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Code for Design of Low Voltage Electrical Installations

低压配电设计规范

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Jointly Issued by the Ministry of Housing and Urban-Rural Development (MOHURD) and the General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) of the People's Republic of China

National Standard of the People's Republic of China

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Announcement on Publishing the National Standard "Code for Design of Low Voltage Electrical Installations"

"Code for Design of Low Voltage Electrical Installations" has been approved as a national standard with a serial number of GB 50054-2011 and shall be implemented from June 1, 2012. Thereinto, Articles 3.1.4, 3.1.7, 3.1.10, 3.1.12, 3.2.13, 4.2.6 and 7.4.1 are compulsory and must be enforced strictly.

Authorized by the Standard Rating Research Institute of the Ministry of Housing and Urban-Rural Development of the People's Republic of China, this code is published by China Planning Press.

Ministry of Housing and Urban-Rural Development of the People's Republic of China

July 26, 2011

Foreword

According to the requirements of Document Jian Biao [2002] No.85 issued by the former Ministry of Construction (MOC) - "Notice on Printing and Publishing the Development and Revision Plan of National Engineering Construction Standards in 2001 ~ 2002", this code was formulated through revising "Code for Design of Low Voltage Electrical Installations" (GB 50054-95) jointly by China Electric Design & Research Institute Co., Ltd. and organizations concerned.

During the revision process, this code was reviewed and finalized by the drafting group on the basis of wide investigation, earnest summary of practical experience and reference to relevant international standards and foreign advanced standards as well as extensive solicitation for opinions.

This code comprises 7 Chapters and 1 Appendix: the main technical content includes general provisions, terms, selection of electrical devices and conductors, layout of Distribution Equipment, protection against electronic shock in electrical installation, protection for power circuits and erection of wiring systems.

The main technical revisions are as follows:

1. The applicable voltage was changed from AC 500V power frequency to AC 1000V power frequency;
2. The provision that copper and aluminum conductors shall be selected in the General Provisions of the former code was cancelled;
3. The terms were added as a separate chapter while the term explanation in the Appendix was deleted;
4. The requirements for the selection and installation of functional switching devices and residual current action protection devices were added;
5. The requirements of selecting switching device with neutral pole were added;
6. The requirements of installing electrical devices for insulation monitoring in IT system were added;
7. The requirements for selecting sectional area of protective bonding conductor for local equipotential bonding were added;
8. The "3.2 Safety Precautions in Layout of Distribution Equipment" of "Chapter 3 Layout of Distribution Equipment" was incorporated into "4.4 Protection against Earth Fault" of "Chapter 4 Protection for Power Circuits" in the former code, and "SELV System, PELV System and FELV System" were added in "Chapter 5 Protection against Electronic Shock in Electrical Installation";
9. The "Protection against Electrical Fire of Power Circuits" was added in "Protection for Power Circuits";
10. The requirements for "wiring of pliable metal conduit", "wiring of underground concealed metal trunking", "mineral insulated cable erection" and "pre-branch cable erection" were added;
11. Supplement, improvement and adjustment were made the partial provisions in the former code.

The provisions printed in bold type in this code are compulsory and must be enforced strictly.

The Ministry of Housing and Urban-Rural Development (MOHURD) is in charge of the administration of this code and the explanation of compulsory provisions, China Machinery Industry Federation is responsible for the routine management and China Electric Design & Research Institute Co., Ltd. is responsible for the explanation of specific technical contents. All relevant organizations are kindly requested to sum up and accumulate your experiences in actual practices during the process of implementing this code. The relevant opinions and advice, whenever necessary, can be posted or passed on to China Electric Design & Research Institute Co., Ltd. (address: China Electrical Building, No.9 Capital Gymnasium South Road, Haidian District, Beijing 100048; E-mail: yaodalin@cneec.com.cn) for future reference in revision.

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China Mechanical Industrial Exploration and Design Association

Chief development organization:

China Electric Design & Research Institute Co., Ltd.

Participating development organizations:

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China Aviation Planning and Construction Development Co., Ltd. (the former China Aeronautical Project and Design Institute)

Beijing Institute of Architectural Design

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Contents

Code for Design of Low Voltage Electrical Installations

低压配电设计规范

1 General Provisions

1.0.1 This code is formulated with a view to ensuring personal and property safety, energy conservation, advanced technology, full function, economic rationality, reliable electrical installation as well as convenient installation and operation in the design of low-voltage electrical installations.

1.0.2 This code is applicable to the design of low-voltage electrical installations at 1000V AC power frequency in construction, extension and renovation engineering.

1.0.3 The design of low-voltage electrical installations shall not only meet the requirements of this code, but also comply with those in the current relevant ones of the nation.

2 Terms

2.0.1 Prospective touch voltage

The voltage between conductive parts which may be touched by human being and animals simultaneously where they haven't yet touched the conductive parts.

2.1.2 Conventional prospective touch voltage limit

The maximum value of prospective touch voltage which may exist continuously under specified external influence.

2.0.3 Direct contact

Electrical contact with live part by human being or animals.

2.0.4 Indirect contact

Electrical contact with live exposed conductive part under fault by human being or animals.

2.0.5 Protection against direct contact

Protection against electronic shock under no fault

2.0.6 Protection against indirect contact

Protection against electronic shock under a single fault

2.0.7 Additional protection

Protective measures other than protection against direct contact and indirect contact.

2.0.8 Arm's reach

The maximum range where human being can reach with hands, by virtue of no means, in any direction from any point on the surface where human being usually stands or acts.

2.0.9 Enclosure

The outer cover which can provide protection type and protection grade to adapt to expected application.

2.0.10 Protective barrier

A barrier for avoiding direct contact from normally possible approaching direction.

2.0.11 Protective obstacle

An obstacle for avoiding unintentional direct contact.

