of GB 4943-2001, and the following clauses apply.

If the equipment has a neutral line, the neutral line should be the same as the phase line that it is isolated from the ground and the machine body. The rated working voltage of components that connect the neutral line to the ground should be equal to the phase voltage. When the output and input neutral lines are separated, the maintenance staff responsible for their installation should allocate the output neutral line according to the wiring code at the site and the detailed description provided by the installation manual.

Check compliance through inspection.

4.5 Labelling and description

4.5.1 Outline

Labels or equivalent words should be provided which meet the following detailed requirements. With the exception of equipment intended for installation by the maintenance staff, labels stuck in operator access areas or on the outer surface of equipment should be obvious and can be easily seen. If labels are fixed to the outer surface of the equipment they should remain obvious and easily seen after being installed according to the conditions for normal use.

If the labels are outside the equipment and cannot be seen but can only be directly seen after opening the door or shielded by the equipment, this also meets the requirements. If labels are placed behind doors or are shielded and are not located in the operator access areas, additional indications must state where the labels should be shown on so as to be easily seen (the adoption of temporary indications is allowed).

4.5.2 Rated value of power

Sufficient labelling requirements for equipments:

— Input power requirements;

— Rated value of output power.

Equipment with multiple rated voltages should be indicated by the corresponding rated currents, which should be separated by slashes, “/” in the correct order. The

corresponding relationships between the rated voltages and the rated currents should be clearly visible.

For equipment with specified rated voltage range, the maximum rated current or current range should be indicated.

In addition to the related content set out in GB 4943 – 2001, the input and output labels should also include:

— Rated output voltage;

— Rated output current or rated power (the unit is volt-ampere, VA) or active power (the unit is watt, W);

— If the rated output power factor is smaller than 1, the rated output power factor should be indicated, or the active power and apparent power, or the active power and rated current should be indicated;

— Output phase number (1• or 3•), with or without neutral line;

— Rated output active power, with its unit being watt (W) or kilowatt (kW) (see Appendix M);

— Rated output apparent power, with its unit being volt-ampere (VA) or kilovolt-ampere) (kVA) (see Appendix M);

— Maximum temperature range of functioning environment (optional).

Note: Check compliance according to Appendix M.

For equipment designed with additional independent automatic bypass/maintenance bypass, additional AC power input or external storage battery, the rated value of the corresponding power can be specified in the random installation manual. In this case, at the connection point or the surrounding area the following description should be indicated:

Please read the installation manual carefully before connection with power.

If the direct connection method for primary power is not provided, it is not necessary for the rated current to be indicated.

4.5.3 Safety description

Special items must be provided in order to avoid any danger from being caused when operating, installing, maintaining, transporting or storing the UPS. The manufacturer should provide the necessary description as regards these items.

Note 1: When requiring special attention, e.g. the connection of the power-connected equipment to the storage battery, or the interconnection amongst different independent units (if available). The protective UPS connection, the storage battery box, and equipment terminals or output sockets with power supplied by UPS should remain interconnected even when the UPS power plug is cut off.

Note 2: Where applicable, the description concerning installation should refer to the national wiring code.

Note 3: Information regarding maintenance is usually provided for maintenance staff.

An operation manual should be provided to users. Users should also be provided with an installation manual explaining the method for installing all pluggable equipment designed for installation by the user.

The manufacturer should provide guidance to the user according to the level of capability required for the installation of equipment, such as:

— Operator can install: Type A or Type B pluggable equipment with storage battery installed by the supplier;

— Maintenance staff can install: fixed equipment or equipment for which the storage battery must be installed on the spot.

The manufacturer should provide guidance to the user according to the level of capability required for the operation of equipment, such as:

— Equipment to be operated by inexperienced staff;

— Equipment to be operated by experienced staff.

When the disconnection device to be used in isolation from the electric network is not installed in the equipment (see Subsection 3.4.2 of GB 4943-2001) or when the power cord plug serves as the disconnection device, it should be stated in the installation manual that:

—For permanently connected UPS, an easy-to-operate, appropriate disconnection device should be installed on its fixed wiring;

— For pluggable UPS, the power output socket supplying power to UPS should be installed around the UPS for easier operation. When the UPS power wire has to be connected to the grounding power socket for safety reasons, it should be stated on the label or installation manual of UPS that all other equipment connected to the UPS or the special equipotential grounding connection of the Type I equipment load should also meet this requirement.

Note 4: in general, power wire fitted with plugs should not be over 2 meters long.

For permanently connected UPS without built-in automatic backfeed isolation (see Subsection 5.1.4), it should be stated in the manual that the user is required to increase warning tags on all primary power isolation devices that are far from the location of the UPS, providing a warning to the electric maintenance staff that this circuit supplies power to UPS.

The warning tags should contain the following words or the equivalent sentences:

Disconnect the UPS before working off circuit.

4.5.4 Adjustment of power voltage

See Subsection 1.7.4 of GB 4943-2001.

4.5.5 Power output socket

See Subsection 1.7.5 of GB 4943-2001.

4.5.6 Fuse

See Subsection 1.7.6 of GB 4943-2001.

4.5.7 Wiring terminal

See Subsection 1.7.7 of IEC 60950-1: 2001.

4.5.8 Wiring terminal of storage battery

The wiring terminal due to be connected to the storage battery should be indicated with polarity according to GB/T 5465.2, or decrease the possibility of misconnection by its structure.

4.5.9 Control device and indicator

See Subsection 1.7.8 of GB 4943-2001.

4.5.10 Isolation of multiple power supply

See Subsection 1.7.9 of GB 4943-2001.

4.5.11 IT power distribution

See Subsection 1.7.10 of GB 4943-2001.

4.5.12 Protection inside the building facilities

If Type B pluggable equipment or permanently connected equipment relies on the protective device of building facilities to provide protection for the internal wiring of the equipment, this should be stated in the form of a detailed description in the installation manual, and the requirements for short circuit or overcurrent protection should be provided. Where necessary, the requirements for both situations should be given at the same time (see Subsection 5.6.1).

If the UPS electric shock protection (see Subsection 5.1) relies on the residue current device of the building facilities, and the circuit design of UPS makes the DC parts possibly have a malfunctioning current, then such a requirement should be stated in the installation manual: the 3-phase UPS of the residue current device of building facilities should be Type B (GB 6829), and the single-phase UPS should be Type A (GB 16916.1 or GB 16917.1).

Notes: Pay attention to the protective requirements relating to the public power supply system in the national wire code (if available).

4.5.13 Great leakage of current

The following contents and Subsection 5.1 of GB 4943-2001 apply.

For UPS intended for use as Type B pluggable equipment or for fixed UPS, if under any single mode, the total current leakage of UPS and all the connected load makes the current leakage on the preliminary protective grounding conductor of UPS exceed or possibly exceed the limitation specified in Subsection 5.1 of GB 4943-2001, then the UPS should contain a warning tag as specified in Subsection 5.1 of GB 4943-2001. The connection method for primary power should be specified in the instruction manual.

4.5.14 Temperature control and other adjustment devices

See Subsection 1.7.11 of GB 4943-2001.

4.5.15 Language

Unless otherwise specified, the documents provided to end user, the man-machine interface and the labels should be all printed in standard Chinese.