2.0.12 Electrical separation

Protective measures for insulating dangerous live parts against other electric loops and electric components as well as against earth, and for avoiding all contacts.

2.0.13 Protective separation

Separation of one circuit from other circuits through double insulation, reinforced insulation or basic insulation and electrical protection shielding.

2.0.14 Extra-low voltage

The voltage where the voltage between phases or phase-to-ground voltage is less than or equal to AC root mean square (RMS) value 50V.

2.0.15 SELV system

An electrical system, unearthed under normal conditions, whose voltage is less than or equal to extra-low voltage.

2.0.16 PELV system

An electrical system, earthed under normal conditions, whose voltage is less than or equal to extra-low voltage.

2.0.17 FELV system

An electrical system whose unsafe voltage for operation is less than or equal to extra-low voltage.

2.0.18 Equipotential bonding

A bonding among a few conductive parts to reach the equipotential.

2.0.19 Protective equipotential bonding

An equipotential bonding for safe purpose.

2.0.20 Functional equipotential bonding

An equipotential bonding for normal operation.

2.0.21 Main equipotential bonding

A bonding, in protective equipotential bonding, to connect such conductive parts as main protective conductor, main earthing conductor or main earthing terminal as well as metal piping and available metal structure inside building.

2.0.22 Supplementary equipotential bonding

A protective equipotential bonding to directly connect conductive parts with conductors so that their potentials is equal or close.

2.0.23 Local equipotential bonding

A protective equipotential bonding to connect conductive parts within a partial range.

2.0.24 Earth fault

An accidental conductive pathway between live conductor and earth.

2.0.25 Conduit

A round-section component where insulated conductor or cable may penetrate or get replaced.

2.0.26 Cable trunking

A closed shell, consisting of a base with movable cover, used for enclosing insulated conductor, cable and flexible wire.

2.0.27 Cable tray

A cable supporter with continuous chassis and side but without cover.

2.0.28 Cable ladder

A cable supporter with a series of transverse supporting members firmly fixed on longitudinal main supporting components.

2.0.29 Cable brackets

Spaced horizontal cable supporters with only one fixed end.

2.0.30 Mobile equipment

A kind of electrical equipment which is movable during operation or is easy to move from one position to another position where it is power-connected.

2.0.31 Hand-held equipment

Electrical equipment held in hand(s) during normal use.

2.0.32 Switching device

A device for making or breaking circuits.

2.0.33 Switch

A mechanical switching device which is capable of making, carrying or breaking current under normal working conditions or under overloading condition as well as capable of carrying current for a certain period under short-circuit conditions or other abnormal conditions.

2.0.34 Switch-disconnector

A switch capable of satisfying the isolation requirements of an isolator at the disconnected position.

2.0.35 Device for isolation

A device with isolation function.

2.0.36 Circuit-breaker

A mechanical switching electrical installation which is capable of making, carrying or breaking current under normal working conditions as well as capable of making and carrying current for a certain period and breaking current under such abnormal conditions as short-circuits

2.0.37 Mineral insulated cables

Cables, in the same metal sheath, consisting of one conductor or several conductors which are subject to compressed mineral power insulation.

3 Selection of Electrical Devices and Conductors

3.1 Selection of Electrical Devices

3.1.1 The electrical devices for the design of low-voltage electrical installations shall reach the relevant national current product standards and meet the following requirements:

1 The electrical devices shall adapt to the local occupancies and environmental conditions;

2 The rated frequency of electrical devices shall be commensurate with the frequency of all loops;

3 The rated voltage of electrical devices shall be commensurate with the nominal

voltage of all loops;

4 The rated current of electrical devices shall be commensurate with the calculating current of all loops;

5 The electrical devices shall meet the requirements of dynamic stability and thermal stability under short-circuit conditions;

6 The electrical devices for disconnecting short circuit current shall reach the making capacity and breaking capacity under short circuit condition.

3.1.2 The expected short circuit current under making or breaking condition at installation position shall be adopted to recalculate the making capacity and breaking capacity of electrical devices under short circuit condition; where the sum of rated current of connected motor nearby the short circuit point exceeds 1% of the short circuit current , the effect of motor feedback current shall be counted in.

3.1.3 Where power supply is cut off for equipment maintenance, test and overhaul, device for isolation shall be arranged. The device for isolation shall ensure all poles of power supply are disconnected simultaneously or be unipolar and close to each other. Where serious accidents are caused due to mis-operation of device for isolation, measures shall be taken to avoid such mis-operation.

3.1.4 The protective earthing neutral conductor in TN-C system shall not be isolated and must not be connected to switching device.

3.1.5 The device for isolation shall meet the following requirements:

1 The isolation distance between disconnected contactors shall be visibly or obviously indicated with "closed" and "open";

2 The device for isolation shall be capable of closing to avoid any accident;

3 Locking measures shall be taken to inadvertent disconnection of device for isolation.

3.1.6 The following electrical devices shall be adopted for device for isolation:

1 Unipolar or multipolar isolator, switch -disconnector or plug-disconnector;

2 Plug and socket;

3 Connecting sheet;

4 Special terminals where no conductor need be removed;

5 Fuse;

6 Switch and circuit breaker with isolation function.

3.1.7 Semi-conductor switching device must not be used as device for isolation.

3.1.8 Functional switching devices shall be installed to control each part of circuit for electrical installation separately.

3.1.9 The following electrical devices shall be adopted for functional switching devices:

1 Switch;

2 Semi-conductor switching device;

3 Circuit breaker;

4 Contactor;

5 Relay;

6 16A or below plugs and sockets.

3.1.10 Isolator, fuse and connecting sheet must not be used as functional switching devices.

3.1.11 The residual current action protection devices shall be selected according to the

following requirements:

1 Except in TN-S system, where neutral conductor is at reliable earth potential, it may not be disconnected and shall be able to disconnect all live conductors for protection loops;

2 The rated residual non-action current of residual current action protection devices shall be greater than the expected earth leakage current during normal operation at load;

3 The type of residual current action protection devices shall be determined based on the type of earth fault according to the relevant requirements of the current national standard "General Requirements for Residual Current Operated Protective Devices" (GB/Z 6829).

3.1.12 Protective conductor must be equipped where the residual current action protection devices are adopted as the loops of electrical devices for protection against indirect contact.

3.1.13 In TT system, except that the electrical installation between power supply inlet terminal of electrical installation and protection device complies with the requirements of or has the same insulation level as Category II equipment stated in "Protection against Electric Shock - Common Aspects for Installation and Equipment" (GB/T 17045), the protection device shall be arranged at the power supply inlet terminal of electrical installation where the electrical installation is protected by a single residual current action protection device.

3.1.14 In IT system, the rated residual non-action current shall be greater than or equal to the current flowing across the faulted loop during first earth fault where residual current action protection devices are used to protect electrical installations and the circuits are not disconnected during first earth fault.

3.1.15 Under one of the following cases, switching devices with disconnected neutral pole shall be selected:

1 Power-conversion switching device between IT system with neutral conductor and TT system or TN system;

2 In TT system, device for isolation is selected where there is neutral conductor at loading side;

3 In TT system, switching device is selected where there is neutral conductor.

3.1.16 Where the current in circuits need be prevented from flowing across unexpected paths, switching device with disconnected neutral pole may be selected.

3.1.17 The electrical devices for insulation monitoring in IT system shall be capable of monitoring the insulation of electrical installations continuously. The setting values of electrical devices for insulation monitoring can only be changed through a key or tool; the setting values of its test voltage and insulation resistance shall meet the following requirements:

1 The test voltage of SELV and PELV loops shall be 250V while the setting value of insulation resistance shall be less than 0.5MΩ;

2 The test voltage of other loops (except SELV and PELV loops) which is less than 500V shall be 500V while the setting value of insulation resistance shall be less than 0.5MΩ;

3 The test voltage of over 500V loops shall be 1000V while the setting value of insulation resistance shall be less than 1.0MΩ.

3.2 Selection of Conductors

3.2.1 The conductor type shall be selected according to their laying modes and environmental conditions. The insulated conductors shall not only satisfy the

above-mentioned conditions, but also meet the requirements of working voltage.

3.2.2 The selection of conductors section shall meet the following requirements:

1 The current carrying capacity of conductors shall be determined according to their laying modes and environmental conditions and shall be greater than or equal to the calculating current;

2 The conductors shall meet the requirements of circuit protection;

3 The conductors shall meet the requirements of dynamic stability and thermal stability;

4 The circuit voltage loss shall meet the requirements of electrical equipment terminal voltage during normal operation and start-up;

5 The minimum section of conductors shall meet the requirements of mechanical strength. The minimum section of fixed conductors shall be determined based on their laying modes, spacing between insulator supporting points as well as conductor material in accordance with those specified in Table 3.2.2.

Table 3.2.2 Minimum Section of Fixed Conductors

Laying mode	Spacing between insulator supporting points (m)	Minimum section of conductors (mm^2)	
		Copper conductor	Aluminum conductor
Bare conductor is laid on insulator	—	10	16
Insulated conductor is laid on insulator	≤2	1.5	10
	>2, and ≤6	2.5	10
	>6, and ≤16	4	10
	>16, and ≤25	6	10
Insulated conductor is laid through conduit or laid in trunking	—	1.5	10

6 The conductor section of cables with long-term stable load may be selected according to economical current density if it proves reasonable based on technical economical comparison, and shall meet the relevant requirements of the current national standard "Code for Design of Cables of Electric Work" (GB 50217).

3.2.3 The temperature generated by load current of conductor during continuous normal operation shall ensure the insulation temperature is less than or equal to those specified in Table 3.2.3.

Table 3.2.3 Maximum Operating Temperature of Different Insulation Types (℃)

Insulation type	Conductor insulation	Sheath
PVC	70	—
Crosslinked polyethylene and ethylene-propylene-diene monomer	90	—
Mineral insulated cable with PVC sheath or accessible mineral insulated cable with bare sheath	—	70
Inaccessible mineral insulated cable with bare sheath, away from combustibles	—	105

3.2.4 The current carrying capacity of insulated conductor and in-armored cable as well as their correction factors of the capacity shall be determined according to the current national standard "Electrical Installations of Buildings - Part 5: Selection and Erection of Electrical

Equipment - Section 523: Current-carrying Capacities of Wiring Systems" (GB/T 16895.15). The current carrying capacity of armored cable and the correction factor of the capacity shall be determined according to the relevant requirements of the current national standard "Code for Design of Cables of Electric Engineering" (GB 50217).

3.2.5 The ambient temperature at the laying positions of insulated conductor or cable shall be determined according to those specified in Table 3.2.5.

Table 3.2.5 Ambient Temperature at the Laying Positions of Insulated Conductor or Cable

Cable laying position	Whether mechanical ventilation is available	Selected ambient temperature
Directly buried in soil	—	Average earth temperature at the buried depth in the hottest month
Underwater	—	Daily mean highest water temperature of the hottest months
At the outdoor air or cable trench	—	Daily mean highest temperature of the hottest months
In factory buildings with heat source equipment	Available	Ventilation design temperature
	Unavailable	Daily mean highest temperature of the hottest months plus 5℃
In ordinary factory buildings and other buildings	Available	Ventilation design temperature
	Unavailable	Daily mean highest temperature of the hottest months
At indoor cable trench	Unavailable	Daily mean highest temperature of the hottest months plus 5℃*
In tunnel or electric shaft		
In tunnel or electric shaft	Available	Ventilation design temperature

Note: * over 70℃ working temperature of a number of cables laid in tunnel or electric shaft without mechanical ventilation shall be counted into the effect on ambient temperature rise rather than directly plus 5℃.