4.5.16 Durability of labels

See Subsection 1.7.13 of GB 4943-2001.

4.5.17 Components that can be dismantled

See Subsection 1.7.14 of GB 4943-2001.

4.5.18 Replaceable storage battery

See Subsection 1.7.15 of GB 4943-2001.

4.5.19 Access by tools used by operator

See Subsection 1.7.16 of GB 4943-2001.

4.5.20 Storage battery

On the external storage battery box and the internal storage battery box of the UPS should be printed the following clear and decipherable messages, the positions of which should be easily seen by maintenance staff when maintaining the UPS, and which should meet the requirements of Subsection 1.7.1 of GB 4943-2001:

a) Type of storage battery (lead-acid, nickel-cadmium) and number of nodes or number of units in a storage battery pack;

b) Total nominal voltage of a storage battery pack;

c) Total nominal capacity of a storage battery pack (optional);

d) Warning tags should clearly display the energy or the electric shock and chemical risk of the equipment. Refer to the requirements of protective handling and waste disposal specified in the following description.

Exception: for internal storage battery packs intended to be installed on the upper part, lower part or by the side of the UPS device, or for independent storage battery boxes, or Type A pluggable UPS to be installed and connected with the socket by operators using the plug - these need only be equipped with warning tags stuck to the outside of the equipment (see item D above).

All other messages should be provided in the user manual.

Description

a) Internal storage battery

— Sufficient messages should be provided in the manual to ensure the appropriate change of the recommended model of storage battery;

— The installation / maintenance manual should contain a description on the safe areas permitted for access by maintenance staff;

— If the storage battery is to be installed by the maintenance staff, the

description on the interconnection of terminal torsion should be given.

The operation manual should include the following descriptions:

— Maintenance of the storage battery should be carried out by a person with professional knowledge of storage batteries or completed under this person's supervision, and the related measures should be clear.

— When changing the storage battery, the same model number and quantity of storage batteries should be replaced, or replaced by storage battery bag.

Warning: Do not allow the storage battery to come into contact with a flame or fire, as it may explode.

Warning: Do not open or damage the storage battery. When released, electrolyte is harmful to the eyes and skin, and may even poison those who it comes into contact with.

b) External storage battery

— When no storage battery is allocated by the UPS manufacturer, the installation manual should provide the voltage, rated value of ampere-hour (AH), method for charging, required protective methods during the installation of the storage battery, and the protective methods for the coordination work of UPS protective device;

— The storage battery manufacturer should provide a description of storage battery unit.

c) External storage battery box

If no cable is allocated by the UPS manufacturer, sufficient descriptive requirements for installation and the size of the cable connecting the UPS should be printed on the external storage battery box allocated to the UPS. If the storage battery unit or pack is not installed and connected in advance, or if no detailed description is provided by the UPS manufacturer, the storage battery manufacturer should provide a description on the installation of storage battery pack.

4.5.21 Installation manual

The installation manual should provide sufficient information related to purposes and connections such as the signal circuit, relay contact point and emergency disconnection circuit. When connected to other equipment, pay attention to protect the TNV, SELV or ELV circuits.

The installation manual should contain sufficient information (including the basic allocation of the internal circuit of UPS) so as to highlight its compatibility with the power distribution.

Particular attention should be paid to the compatibility with the related wire code and

bypass circuit.

5 Basic design requirements

5.1 Protection from electric shock and energy danger

Subsections 2.1.1.2, 2.1.1.4, 2.1.1.6 and 2.1.1.7 of GB 4943-2001, Subsection 2.1.1.5 of IEC 60950-1: 2001 and the following clauses apply.

5.1.1 Operator access

This Part specifies two kinds of protective requirements for electric shock caused by electrified components, and increases the protective requirements of energy risks set out in Subsection 2.1.1.5 of IEC 60950-1: 2001.

Note 1: Regarding the definition of SELV circuit, please refer to Subsection 1.2.8.6 of GB 4943-2001.

These requirements are based on the following principles:

a) Permitted operator access

— Naked components in SELV circuit;

— Naked components in current-limiting circuit;

— Insulation of ELV circuit wiring under the conditions specified in Subsection 2.1.1.3 of GB 4943-2001.

Note 2: Attention should be paid to the AC 25V~50V and DC 60V~120V accessible naked electric-conducted components.

b) Prohibited access by operator

— Naked components of ELV circuit or hazardous voltage circuit;

— The working insulation or basic insulation of components under conditions other than those specified in Subsection 5.1.2;

— The ungrounded electric-conducted components isolated from ELV or hazardous voltage components only by using working insulation or basic insulation.

5.1.2 Access by ELV wiring

Subsection 2.1.1.3 of GB 4943-2001 and the following contents apply.

Notes: The maximum non-synchronic voltage or non-synchronic situation of inverter should be considered.

Check compliance through inspection (testing, if necessary).

5.1.3 Discharge of main-circuit capacitor

Subsection 2.1.1.7 of GB 4943-2001 and the following contents are applicable.

Remarks: It should be noted that for special allocation, the electric shock danger of electrified UPS not only comes from its internal capacitor, but also from the capacitor connecting with the load of UPS. It should be considered when designing its installation.

5.1.4 Backfeed protection

Backfeed protection should be allocated. Under normal circumstances and under the condition that the AC input voltage power failure causes single malfunction to the components (such as those in control circuit), there should be no drisk of electric shock (hazardous voltage, hazardous energy, hazardous contact current) at the input terminal of backfeed protective device.

For fixed UPS, backfeed protection can be allocated inside the UPS or externally on its AC input wire.

If the backfeed protective isolation device of UPS is installed externally, the supplier should provide its suitable model number.

Tags should be in place close to the input terminal (see Subsection 4.5.3).

Check compliance through tests and inspections of equipment and related circuits, and by simulating the malfunction conditions indicated in Subsection 5.3 of GB 4943-2001.

If the backfeed protection applies an air gap, the air gap should be equivalent to the following definition or effects:

a) In times of normal work, the distance among different phases should meet the basic insulation requirements (see Tables 2K and 2L of GB 4943-2001);

b) If the equipment works in an inverted way, the input source can be regarded as the secondary power without transient state over-voltage (see the last row of Table 2K of GB 4943-2001). For example, the basic insulation of the current with the R.M.S. value of voltage being lower than 150V is required to be 0.7mm, and the basic insulation of the current with the R.M.S. value of voltage being 150V~300V is required to be 1.4mm. For the UPS of electrical gap that is ground-free output, and all those with phase line open circuit and neutral line adopting basic insulation requirements, their compliance is acceptable. If the output takes the engine frame as the ground, insulation must be strengthened or made equivalent to it;

c) If the quality guaranteed manufacturing procedures have at least the same level as the quality guarantee in example R.2 of GB 4943-2001, and can afford the voltage specified in Table G.2 of GB 4943-2001, then the electrical gap of the components may be further decreased. For example, for a voltage with its R.M.S. value not exceeding 300V, an air gap of 0.4mm is considered to be acceptable.

Check compliance through inspections.

5.1.5 Emergency switch device

UPS should be necessarily allocated with a single emergency switch device (or a

terminal connected with the remote emergency switch device) to prevent UPS from continuously supplying power to the load under any mode. If the additional disconnection device is attached to the electrical device of a building, it should be stated in the installation manual. For pluggable UPS, if it is acceptable by the national wire code or the related circuit, these requirements are non-mandatory.