3.2.6 Where the heat dissipation conditions of cables differ along the laying path in different places, the heat dissipation condition of cables shall be determined according to the most unfavorable place.

3.2.7 Under one of the following circuits, the section of neutral conductor shall be the same as that of phase conductor:

1 Single-phase two-wire circuit;

2 Three-phase four-wire circuit where the copper and aluminum phase conductor section are less than or equal to $16mm^2$ and $25mm^2$ respectively.

3.2.8 For the circuits under one of the following conditions, the section of neutral conductor may be less than that of phase conductor:

1 Where the copper and aluminum phase conductor section is greater than $16mm^2$ and $25mm^2$ respectively;

2 Where the copper and aluminum phase conductor section is greater than or equal to $16mm^2$ and $25mm^2$ respectively;

3 During the normal operation, the expected maximum current of neutral conductor (including harmonic current) is less than or equal to the allowable current carrying capacity of neutral conductor;

4 Where overcurrent protection is carried out for neutral conductor.

3.2.9 Where harmonic current flows in three-phase four-wire circuit, the current for calculating neutral conductor shall be counted into the effect of harmonic current. Where the current of neutral conductor is greater than that of phase conductor, the cable phase conductor section shall be selected in accordance with the neutral conductor current. Where harmonic current flows in three-phase balanced system, the neutral conductor and phase conductor in 4-cored or 5-cored cables are equipped with the same material and section, the reducing factor of the current-carrying capacity of the cable shall be determined according to those specified in Table 3.2.9.

Table 3.2.9 Reducing Factor of Cable Current-carrying Capacity

Triple harmonic component in current (%)	Reducing factor	
	Selecting section according to phase current	Selecting section according to neutral conductor current
0~15	1.0	—
>15, and ≤33	0.86	—
>33, and ≤45	—	0.86
>45	—	1.0

3.2.10 The sectional area of fixed copper protective earthing neutral conductor in power circuits shall be greater than or equal to 10mm^2 while the sectional area of protective earthing neutral conductor shall be greater than or equal to 16mm^2.

3.2.11 The protective earthing neutral conductor shall be insulated according to the expected maximum voltage.

3.2.12 Where the protective earthing neutral conductor is transformed into single neutral conductor and protective conductor from certain point of the electrical system, it shall meet the following requirements:

1 Separate terminal or bus bar shall be arranged for protective conductor and neutral conductor;

2 The protective earthing neutral conductor shall be first connected to terminal or bus bar for protective conductor;

3 The neutral conductor shall not be connected to any other earthing part of electrical system.

3.2.13 The conductive part outside the device must not be regarded as part of the protective earthing neutral conductor.

3.2.14 The sectional area of protective conductor shall be selected the following requirements:

1 The sectional area of protective conductor shall satisfy the automatic power dump conditions of protection against indirect contact for electrical system and shall be capable of bearing expected fault current or short circuit current;

2 The sectional area of protective conductor shall be determined based on Formula (3.2.14) or according to those specified in Table 3.2.14.

$$S \geq \frac{I}{k}\sqrt{t} \tag{3.2.14}$$

Where

S - sectional area of protective conductor, mm^2;

I - expected fault current or short circuit current passing through protection device [AC RMSV (Root Mean Square Value) (A)];

t - action time for automatic current interrupt of protection device, s;

k - factor, calculated according to Formula (A.0.1) or determined in accordance with those specified in Tables A.0.2~A.0.6 in this code.

Table 3.2.14 Minimum Sectional Area of Protective Conductor (mm^2)

Sectional area of phase conductor	Minimum sectional area of protective conductor	
	The same material is used for protective conductor and phase conductor	Different materials are used for protective conductor and phase conductor
≤16	S	$\frac{S \times k_1}{k_2}$
>16, and ≤35	16	$\frac{16 \times k_1}{k_2}$
>35	$\frac{S}{2}$	$\frac{S \times k_1}{2 \times k_2}$

Notes: **1** S - sectional area of phase conductor;

2 k_1 - factor of phase conductor, determined according to those specified in Table A .0.7 in this code;

3 k_2 - factor of protective conductor, determined according to those specified in Tables A .0.2~A.0.6 in this code.

3 The sectional area of protective conductor outside cable or protective conductor not in the same enclosure as phase conductor shall meet the following requirements:

1) Where there is protection against mechanical damage, the sectional area of copper conductor and aluminum conductor shall be greater than or equal to 2.5mm^2 and 16mm^2 respectively;

2) Where there is no protection against mechanical damage, the sectional area of copper conductor and aluminum conductor shall be greater than or equal to 4mm^2 and 16mm^2 respectively.

4 Where two or more loops share one protective conductor, the sectional area shall be determined according to the following requirements:

1) The sectional area shall be determined according to the most severe expected fault current or short circuit current in loops and the action time, and shall meet the requirements of Formula (3.2.14);

2) Corresponding to the maximum sectional area of phase conductor in loops, the sectional area shall be determined according to Table 3.2.14.

5 Where the expected current of protective conductor for permanently-connected electrical equipment exceeds 10mA, the sectional area of protective conductor shall be determined in accordance with one of the following conditions:

1) The sectional area of copper conductor shall be greater than or equal to 10mm^2 or the sectional area of aluminum conductor shall be greater than or equal to 16mm^2;

2) Where the sectional area of protective conductor is less than those specified in Item 1 above, the second protective conductor shall be laid for electrical equipment and

its sectional area shall be greater than or equal to that of the first protective conductor. The second protective conductor shall be laid until where its sectional area is greater than or equal to 10mm^2 for copper protective conductor or 16mm^2 for aluminum protective conductor; and a separate wiring terminal shall be arranged for the second protective conductor of electrical equipment;

3) Where the copper protective conductor and copper phase conductor are in the same multi-core cable, the sectional area sum of all copper conductors shall be greater than or equal to 10mm^2;

4) Where the protective conductor is installed inside metal conduit and spliced with it, copper conductor with sectional area greater than or equal 2.5mm^2 shall be adopted.

3.2.15 The sectional area of protective bonding conductor for main equipotential bonding shall be greater than or equal to 1/2 maximum sectional area of protective conductor for power circuits while the minimum and maximum sectional areas of protective bonding conductor shall be in accordance with those specified in Table 3.2.15.

Table 3.2.15 Minimum and Maximum Sectional Areas of Protective Bonding Conductor (mm^2)

Conductor material	Minimum sectional area	Maximum sectional area
Copper	6	25
Aluminum	16	Determined provided that its current carrying capacity is the same as the current carrying capacity of 25mm^2 copper conductor
Steel	50	

3.2.16 The sectional area of protective bonding conductor for supplementary equipotential bonding shall be selected according to the following requirements:

1 The conductance of protective bonding conductor connecting two exposed conductive parts shall be greater than or equal to the conductance of smaller protective conductor connected to exposed conductive parts;

2 The conductance of protective bonding conductor connecting exposed conductive parts and conductive parts outside devices shall be greater than or equal to the conductance of conductor with 1/2 sectional area of the protective conductor;

3 The sectional area of separate protective bonding conductor shall be in accordance with Item 3 of Article 3.2.14.

3.2.17 The sectional area of protective bonding conductor for local equipotential bonding shall be selected according to the following requirements:

1 The conductance of protective bonding conductor shall be greater than or equal to the conductance of conductor with 1/2 maximum sectional area of protective conductor at local position;

2 Where copper conductor is adopted as protective bonding conductor, its maximum sectional area shall be 25mm^2. Where other metal conductor is adopted as protective bonding conductor, its maximum sectional area shall be determined provided that it has the same current carrying capacity as 25mm^2 copper conductor;

3 The sectional area of separate protective bonding conductor shall be in accordance with Item 3 of Article 3.2.14.

4 Layout of Distribution Equipment

4.1 General Requirements

4.1.1 The distribution room shall be close to the power load center, and should be arranged in a dry and vibration-free place of little conduction dust and corrosion medium and with some development room.

4.1.2 The layout of distribution equipment shall conform to the principles of safety, reliability, application and economy, and be convenient for installation, operation, transportation, test, monitoring, examination and reparation.

4.1.3 Except the pipings needed in the room, no other pipings shall pass the distribution room. The water and gas pipings in the room shall not be equipped with valves and head joints; the connection between water and gas pipings and radiators shall be welded and equipotential bonding shall be made. The upside and downside of the distribution board and the inside of cable trench shall not be laid with water and gas pipings.

4.2 Safety Precautions in Layout of Distribution Equipment

4.2.1 The bottom of the floor-type distribution box shall be raised to no less than 50mm above the ground level in the room and no less than 200mm outside; enclosure measures shall be taken in the surroundings of the base and be capable of keeping outside such small animals as mice and snakes.

4.2.2 As for the two adjacent sections of buses in the same distribution room, fire precaution shall be taken between them where any of them is equipped with load of Grade 1.

4.2.3 Where the high voltage and low voltage distribution equipment are arranged in the same room and the exposed buses are set on one side of the cabinet top of the two equipments, the clear space between the two assemblies shall not be less than 2m.

4.2.4 For distribution board arranged in rows, where the length exceeds 6m, the passage behind the board shall be arranged with two exits which should be arranged on the both ends; where the distance between two exits exceeds 15m, some exit(s) shall be added between them.

4.2.5 Where the protection grade is no less than the IP 2× Grade specified in the current national standard of "Grade of Protection Provided by Shells (IP code)" (GB 4208), the minimum width of passages of distribution board arranged in rows shall meet the requirements in Table 4.2.5.

Table 4.2.5 Minimum Width of Passages of Distribution Boards in Rows

Distribution board category		Outlaid in single row			Outlaid in double rows face to face			Outlaid in double rows back to back			Outlaid equi-directionally in multi-rows			Board-side passage
		Board front	Board back		Board front	Board back		Board front	Board back		Between boards	Distance between the walls and boards in front and back rows		
			Maintenance	Operation		maintenance	Operation		Maintenance	Operation		Board front in front rows	Broad back in back rows	
Fixed type	Free from restriction	1.5	1.0	1.2	2.0	1.0	1.2	1.5	1.5	2.0	2.0	1.5	1.0	1.0
	Restricted	1.3	0.8	1.2	1.8	0.8	1.2	1.3	1.3	2.0	1.8	1.3	0.8	0.8
Drawer type	Free from restriction	1.8	1.0	1.2	2.3	1.0	1.2	1.8	1.0	2.0	2.3	1.8	1.0	1.0
	Restricted	1.6	0.8	1.2	2.1	0.8	1.2	1.6	0.8	2.0	2.1	1.6	0.8	0.8

Notes: 1 Restriction refers to that of the building plane and that of such partial projections as columns in the passage.

2 Operation passage behind the board refers to the passage of the distribution which needs to be operated behind the board.

3 The passage width before the boards arranged back to back may be determined at the passage dimension before the boards arranged back to back in two rows, specified in the table.

4 The minimum passage width before and behind the control board, control cabinet and floor- type power distribution box may be determined according to the table.

5 The passage width of the box-front operation of wall-hung distribution box should not be less than 1m.

4.2.6 The exposed electrified body above the passages in distribution room shall not be less than 2.5m above the ground; where the height is less than 2.5m, barriers or enclosures shall be arranged at no less than IP××B grade or IP2× grade specified in current standard "Grade of Protection Provided by Shells" (IP code)" (GB 4208).The bottom of barriers and enclosures shall not be less than 2.2m above the ground.