Check compliance through inspections.

5.2 Insulation

Subsections 2.2.3.1, 2.2.3.2 and 2.2.3.3 of GB 4943-2001 apply.

5.3 Current-limiting circuit

Subsections 2.4.1, 2.4.2 and 2.4.3 of IEC 60950-1: 2001 apply.

5.4 Measures of protective grounding

Subsections 2.6 of IEC 60950-1: 2001 and the following clauses apply.

5.4.1 Protective grounding

When a single insulation fails, a hazardous voltage may exist in the accessible electric-conducted parts of Type I equipment. Hence a reliable connection should be made with the protective grounding terminal inside the UPS.

This requirement does not apply to accessible electrically conducted parts that are isolated from the hazardous voltage parts through the following methods:

— Grounding metal parts; or

— Solid insulation or air gaps that meet the requirements of double insulation or strengthened insulation, or a combination of both. Under these circumstances, the fixing and strength of the involved parts should make the applied action force as required in the related tests in Subsections 2.10 and 4.3.2 of IEC 60950-1: 2001 maintain at the smallest distance.

Check compliance through the inspection of the related requirements in Subsection 2.6.1 of IEC 60950-1: 2001 and Subsection 5.3 of GB 4943-2001.

5.4.2 Connection

The UPS of Type A pluggable Type I equipment should be allocated with sufficient terminals, grounding sockets or other means, providing other Type I equipments in the final system allocation (including the external storage battery box) with potential connection to the UPS, etc. Such connection is unrelated to whether the one-time protective conductor of UPS is cut off from its power supply. A description of any special connections should be provided in the user manual.

Check compliance through inspecting the ground resistance test at the corresponding connecting area.

5.5 Separation of alternating current (AC) and direct current (DC) power

Subsections 2.6.2, 2.6.3, 2.6.4 and 2.6.5 of IEC 60950-1: 2001, and the following clauses apply.

5.5.1 Disconnection device

Equipment should be allocated a disconnection device in order that qualified staff can disconnect UPS from the AC power during maintenance.

Note: Unless there are requirements of application functions, isolation measures may be taken at both the maintenance access area, and outside the equipment.

5.5.2 3-phase equipment

For 3-phase UPS, the disconnection device should simultaneously cut off all the phase lines from the power supply source. For UPS with a power supplied by IT power distribution, the disconnection device should be quadruple, and can cut off all the phase lines and neutral lines. If UPS is not allocated this type of quadruple disconnection device, concrete requirements that it should serve as part of the building facilities should be set out in the installation manual.

If the disconnection device cuts off from the neutral line, it should simultaneously cut off all the phase lines (see Subsection 1.7.2 of GB 4943-2001).

5.5.3 Switch serving as a disconnection device

If the disconnection device is installed at the switch inside the equipment, the "Connect" and "Disconnect" positions should be indicated according to the requirements set out in Subsection 1.7.8 of GB 4943-2001.

5.5.4 Multiple powers

If the power of permanently connected UPS is supplied by more than one source of external power (e.g. the power of different voltages/frequencies is used as the backup power), a clearly decipherable label should be stuck to each disconnection device, and the detailed description on the disconnection from all external power should be provided.

Note: Pay attention to the protective grounding conductor. Even if a power cable is removed, protective grounding should be kept.

5.5.5 Ungrounded conductor

For those with both internal and external DC storage battery for supplying power, the disconnection device or isolation measure should disconnect all ungrounded conductors from connections to the storage battery or storage battery pack.

Check compliance with Subsection 5.5 through inspections.

5.6 Overcurrent protection and grounding malfunction protection

Subsections 2.7.3, 2.7.4, 2.7.5 and 2.7.6 of GB 4943-2001, and the following clauses apply.

5.6.1 Basic requirements

The grounding malfunction protection of the overcurrent, short circuit and input and output circuits should be allocated. The protective device is regarded as part of the equipment as a whole, and also a part of the building facilities.

a) With the exception of description b), the necessary protective devices meeting the requirements of Subsection 8.3 should serve as a part of the whole equipment;

b) Components in series connection with the equipment input, such as the power cord, apparatus coupler, RFI filter, the short circuit and grounding malfunction protection of bypass and switch should be provided by the protective device of the building facilities;

c) If the building facilities must be relied on to provide protection, with the exception of Type A pluggable equipment, the installation manual should meet the terms set out in Subsection 4.5.12. The provision of such protection is based on the rated value of socket and focusing on the inapplicable situation of Subsection 4.5.12;

d) The manufacturer should specify the R.M.S. value of malfunctioning currents produced under the strictest conditions in order that the neutral line, protective line and phase line of the permanently connected output circuit to select suitable dimension. If the manufacturer allocates the output circuit protection or the output of Type A pluggable equipment, the malfunction current does not need to be provided.

When current-limiting circuit independently controls the output current of the inverter, its short circuit or overload current should not produce the risks described in this Part. Short circuit protection should function within 5 seconds.

Notes: The above requirement is in place to decrease the risk of electric shock or fire in case of short circuit at an output terminal. Allocating at the output terminal a disconnector with the same rated value of output circuit or the same limited current value also meets the standard requirements.

Check compliance through inspections and function tests.

5.6.2 Circuit protection of storage battery

The power supply circuit of storage battery should be allocated with the overcurrent protection that meets the requirements of Subsections 5.6.3, 5.6.4 and Table 1.

5.6.3 Position of protective device

When the storage battery is installed inside the UPS, a protective device should be allocated to the power supply circuit of the storage battery close to the connection to the storage battery, and before any element devices (such as capacitor, semi-conductive device or similar components) that may short-circuit malfunction.

When the storage battery is installed outside the UPS, the position of overcurrent protective device is shown as in Table 1.

Table 1 Position of the protective device of storage battery

Position and/or type of storage battery	Position of protective device	Quantity of overcurrent protective devices	Quantity of protective devices for grounding malfunction
1) Inside UPS	UPS	1	1 or 2[a]
2) Mobile or independently erected storage battery box	Storage battery box	1	1 or 2[a]
3) Independent fixed storage battery box	Storage battery box	1	1 or 2[a]
4) Independent storage battery chamber [b]	Storage battery chamber	1	1 or 2[a]
a A protective device of grounding malfunction must be located on each pole of ungrounded storage battery, unless the fuse of external circuit has the same function. b The rated values of the overcurrent protective device and cable allocated to UPS should be indicated on the UPS operation manual. If the storage battery box does not serve as the overall allocation of UPS, such requirement is also applicable to Item 2 and Item 3.			

For UPS with independent power supply from a storage battery, the rated value of overcurrent protective device should be indicated in the operation manual. The rated value of the current of conductor between UPS and the power-supply storage battery should be confirmed according to the requirements in Subsection 6.2.

5.6.4 Rated value of protective device

The rated value of the built-in overcurrent protective device should exert protective function to the situation stated in Subsection 5.3.1 of GB 4943-2001.

Check its compliance with Subsection 5.6 through inspection and test.

5.7 Personal protection — Safety interlock devices

5.7.1 Operator Protection

In operator access areas, Subsection 2.8 of GB 4943-2001 applies.