4.3 Requirements for Buildings

4.3.1 Fire resistance rating of supporting members on the roof of the distribution room shall not be less than Grade 2 and the other parts shall not be less than Grade 3.Where the distribution room is adjacent to other locations, the fire resistance rating of the door shall be determined according to the higher grade between them.

4.3.2 Where the length of distribution room exceeds 7m, two exits shall be arranged at both ends of the room. Where distribution rooms are arranged on two layers, the exit of the room upstairs shall be arranged with an emergency outlet leading to the floor corridor or outdoors. All the doors of the distribution rooms shall be opened outwards, but the doors to the high voltage distribution room shall be opened in double directions.

4.3.3 The material difficult for dust stratification and abrasion mark shall be applied for the architectural decoration on the ceiling, wall surface and floor in the distribution room; the ceiling shall not be plastered.

4.3.4 Waterproof and drainage measures shall be taken for the cable trenches in the distribution room. The ground in the distribution room should be 50mm above the floor ground or watertight thresholds should be equipped.

4.3.5 Where the winter room temperature affects the normal operations of the equipment in severe cold areas, the distribution room shall be equipped with heating. For the distribution room in hot areas in summer, such cooling measures as heat insulation, ventilation or air conditioning shall be taken according to the weather conditions in the area. Natural lighting should be adopted for the distribution room with a watch-keeper. Water supply and drainage facilities should be arranged in the watch-keeper's room. A new toilet should be set up without a nearby toilet.

4.3.6 Equipment transportation passages, ventilation and lighting facilities shall be arranged in the distribution room s in the basement and storeys.

4.3.7 The doors and windows of the distribution room shall be closed tightly; the cavity and vent-holes leading outdoors shall be arranged with mesh enclosures to avoid such small animals as mice and snakes, the protection grade of which should not be lower than IP3× Grade specified in the current national standard of "Grade of Protection Provided by Shell (IP code)" (GB 4208). Measures shall be taken to keep rain and snow outside for the vent-hole connected directly to the outdoors.

4.3.8 The distribution room should not be arranged in the bottommost basement. Where it is the case, measures shall be taken to keep water out of the distribution room.

5 Protection Against Electronic Shock in Electrical Installation

5.1 Protection Measures for Direct Contact

(I) Keeping the alive part insulated

5.1.1 All the alive part shall all be covered with insulating layers which shall endure such various adverse effects as mechanical, chemical, electrical and hot ones in operation for long time.

(II) Adoption of barrier or enclosure

5.1.2 Barriers and enclosures shall be arranged for the exposed electrified body easily accessible at nominal voltage exceeding AC root mean square (RMS) value 25V. The protection grade shall not less than IP××B grade or IP2× grade specified in the current national standard of "Grade of Protection Provided by Shell (IP code)" (GB 4208).The tapping for the exchange of such parts as lamp holder, socket or fuse or the realization of the normal operation may be excluded after the adoption of the following two measures:

1 Protection facilities arranged to keep humans and animals off the alive parts;

2 The mark "Keep off the Tapping" shall be arranged at the tapping where the touch on the alive part is possible..

5.1.3 As for the top surface of barriers or enclosures accessible the protection grade shall not be lower than IP××D grade or IP4× grade specified in the current national standard of "Grade of Protection Provided by Shell (IP code)" (GB 4208).

5.1.4 The barriers or enclosures shall be fixed stably, durably and reliably.

5.1.5 For the barriers required to be moved, enclosures required to be opened and the their parts required to be removed, one of the following protection measures shall be taken:

1 Only keys or other tools may be applied to move, open and remove the barriers or enclosures.

2 After the power of the live part protected by the barrier or enclosure is cut off, the power supply can be restored after the barrier or enclosure is put back or reclosed.

3 The intermediate barrier arranged at the protection grade of no less than IP××B grade or IP2× grade specified in the current national standard "Grade of Protection Provided by Shell (IP code)" (GB 4208) shall be capable of preventing from the touch of the alive part and being removed with keys or tools.

5.1.6 The clear space between barriers or enclosures and the exposed electrified body shall meet the following requirements according to Article 5.1.2 of this code:

1 In adoption of mesh-like barrier or enclosure the distance shall not be less than 100mm;

2 In adoption of the plate-like barrier or enclosure the distance shall not be less than 50 mm.

(III) Adoption of obstacles

5.1.7 Where the exposed electrified body has difficulty in adopting barrier or enclosure protection, the handrail or mesh-like screen should be adopted for protection in the electrical room or area. The obstacles shall be capable of preventing human body from approaching the exposed electrified body unconsciously in the operation of the equipment or on other occasions.

5.1.8 The obstacles shall be fixed properly, but it can be removed without keys or tools.

5.1.9 Where the obstacles are at the protection grade lower than IP××B grade or IP2× grade specified in the current national standard "Grade of Protection Provided by Shell (IP code)", (GB 4208) the clear horizontal distance between the obstacles and exposed electrified body shall not be less than 1.25m and the height of the obstacles shall not be less than 1.4m.

(IV) Arrangement out of the arm’s reach

5.1.10 Where barrier, enclosures or obstacles with protection grade equal to or higher than

the IP××B grade or IP2× grade specified in the current national standard of "Grade of Protection Provided by Shell (IP code)" (GB 4208) are not adopted in the specially-electrical room or area, the current-carrying part in different electrical potentials accessible unconsciously by humans shall be arranged out of arm's reach.

5.1.11 The arm's reach (Figure 5.1.11) shall meet the following requirements:

1 Where the exposed electrified body is arranged above the area where somebody moves, the vertical clear distance between the electrified body and platform or ground shall not be less than 2.5m.