5.7.2 Protection for maintenance staff

Besides the requirements set out in Subsection 2.8 of GB 4943-2001, the following clauses also apply to the maintenance staff’s adjustment and measurement of the upper part, lower part and surrounding places of the non-insulated electric part, or crossing over that part, or moving that part when the UPS is electrified.

5.7.2.1 Shield

The shield and parts with hazardous voltage or energy levels should be appropriately placed, so as to decrease the risk of electric shock or great currents caused by the removal or replacement of the shield.

5.7.2.2 Position and protection of parts

Parts with hazardous voltage or energy levels and with mobile components that may

cause personal harm should be fixed, isolated or have increased protective devices so as to decrease the adjustment, restoration or similar action made by the maintenance staff, or decrease the possibility of accidental access during the mechanical functional operation of electrified UPS (e.g. lubrication of electric machine, adjustment of the installation of the controller of dial with figures or the dial without figures, restoration release device or manual operation switch).

5.7.2.3 Parts on the door

Parts with hazardous voltage or energy levels installed behind the door should be isolated or have increased protective devices so as to decrease the possibility of accidental access of electrified parts by the maintenance staff.

Check compliance with Subsections 5.7.1 and 5.7.2.3 through inspections, tests and finger tests (Figure 2A of GB 4943-2001).

5.7.2.4 Access to components

For the installation and fixing of components in need of inspection, restoration, adjustment, maintenance or reparations when being electrified, during electrical maintenance other possibly accessible components and the grounding metallic parts should not cause any electric shocks to the maintenance staff, any hazardous energy levels or any danger caused by great currents, and the mobility of the adjacent components shall not cause personal harm. Other components or leads should not obstruct the access of a certain component.

When the electrified UPS is adjusted by screwdriver or similar tool, the necessary protection according to the requirements set out in Subsection 2.8.3 of GB 4943-2001 should be provided, so as to prevent any risk of electric shock or hazardous energy levels caused by accidental access to the adjacent uninsulated hazardous electrified parts. Danger caused by the non-aiming of tools should also be considered.

Protection can be made in the following ways:

— Adjust the position of device to be far from the uninsulated hazardous electrified parts; or

— Use a protective device to decrease the possibility of access by tools to uninsulated electrified parts.

Check compliance through inspections, and through malfunction simulation inspection, if necessary.

5.7.2.5 Mobile components

Fix or protect the mobile components that may cause personal harm during the maintenance process, so that they cannot be accidentally accessed.

5.7.2.6 Capacitors

The capacitors should be discharged to protect the maintenance staff. If the discharge time exceeds 1.0 second, this should be indicated by a warning tag, reducing the

danger to the required time of safety level (not exceeding 5 minutes) as defined in Subsections 1.2.8.4 and 1.2.8.7 of GB 4943-2001.

5.7.2.7 Internal storage battery

The placement of an internal storage battery should minimize the risk of electric shock caused by accidental access to the wired terminal. The interconnection should minimize short circuits and the risk of electric shock during maintenance or replacement.

Check compliance with Subsections 5.7.2.4 to 5.7.2.7 through inspections.

5.8 Electrical gap, creepage distance and insulation penetration distance

Refer to Subsection 2.10 of IEC 60950-1: 2001.

5.9 External signal circuit

Subsections 2.3 and 2.5 of GB 4943-2001 apply.

5.10 Limited power

Subsection 2.5 of GB 4943-2001 applies.

6 Wiring, grounding and power supply

6.1 Outline

Subsection 3.1 of GB 4943-2001 applies.

6.2 Power connection

Subsections 3.2.2, 3.2.3, 3.2.4, 3.2.5, 3.2.6, 3.2.7 and 3.2.8 of GB 4943-2001, Subsection 3.2.5.2 of IEC 60950-1: 2001, and the following clauses apply.

6.2.1 Connection Methods

In order for a safe and reliable connection with the primary power to exist, UPS should contain one of the following connection devices:

— Wiring terminal permanently connecting with power;

— Power cord that cannot be dismantled permanently connected with power or connected with power by plug;

— Apparatus plug connecting with power cord that can be dismantled.

If the equipment has more than one kind of power connection (e.g. the power of different voltages/frequencies, or that served as backup power), the design should meet all the following conditions:

— Provide different circuits with independent connection ways;

— If the wrong insertion of power-plug connection devices may cause any danger, they should not be able to be interchanged;

— When one or multiple connectors are cut off, the operator should refrain from accessing any naked parts with ELV or hazardous voltage (e.g. plug).

Check compliance through inspection.

6.3 Wiring terminal of external power conductor

Subsections 3.3.1 to 3.3.8 of GB 4943-2001 apply.

7 Structural requirements

Subsection 4.1 of GB 4943-2001 and the following contents apply.

7.1 Enclosures

In the scheduled functioning, the engine stand or engine frame of equipment should not be used to carry the current.

Notes: the grounding engine stand or engine frame may carry leaked current or current in case of electrical malfunction.

The part of the numerical dial or nameplate serving as a functional part of enclosures should meet the requirements of enclosures.

If different modules of modularised units are to be assembled on the spot (these modules can be in open structure - without enclosure or partly with enclosure), the modules of modularised units should meet the requirements set out in Subsection 2.1 of IEC 60950-1: 2001. The labels of modules and electrical bonding between modules should meet the requirements set out in Chapter 3 of IEC 60950-1: 2001.

Enclosures should protect each part of the modularised units. The composing parts of enclosures should meet the related requirements for the protection of the danger of fire, electric shock, personal harm and hazardous energy level.

Check compliance through inspection.

7.2 Stability

Subsection 4.1 of GB 4943-2001 and the following contents apply.

The stability of units and equipment structure should not bring any danger to operators and maintenance staff under normal working conditions.

If the use of a certain reliable stability device can improve the stability of the opening of drawer parts or doors, the stability device should function automatically when used by the operator. If it is not automatic, appropriate and bright labels should be stuck in place as a warning to maintenance staff.

Check compliance by carrying out the following related tests. Each test should be carried out independently. In the tests, the boxes and cabinets of equipment should be placed with the objects producing undesirable conditions within the rated volume range. If caster wheels are used during the normal function of equipment, the caster wheels should be placed at an undesirable position.

Whether with or without a storage battery, when the equipment is under the strictest situation as described in GB 4943-2001, the equipment should not tumble.

7.3 Mechanical strength

Subsection 4.2 of GB 4943-2001 and Subsection 4.2.7 of IEC 60950-1: 2001 apply.

7.4 Structural design details

Subsection 4.3 of GB 4943-2001, Subsection 4.3.13 of IEC 60950-1: 2001, and the following contents apply.

7.4.1 Opening

The size of the anti-fire enclosure or the top of electrical protective enclosure, the right top opening of the naked part with hazardous voltage in any direction should not exceed 5mm, unless the equipment adopts labyrinth structure or similar limited structure (see Figure 4B of GB 4943-2001) to prevent the vertically entered foreign matter from accessing the naked part. This requirement is inapplicable to the top opening of equipment enclosure at a height exceeding 1.8m.

7.4.2 Concentration of gas

If the equipment contains a storage battery under normal application conditions, s sufficient safety measures should be in place so as to avoid the risk of explosive gas accumulation and internal or external leakage.

Note: Also see Subsection 7.6.

Check compliance through inspection.

7.4.3 Mobility of equipment

For equipment with caster wheels for aiding mobility to the installation position, when rigid fixed wiring is due to be carried out, additional measures should be taken to ensure immobility during installation. For units with a mass of greater than or equal to 25kg, the action force of 20% of its weight (but not exceeding 250N) should be applied to test whether it is moveable.

Check compliance through inspections and tests.

7.5 Fire prevention

Subsection 4.7 of GB 4943-2001 and Subsections 4.7.2 and 4.7.3 of IEC 60950-1: 2001 apply.

The fire retardant grade of the storage battery should be at least Grade HB (see Appendix A).

7.6 Placement of storage battery

Storage batteries for use in UPS are required to have an independent and enclosed installation position. This can be designed as:

— An independent storage battery chamber or storage battery room;

— An indoor or outdoor independent storage battery box or storage battery cabinet;

— A storage battery tank or storage battery cell built inside the UPS.

When installing the storage battery the following requirements should be taken into consideration.

Check compliance according to Subsections 7.6.1 to 7.6.8 where applicable.

7.6.1 Accessibility and protectiveness

The electrode and the connector of the storage battery should be easily accessible so as for using a suitable tool for tightening. When installing storage batteries with electrolyte the cap of the storage battery unit to be accessed easily so as for testing the electrolyte and readjusting its liquid level.

Check compliance through inspections and by using the tool or test equipment allocated or recommended by the storage battery manufacturer.

7.6.2 Vibration

Prevent vibration according to the manual of storage battery manufacturer.

Check compliance through inspection.

7.6.3 Distance

If the enclosure of the storage battery unit is composed of insulated materials or covered by an insulated shield, when the ventilation and the temperature of storage battery meet the requirements, no gap can be left between storage battery.

Check compliance through inspections.

7.6.4 Insulation

The insulation between the nickel-cadmium storage battery units and electric-conducted enclosures as well as between those and the storage battery box or cabinet should meet the requirements set out in Subsection 5.2.

Check compliance through inspections.

7.6.5 Wiring

According to the requirements set out in Chapter 6, protective measures must be taken as regards the contact point, connection and wiring so as to prevent them from being affected by environmental temperature, humidity, gas, steam and mechanical stress.

Check compliance through inspections.

7.6.6 Leakage of electrolyte

Sufficient protection is required in case of electrolyte leakage of the storage battery, such as the anti-electrolyte coating for the storage battery tray and box.

Note: this requirement does not apply to VRLA type storage battery.

Check compliance through inspection.

7.6.7 Ventilation

Good ventilation should be provided, making the potential explosive oxy-hydrogen compound inside spread safe and below a hazardous level.

Appendix N provides the calculation method for achieving the required airflow for guaranteeing that the storage battery cabinet (independent or assembled) reaches a sufficient dilution level.

For equipment assembled with storage battery and electrical components, explosions

caused by the accumulation of hydrogen or oxygen partially occurring to the adjacent areas of arc starting parts should be avoided (such as the air vent of storage battery / contactor and switch by the side of valve).

Fully enclosed components or isolated storage battery cabinets can be adopted, or the technical structure making UPS and storage battery completely ventilated can be adopted to solve this problem.

Technical data about the EUT structure should be provided by the manufacturer to prove that the distance between the air vent/valve of storage battery and any opened arc starting components is sufficient.

If the UPS is equipped with a storage battery, the installation manual should provide appropriate information about the required airflow of the storage battery chamber.

Check compliance through inspections, calculations and measurements. If non-enclosed components are used, a distance of 500mm between the arc starting parts and the air vent/valve of storage battery is regarded as meeting the requirements.

7.6.8 Charging voltage

If any single malfunction occurs, prevent the over-voltage of the storage battery (e.g. turn off the charger or cut off the charging current in case of malfunction. The manufacturer should clearly indicate the limited charging voltage value.

Check compliance through circuit evaluation and performance test.

7.7 Exotherm

Subsection 4.5.1 of GB 4943-2001 and the following contents are applicable.

Table 2 Exotherm limit

Parts	Maximum Exotherm (^{o}C)
Insulation (including coil)	
Grade A material 105	75
Grade E material 120	90
Grade B material 130	95
Grade F material 155	115
Grade H material 180	140
Grade C material 200	150
Grade N material 220	165
Grade P material 240	185

Table 3 Allowed coil temperature limit when the stored energy mode ends

Insulation grade ^{o}C	Temperature measured by average resistance measurement method ^{o}C	Temperature measured by thermocouple measurement method ^{o}C

105	127	117
120	142	132
130	152	142
155	171	161
180	195	185
200	209	199
220	216	206
240	234	224

8 Electrical requirements and simulated abnormal conditions

8.1 Outline

Subsection 5.1.1 of GB 4943-2001 and the following contents apply.

8.1.1 Current leakage on the ground

Under any modes of circuit layout, during the summing of the current leakage on the ground of the UPS and of its connected load carried by the protective grounding conductor of UPS, the UPS should meet the requirements set out in Subsection 5.1.2 of GB 4943-2001.

=When the current leakage on the ground exceeds 3.5mA, Subsection 5.1.7 of GB 4943-2001 is applicable.

Check compliance through inspections and related tests.

8.1.2 Type B pluggable UPS

Type B pluggable UPS should be equipped with a permanently fixed power cord that meets the requirements set out in Subsection 3.2.5 of IEC 60950-1: 2001.

Check compliance through inspection.

8.2 Dielectric strength

Subsection 5.2 of GB 4943-2001 applies.

8.3 Abnormal function and malfunction conditions

Subsections 5.3.1, 5.3.2, 5.3.3, 5.3.4, 5.3.5 and 5.3.8 of GB 4943-2001, and the following contents apply.

8.3.1 Malfunction simulation

Check the compliance of the components and circuits other than those specified in Subsections 5.3.2, 5.3.3 and 5.3.5 of GB 4943-2001 through the simulation of the following conditions:

— Malfunction of any components in the main circuit;

— Malfunction of any components with undesirable effects on additional insulation and strengthened insulation in times of their failure;

— Besides, the malfunction of all the related components for equipment that does not meet the requirements set out in Subsections 4.4.2 and 4.4.3 of GB

4943-2001,

— Malfunction caused after connecting the strictest loaded impedance to the connection terminal and connector, which are allocated to the equipment power supply and signal output.

If multiple outputs have the same internal circuit, it is only required to test one of the outputs.

For the main-circuit components (e.g. power cord, apparatus coupler, RFI filter, bypass, switch and their interconnected leads) connected to the power input and output, if they meet the requirements of Item a) in Subsection 5.3.6 of GB 4943-2001, malfunction simulation is not required.

Notes: In the examples of the short circuit and open circuit of the triode, diode and capacitor (especially the electrolytic capacitor), the malfunction of continuous energy consumption caused by the electrical resistor which is designed to be intermittent energy consumption, and the internal malfunction of integrated circuit producing excessive power consumption.

Testing should be carried out when the equipment is functioning under the rated voltage or at the upper limit of the rated voltage range. Simulate one malfunction condition one time.

Tests may be carried out on the circuits inside the equipment or the simulated circuits, outside the equipment, independent components or accessories.