2 Where the exposed electrified body is arranged beside the platform where somebody moves, the horizontal clear distance between the electrified body and the platform edge shall not be less than 1.25m ;

3 Where the exposed electrified body is arranged below the platform where somebody moves, the vertical clear distance between the electrified body and the under-part of the platform shall not be less than 1.25m and the horizontal clear space between the electrified body and the platform edge shall not be less than 0.75m.

4 For the obstacles, barriers or enclosures of exposed electrified body in the horizontal direction, where the protection grade is lower than IP××B grade or IP2× grade specified in the current national standard "Grade of Protection Provided by Shell (IP code)" (GB 4208) the arm's reach shall not be taken into account from the obstacles, barriers or enclosures.

5 For the obstacles, barriers or enclosures of exposed electrified body above the area where somebody moves, where the protection grade is lower than IP××B grade or IP 2× grade specified in the current national standard of "Grade of Protection Provided by Shell (IP code)" (GB 4208), the arm's reach 2.5m shall be taken into account from the ground where a human being stands.

6 Where a human holds a large or long conductor, the arm's reach shall take the dimension of the object into account.

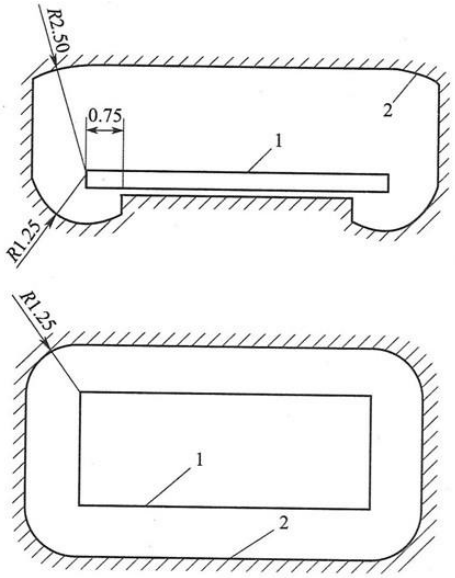

Figure 5.1.11 Arm's Reach (m)

1 - Platform; 2 - Limit of Arm's Reach

(V) Additional protection with residual current devices (RCD)

5.1.12 RCD with rated residual current not exceeding 30mA may be applied as additional

protection after the failure of other measures for protection against direct contact or the negligence of the user, but it cannot be applied as a measure for protection against direct contact separately.

5.2 Measure for Protection against Indirect Contact by Automatic Disconnection of Power

(I) General requirements

5.2.1 Where the following measures for protection against indirect contact are not taken according to the requirements of the current national standard "Electrical Installation of Buildings Part 4-41: Safety Protection Against Electric Shock " (GB 16895.21), the protection measures specified in this Section shall be taken:

1 Adoption of Type II equipment;

2 Adoption of electrical separate measures;

3 Adoption of extra-low voltage power supply;

4 Installation of electrical equipment in non-conductive site;

5 Arrangement of unearthing equipotential bonding.

5.2.2 In the locations of Type I equipment at the prospective touch voltage limit 50V, where faults of electric conductor and exposed conductive part or protective conductor occur in the loop or equipment, the indirect contact protection devices shall cut the power of the loop or equipment automatically before the prospective touch voltage exceeds 50V and the duration time is sufficient to have harmful pathological and physiological effect on human body.

5.2.3 The exposed conductive part of the electrical installation shall be connected with the protective conductor.

5.2.4 The main equipotential bonding in the building shall meet the following requirements:

1 The main equipotential bonding shall be made for the following conductive parts in every building:

1) Main protective conductor (protective conductor, protective earthing neutral conductor);

2) Main earthing conductor or main earthing terminal row of the electrical installation

3) Such various metal main pipes in the building as water pipes, gas pipes, the heating and air conditioner pipes;

4) Metal structure parts which can be connected and applied in the building.

2 Main equipotential bonding shall be made at the site where it is nearest to the lead-in point in the building for the conductive part from outside specified in Item 1 of Article 5.2.4.

3 The conductors of the main equipotential bonding shall meet the relevant requirements of Articles 3.2.15~3.2.17 in this code.

4 Where the equipotential bonding is made on the external metal protection of the communication cables, the permission shall be asked from relevant authorities.

5.2.5 Where the electrical devices of protection against indirect contact is not capable of meeting the requirements of automatic disconnection of supply after the earthing fault of the electrical installation or a certain part of the electrical equipment, another local equipotential bonding shall be made in a local scope on the conductive parts listed in Item 1 of Article 5.2.4 in this code; the supplementary equipotential bonding may also be made between the two conductive parts accessible simultaneously within the arm’s reach. The effectivity of local

equipotential bonding or supplementary equipotential bonding shall meet the requirements of the following formula:

$$R \leq \frac{50}{I_a} \tag{5.2.5}$$

Where

R - the resistance of a circuit section where contact voltage is caused by the voltage drop produced by fault current between the exposed conductive part and the conductive part outside the equipment accessible simultaneously, Ω

I_a - the action current of the fault loop ensured to be cut off by electrical devices of protection against indirect contact within the specified time, A.

5.2.6 Selectivity shall be provided between operating characteristics of superior and inferior electrical installation of protection against indirect contact on the distribution circuits.

(II) TN system

5.2.7 All the exposed conductive parts of electrical devices in TN system shall be connected with the earthing point of power system through protection conductor.

5.2.8 The action characteristics of electrical devices of protection against indirect contact of the distribution circuit in TN system shall meet the requirements of the following formula:

$$Z_s I_a \leq U_0 \tag{5.2.8}$$

Where

Z_s - impedance of earthing fault loop, Ω;

U_0 - nominal phase conductor voltage to the ground, V.