With the exception of the compliance criterion specified in Subsection 5.3.3 of GB 4943-2001, the temperature of transformers supplying power to the components during testing should not exceed the requirements specified in Appendix C, and the detailed descriptions relating to exceptions in this Appendix should also be considered.

8.3.2 Test conditions

When equipment is functioning under the rated voltage or at the upper limit of the rated voltage range, tests should be carried out under any conditions of expected normal application and faulty operation.

Notes: examples of normal application or faulty operation:

— Any operation of the accessible operation devices not following the instructions of the manufacturer, such as handle, hand lever, key and baffle;

— The air vents that may be simultaneously covered or sequentially covered (such as located at one side or at the top of the equipment);

— Operation under any output overload conditions (including short circuit).

Moreover, if a protective shield is attached to the equipment, the protective shield should be placed as normal. The test starts from the normal idling to the entry of a stable state.

9 Connection with communication network

Chapter 6 of GB 4943-2001 and the following contents are applicable:

Subsections 1.4.11, 2.1.1, 2.1.1.1, 2.1.1.2, 2.1.3, 2.3, 2.3.1, 2.3.2, 2.3.3, 2.3.4, 2.3.5, 2.6.1, 2.9.5, 2.10.4, 3.5, 3.5.1 and 3.5.2 of GB 4943-2001, Appendix M and Subsections 1.4.8, 2.6.5.8, 2.10.3.3 and 2.10.3.4 of IEC 60950-1: 2001.

Appendices

Appendix A (Standardised Appendix) Heat resistance and fire prevention tests
See Appendix A of GB 4943-2001.

Appendix B (Standardised Appendix) Electrical motor test under abnormal conditions
See Appendix B of GB 4943-2001

Appendix C (Standardised Appendix) Transformer
See Appendix C of GB 4943-2001.

Appendix D (Standardised Appendix) Measurement instruments for current contact tests
See Appendix D of GB 4943-2001.

Appendix E (Standardised Appendix) Exotherm of coil
See Appendix E of GB 4943-2001.

Appendix F (Standardised Appendix) Measurement methods of electrical gap and creepage distance
See Appendix F of GB 4943-2001.

Appendix G (Standardised Appendix) Alternative method for confirming minimum electrical gap
See Appendix G of GB 4943-2001.

Appendix J (Informative Appendix) Electrochemical potential table
See Appendix J of GB 4943-2001.

Appendix K (Standardised Appendix) Temperature control device
See Appendix K of GB 4943-2001.

Appendix H

(Informative Appendix)
Guide rules for preventing the entry of water and external foreign matters

When it is possible for water or external foreign matters to enter the scheduled application site, applicable protective grade should be selected from GB 4208. This Appendix is extracted from GB 4208.

Protective-grade components that ensure that the prevention of water and foreign matters meet the requirements should not be able to be dismantled without the aid of tools.

The content of Tables H.1 and H.2 are extracted from GB 4208. For test conditions and compliance, please refer to GB 4208.

Table H.1 Protective grade of the prevention of the entry of external foreign matters represented by the first-place feature figure

The first-place feature figure	Protective grade	
	Brief description	Implication
0	Without protection.	—
1	Prevent the solid foreign matter with diameter of no less than 50mm.	Spherical test tool with diameter of 50mm cannot completely enter the enclosure [a].
2	Prevent the solid foreign matter with diameter of no less than 12.5mm.	Spherical test tool with diameter of 12.5mm cannot completely enter the enclosure [a].
3	Prevent the solid foreign matter with diameter of no less than 2.5mm.	Spherical test tool with diameter of 2.5mm cannot completely enter the enclosure [a].
4	Prevent the solid foreign matter with diameter of no less than 1.0mm.	Spherical test tool with diameter of 1.0mm cannot completely enter the enclosure [a].
5	Anti-dust	The entry of dust cannot be completely prevented, but the dust volume entered does not affect the normal functioning of equipment, and neither the safety.
6	Dust tight	No entry of dust.
a The diameter part of test tool cannot enter the opening of enclosure.		

Table H.2 Protective grade of water prevention represented by the second-place feature figure

The second-place feature figure	Protective grade	
	Brief description	Implication
0	Without protection.	—
1	Prevent vertical dripping.	Dripping in a vertical direction should bring no harmful effect.
2	Prevent vertical dripping when the enclosure inclines within the range of 15°.	When each vertical side of enclosure inclines within the range of 15°, vertical dripping should bring no harmful effect.
3	Prevent water sprinkling.	Water sprinkled in each vertical side within a range of 60° should bring no harmful effect.
4	Prevent water splashing.	Water splashed on each direction of the enclosure should bring no harmful effect.
5	Prevent water spraying.	Water sprayed in each direction of the enclosure should bring no harmful effect.
6	Prevent powerful water spraying.	Powerful water spraying in each direction of enclosure should bring no harmful effect.
7	Prevent short-while water immersion effect.	After immersion in water under specified pressure for a specific period of time, the water volume having entered the enclosure should bring no harmful effect.
8	Prevent continuous plunging effect.	After continuous plunging according to the conditions agreed by the manufacturer and user (the conditions being stricter than those represented by the figure of 7), the water volume having entered the enclosure should bring no harmful effect.

Appendix L

(Standardised Appendix)
Backfeed protection test

L.1 Outline

When the UPS is in stored energy mode, its current may not be over the limit between any single pair of input terminals. When the measured R.M.S. open circuit voltage value does not exceed 30V (AC peak value 42.4V, DC 60V), this test is not required.

Check compliance through circuit analyses, testing failed control circuit components, and the tests set out in L.2 and L.3.

L.2 Type A pluggable UPS and Type B pluggable UPS

When UPS is in stored energy mode and when its input terminal or plug is cut off, both the idling and full load situations should meet the following conditions:

a) under normal conditions and any single malfunction condition, the current of any two circuit-tested user-accessible input terminals indicated in Appendix D should not exceed 3.5mA;
b) the AC input power should be cut off within 1 second.

L.3 Tests of permanently connected UPS

When UPS is functioning normally, there is the load of AC output current and the idling, and the components to be evaluated are made to be at a single malfunction situation. Then this malfunction should simulate the failed model of the component. After that, cut off the AC input power. Under normal conditions and single malfunction conditions, the current of any two input terminals accessible to the user should not exceed 3.5mA.

If an external backfeed protective device is equipped, check its compliance through the inspection of the related circuit diagram and the circuit functioning test made by external backfeed isolator.

The protective conductor of UPS should not be disconnected during the testing period.

The AC input power should be cut off within 15 seconds.

L.4 Single malfunction conditions

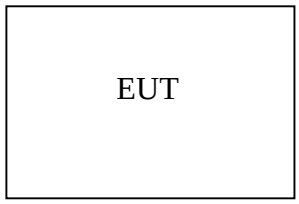
For the L.2 and L.3 test methods, a single malfunction is confirmed on the foundation of circuit research. However, it should also include the potential load failure, as well as the relative insulation failure.

Single-phase output:

EUT

C = 22 nF

3-phase output:



3 x R

C = 22 nF

In the figure: EUT — equipment under test

Figure L.1 Load malfunction

The value of the resistance load R should be equal to the maximum load of the unit power factor as specified by the manufacturer.

Appendix M

(Standardised Appendix)
Examples of standard load conditions

M.1 Outline

UPS can be loaded according to the technical conditions specified in the manufacturer's operating manual. If no related technical conditions apply, the following standard load conditions shall apply.

UPS can be loaded with different linear and non-linear loads (see Subsection 3.3).

If the sine wave voltage is applied to a load, the current flowing over the load is just the sine wave, and then it is defined as linear load.

The current flowing in the non-linear load being applied with sine wave voltage is the non-sine wave.

The most general kinds of linear load are:

— Resistance;

— Sensibility-resistance;

— Capacitivity-resistance.

Non-linear loads could be:

— Rectified capacitive load;

— Load controlled by thyristor or saturated electric reactor (phase control).

For low power ranges of less than 3kVA, the bridge-type rectifier connecting with the capacitive load is most commonly used. The following symbols are used to express the load characteristics:

S — Output apparent power, with the unit of volt-ampere (VA);

P — Output active power, with the unit of watt (W);

• — Power factor, • = *P/S*;

U — Output voltage, with the unit of voltage (V);

f — Frequency, with the unit of hertz (Hz).

M.2 Standard resistance load

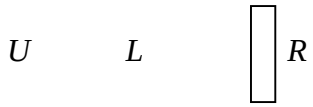
For resistance load, UPS can add it to the standard power.

M.3 Standard sensibility-resistance load

Sensibility-resistance load is the series connection or parallel connection of an electrical inducer and an electrical resistor. The values of electrical resistor R and electrical inducer L are calculated using the following formulae:

a) Series connection

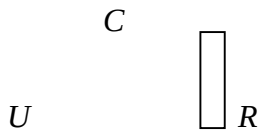
b) Parallel connection



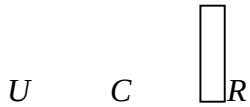
M.4 Standard capacitivity-resistance load

Capacitivity-resistance load is the series connection or parallel connection of an electrical capacitor and an electrical resistor. The values of electrical resistor R and electrical capacitor C are calculated by the following formulas:

a) Series connection

	*R* = …….
	C = …….

b) Parallel connection

	*R* = …….
	C = …….

M.5 Standard non-linear load

In order to simulate the load of single-phase stationary rectifier/capacitor, the load connecting to the UPS is a diode rectifying bridge. Its output terminal is connected with a parallel-connected circuit of capacitor and resistor.

Note 1: Below is referring to the maximum distortion 8% of the output voltage 50Hz (according IEC 61000-2-2: 2002), power factor • = 0.7 (implying that 70% of the apparent power *S* serves as the active power consumed on the resistors R_l and R_s).

The entire single-phase load can be composed of a single load or multiple equivalent loads in parallel connection.

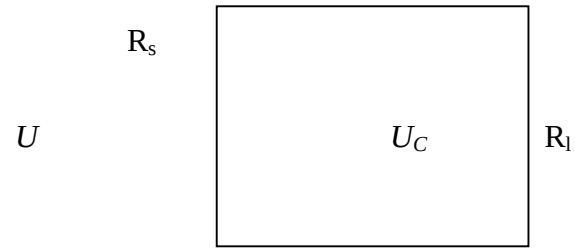
Note 2: The resistor Rs can connect with the AC side or DC side of the rectifying bridge.

Note 3: The actual value of element device for use in test should be within the following range of calculation values:

—R_s: ± 10%;

— R_l: Adjustable in tests so as to acquire the rated output performance power;

— C: +25%.



In the figure, U_C — Rectified voltage value, with the unit of voltage (V);

R_l — Load resistor, representing 66% of active power in the entire performance power *S*.

R_s — Series connection resistor, representing 4% of active power in the entire performance power *S* (a suggestion about cable voltage reduction according to IEC TC 64).

Figure M.1 Standard non-linear load

The ripple voltage is the capacitive voltage U_C peak — 5% of the peak value. The corresponding time constant of U_C is $R_l \times C = 0.15s$.

Having observed the peak value voltage, power voltage distortion, cable voltage reduction and rectified voltage ripple, the average rectified voltage value U_C shall be:

$$U_C = \bullet 2 \times (0.92 \times 0.96 \times 0.975) \times U = 1.22 \times U$$

The values of resistors R_s, R_l and capacitor C are calculated according to the following formulas:

$R_s = 0.04 \times U^2 / S$

$R_l = U_C^2 / (0.66 \times S)$

$C = 0.15 S / R_l$

Note 4: The value of capacitor C is effective to 50Hz and the mixed design of 50Hz and 60Hz.

M.5.1 Test methods

a) When the UPS under test is under the specified rated output voltage, the standard non-linear load is connected to the AC input power;

b) When supplying power to the standard load, the AC input wave shape distortion caused by AC input power impedance should not exceed 8%;

c) Adjust the resistor R_l until the output apparent power *S* of the UPS under test equals to the specified rated value;

d) After the resistor R_l is adjusted, the standard non-linear load is connected to the output of the UPS under test, and adjustment cannot be made

anymore;

e) According to the requirements of appropriate regulations, all the tests carried out for acquiring the required parameters under the non-linear load should adopt standard load, and adjustment cannot be made anymore.

M.5.2 Connection of standard non-linear load

a) The apparent power *S* used by the single-phase UPS at 33kVA and below is equal to the standard non-linear load of the rated apparent power of UPS;

b) The apparent power used by the single-phase UPS at the rated value of above 33kVA is the standard non-linear load of 33kVA, and is added with linear load, acquiring the rated values of the apparent power and active power of UPS;

c) The 3-phase UPS with its design adopting the single-phase load, apparent power and the rated value of active power being 100kVA and below should connect 3 equivalent single-phase non-linear load to between the UPS phase line and neutral line or between phase lines (depending on the national electric network allocation applicable to the UPS design);

d) The 3-phase UPS with the rated value of above 100kVA should select the load according to C), and should be added with linear load, acquiring the rated values of the apparent power and active power of UPS.

Appendix N

(Standardised Appendix)
Ventilation of storage battery cabinet

N.1 Outline

Under great current discharge, overcharging or similar situations, the opened storage battery releases gas, so its enclosure or cabinet should be well ventilated. Ventilation allows air to circulate, which decreases the danger of pressure and accumulation caused by mixed gas (e.g. hydrogen and air), and helps to avoid personal harm.

The arc starting parts (such as the contact terminals of switch, disconnector and relay) should not be located inside the enclosure or cabinet placed with opened storage battery. The enclosure or cabinet should not emit gas around the arc starting parts. Fuse and connecting devices do not include the arc starting parts. The monitoring sensor of storage battery or storage battery cabinet (e.g. temperature sensor or similar objects) should be placed in the enclosure or cabinet.

If the mixed gas (such as hydrogen and air) is lighter than air, it is required to open a ventilation opening at the top end of the enclosure or cabinet because mixed gas can be accumulated at this part easily.

N.2 Concentration of hydrogen

According to the above contents, the ventilation measures should prevent the concentration of hydrogen from exceeding 4% of the capacity. If sufficient ventilation cannot be obviously acquired, the concentration of gas should be measured according to the ventilation test of storage battery cabinet in Subsection N.4. Under the circumstances that lead-acid storage battery is full, if large part of electric energy is converted as gas, every 63Ah of each lead-acid storage battery unit releases about $0.0283m^3$ of hydrogen. Please refer to Subsection N.4.

N.3 Blocking situation

The ventilation measures of the enclosure or cabinet placed with storage battery should meet the requirements of abnormal conditions, including the locked turning of fan and the blockade of ventilation filter.

N.4 Overcharging test

If a measurement is required to judge whether the storage battery cabinet meets the requirements set out in Subsection N.2, the storage battery should undergo an overcharging test (see Subsection 7.6.8). Both during and after testing, the highest concentration of hydrogen should not exceed 2% of the capacity (the safety coefficient is 2). During the test, intermittent collection of gas in 2h, 4h, 6h and 7h and tests should be carried out at the place inside the storage battery cabinet where the

highest possible hydrogen concentration lies.

When connected to the power supply circuit, which is adjusted to 106% of the rated voltage of UPS, the storage battery power supply system of UPS must overcharge the full storage battery for 7h. Adjust any control of charger or charging circuit adjustable by user, making it situated at the strictest charging speed.

Exception 1: this requirement does not apply to storage batteries connected with UPS but not evaluated together.

Exception 2: this requirement does not apply to UPS equipped with an adjustable circuit, preventing the rise of charging current of storage battery when the AC input voltage rises from the rated value to its 106%.

Exception 3: the following formula can be used to ensure the ventilation requirements of this Appendix.

For equalised charging (boost charging) and valve-controlled storage batteries, this is carried out under a broader environmental temperature range. The coefficient "*I*" should adopt 2.4V/unit.

The necessary ventilation airflow of storage battery cabinet should be calculated by the following formula:

$$Q = v \times q \times s \times n \times I \times C$$

where:

Q — Ventilated airflow volume, with the unit of cubic meter per hour (m^3/h);

v — Necessary dilution value of hydrogen, being (100 – 4) /4 = 24;

q — Hydrogen produced by 0.45×10^{-3} m^3/Ah;

s — Safety coefficient, e.g. s = 5;

n — Number of storage battery units;

I = 2A/100Ah — Traditional rich-solution storage battery;

I = 1A/100Ah — Low-antimony alloyed rich-solution storage battery;

I = 0.5A/100Ah — Rich-solution storage battery with hydrogen release bolt;

I = 0.2A/100Ah — Valve-controlled lead-acid storage battery;

C — Nominal capacity of storage battery, with the unit of ampere-hour (Ah), and the discharge speed is 10h.

vqs = 0.54 m^3/Ah can be employed to simplify the above formula as:

$$Q = 0.54 \times n \times I \times C$$

Ventilation volume should better be guaranteed by natural ventilation; otherwise, compulsory ventilation is needed.

It should be guaranteed that air is able to enter and leave the inlet and outlet. The average airflow speed should be 0.1m/s.

When subjected to natural ventilation, the storage battery cabinet should have both an air inlet and outlet, around which should be an obstacle-free space, K_1 = 28h cm^2/m^3

$$A \bullet K_1 Q$$

where:

A — Area of ventilation opening, with the unit of square centimeter (cm^2);

$K_1 = 28h\ cm^2/m^3$.

Or

$$A \bullet K_2 n I X$$

where:

$K_2 = 1.51\ cm^2/A$.

Note: if hydrogen-producing electric energy is maintained below a certain limit, natural ventilation applies; otherwise, the ventilation opening should be greater than the permitted size. The limited conditions of natural ventilation are determined by the capacity of storage battery, the number of storage battery units and the technology of storage battery (opened storage battery unit or valve-controlled storage battery unit) as well as the charging voltage applied to the storage battery.

Supposing that the heat-generating (exceeding 300°C) or spark-producing components and the ventilation opening of the storage battery or air pressure outlet are maintained at a sufficient distance, using the above calculation method may reach the reliable anti-explosion level. In the storage battery chamber, a distance of 500mm can be thought to be sufficiently safe. In the storage battery cabinet and the storage battery box, or the internal storage battery of UPS, the above distance can be appropriately decreased according to the ventilation conditions.

The abovementioned strictest charging speed is the maximum charging speed that will not cause the overheating and overcurrent protective device to disconnect.

Appendix X

(Informative Appendix)
Disconnection guide for storage battery during Transportation

X.1 Applicable products

This Appendix applies to UPS and storage battery boxes equipped with an internal storage battery. Currently, the following requirements only serve as guidelines. In the future, this Appendix may become a Standardised Appendix.

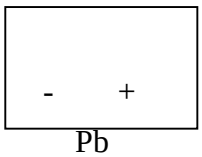
X.2 Disconnection of storage battery

The manufacturer should provide a storage battery disconnection method for the purpose of transportation. The disconnection should aim to be close to the storage battery as possible, and situated in front of any other circuit (including the printed circuit board) or electrical device to which the storage battery is connected.

X.3 Packaging tags / labels

Warning tags should be stuck onto the transportation carton, stating whether the storage battery in the package is connected.

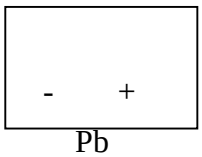
Before transportation, the manufacturer should affix the tag shown in Figure X.1 to the product when the storage battery is disconnected.

<table>
<tr><td colspan="2">• No Damage</td></tr>
<tr><td> 

Storage battery not connected.</td><td>Disclosure of Storage Battery Prohibited
Any deformation, cracking or damage of transportation carton would make the goods disclosed, so it should be placed in an isolated area and checked by qualified staff. If the package is thought to be unavailable for transportation, the goods should be rapidly collected and isolated, and the carrier and shipper should be contacted.</td></tr>
</table>

Figure X.1 Warning tag of products to be transported with storage battery disconnected.

Before transportation, the manufacturer should affix the tag shown in Figure X.2 tothe product when the storage battery is disconnected.

<table>
<tr><td colspan="2">• No Damage</td></tr>
<tr><td> 

Storage battery is connected.</td><td>Disclosure of Storage Battery Prohibited
Any deformation, cracking or damage of transportation carton would make the goods disclosed, so it should be placed in an isolated area and checked by qualified staff. If the package is thought to be unavailable for transportation, the goods should be rapidly collected and isolated, and the carrier and shipper should be contacted.</td></tr>
</table>

Figure X.1 Warning tag of products to be transported with storage battery not disconnected.

Note: In Figure X.1 and Figure X.2, the “Pb” inside the storage battery sign is applicable to the enclosed lead-acid storage battery. As to the use of storage battery made of other chemical substances, adopt the corresponding chemical signs.

X.4 Damage inspection

Any deformation, cracking or damage to the transportation carton would make the goods disclosed, so it should be placed in an isolated area and checked by qualified staff. If the package is thought to be unavailable for transportation, the goods should be rapidly collected and isolated, and the carrier and shipper should be contacted. The manufacturer should inform the transporter or handler of the applicable product guide.

X.5 Importance of safe handling procedures

To ensure the safe air transportation of the equipment to different countries throughout the world, the UPS manufacturer should carry out comprehensive tests. However, please note this important fact: any damage to UPS with internal storage battery and storage battery box may result in fire, smoke or similar risks. If there is any obvious danger, the products should be carefully handled and inspected immediately.