5.2.9 The time for the failure loop disconnection of electrical devices of protection against the indirect contact of distribution circuit in TN system shall meet the following requirements:

1 For the power circuit or the terminal circuit which only supplies power to stationary electrical installations, the time should not be greater than 5s.

2 For the terminal circuit or socket loop which supplies power to hand-held electrical installations and mobile electrical installations, the longest time for the disconnection in TN system shall not be greater than what is specified in Table 5.2.9.

Table 5.2.9 Longest Time for the Connection of Circuits in TN System

Nominal phase conductor voltage to ground (V)	Disconnection time (s)
220	0.4
380	0.2
>380	0.1

5.2.10 Where the distribution box or the distribution loop supplies power directly or indirectly simultaneously to the stationary, handheld and mobile electrical installations in TN system , one of the following measures shall be taken:

1 The impedance of a protective conductor section between the distribution box and the main equipotential bonding point shall meet the requirements of the following formula :

$$Z_L \leq \frac{50}{U_0} Z_s \tag{5.2.10}$$

Where

Z_L - the impedance of one protective conductor section between the distribution box and

the main equipotential bonding point, Ω

2 Local equipotential bonding shall be made between the protection conductor bus rows in the distribution box and the conductive part outside the equipment in the local scope or supplementary equipotential bonding shall be made according to relevant requirements in Article 5.2.5 in this code.

5.2.11 Where the earthing fault occurs between the phase conductor in the TN system and the without equipotential bonding, the earthing resistance ratio shall meet the requirements of the following formula to cause the earthing voltage between the protective conductor and the exposed conductive part connected to the former not to exceed 50V:

$$\frac{R_B}{R_E} \leq \frac{50}{U_0 - 50} \tag{5.2.11}$$

Where

R_B – all the earthing resistance in parallel connection with the earthing electrode of the system(Ω);

R_E - the earthing resistance between phase conductor and the ground (Ω).

5.2.12 Where the requirements of Formula (5.2.11) in this code are not met, other effective measures for protection against indirect contact shall be supplemented or the local TT system shall be adopted.

5.2.13 In TN system where the electrical devices of overcurrent protection shall be adopted for the distribution circuit also as electrical installation of protection against indirect contact, the action characteristics shall meet the requirements of Article 5.2.8 in the code; where the requirements are not met, RCD shall be adopted.

(III) TT system

5.2.14 In TT system, the exposed conductive part protected by the same electrical device of protection against indirect contact in the distribution circuit shall be connected with the common or respective earthing electrodes by protective conductor. For multileveled protection, all the levels shall be equipped with respective or common earthing electrode(s).

5.2.15 The action characteristics of electrical device of protection against indirect contact of the distribution circuits in TT system shall meet the requirements of the following formula:

$$R_A I_a \leq 50V \tag{5.2.15}$$

Where

R_A - the sum of earthing resistance of exposed conductive part and that of protective conductor, Ω.

5.2.16 In TT system, the action current of the fault loop disconnected by the protective electrical installation of protection against indirect contact shall be: the current which ensures the fuse to disconnect the fault loop within 5s where the fuse is adopted; the current which ensures the breaker to disconnect the fault loop instantaneously where the breaker is adopted; the rated residual action current, where the RCD is adopted.

5.2.17 In TT system where the action characteristics of electrical device of protection against indirect contact on the distribution circuits do not meet the requirements of Article 5.2.15 in this code, local equipotential bonding or supplementary equipotential bonding shall be made according to the requirements of Article 5.2.5 in this code.

5.2.18 In TT system RCD or electrical device of overcurrent protection shall be adopted as

the electrical device of protection against indirect contact in the distribution circuits.

(IV) IT system

5.2.19 In the distribution circuits of the IT system, where the first earth fault occurs, the alarm signal shall be given and the fault current shall meet the requirements of the following formula:

$$R_A I_d \leq 50V \tag{5.2.19}$$

Where

I_d - the first earthing fault current between phase conductor and exposed conductive part, the value shall be taken into account the effect of the leakage current and the total earthing impedance of electrical installation, A.

5.2.20 IT system shall be equipped with insulated monitor Where the first earth fault occurs or insulation resistance is lower than the specified setting value, the insulated monitor shall give sound and light signals and the light signal shall last until the fault is eliminated.

5.2.21 **As for** the exposed conductive part of IT system, the common earthing electrode, or the separate earthing electrode individually or in groups shall be connected to the ground and meet the following requirements:

1 Where the exposed conductive parts are connected to the ground jointly and the second earthfault occurs, the disconnection of the fault loop shall meet the requirements of automatic disconnection of power in TN system, specified in this code;

2 Where the exposed conductive parts are connected to the earth separately or in groups and the second earth fault occurs, the disconnection of fault loop shall meet the requirements of automatic disconnection of supply in TT system, specified in this code.

5.2.22 IT system should not include a neutral conductor.

5.2.23 In the distribution circuits of IT system, the longest disconnection time of the fault loop shall not be greater than what is specified in Table 5.2.23, where the second earth fault occurs.

Table 5.2.23 Longest Disconnection Time for the Second Fault of IT System

phase nominal voltage/Interphase nominal voltage (V)	Disconnection time(s)	
	Without neutral conductor	With neutral conductor
220/380	0.4	0.8
380/660	0.2	0.4
580/1000	0.1	0.2

5.2.24 Where the power circuits of IT system meet the requirement of Item 1 of Article 5.2.21 in this code, the electrical device of overcurrent protection or RCD shall disconnect the fault loop and meet the following requirements:

1 Where IT system does not include a neutral conductor, the action characteristics of protective electrical device shall meet the requirements of the following formula:

$$Z_c I_e \leq \frac{\sqrt{3}}{2} U_0 \tag{5.2.24-1}$$

2 Where IT system includes a neutral conductor, the action characteristics of protective electrical device shall meet the requirements of the following formula: