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SERIES K: PROTECTION AGAINST INTERFERENCE

Conformance assessment of radio base stations regarding lightning protection and earthing

Recommendation ITU-T K.119

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Summary

Recommendation ITU-T K.119 provides the technical requirements and measurement methods to assess the validity and reliability of the lightning protection and earthing system of radio base stations (RBSs). It focuses on the quality control in the process of construction, acceptance, inspection and maintenance.

Normally, the conformance assessment is carried out during and immediately after the construction period and it results in the commissioning of the installation to start its operation. Routine inspections are scheduled in order to assure the maintenance of the lightning protection and earthing characteristics, during the operation life of the installation.

Depending on the function and installation location, the lightning protection system of an RBS can be partitioned into 4 parts which consist of an air-termination and down conductor system, earthing system, equipotential bonding network and surge protective devices (SPDs). The conformance assessment is directed to these parts, and may consist in visual inspection, measurement, analysis and other applicable methods.

The assessment requirements of each part for commissioning and routine inspections are presented in clauses 8 to 11 separately. In addition, management rules are introduced in clause 12, which are effective for conformance maintenance during the operation life of the RBS.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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Keywords

Assessment, conformance, earthing, lightning protection, radio base station.

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Table of Contents

Recommendation ITU-T K.119

Conformance assessment of radio base stations regarding lightning protection and earthing

1 Scope

This Recommendation provides the technical requirements and measurement methods to assess the validity and reliability of the lightning protection and earthing system of radio base stations (RBS). It focuses on the quality control of the processes of construction, acceptance, inspection and maintenance.

The detailed requirements for the lightning protection of RBSs are provided by [ITU-T K.56], [ITU-T K.112] and their references.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T K.56] Recommendation ITU-T K.56 (2010), *Protection of radio base stations against lightning discharges.*

[ITU-T K.111] Recommendation ITU-T K.111 (2015), *Protection of surrounding structures of telecommunication towers against lightning*.

[ITU-T K.112] Recommendation ITU-T K.112 (2015), *Lightning protection, earthing and bonding: practical procedures for radio base stations.*

[IEC 61643-11] IEC 61643-11 (2010), *Low-voltage surge protective devices – Part 11: Surge protective devices connected to low-voltage power systems – Requirements and test methods.*

[IEC 61643-21] IEC 61643-21 (2012), *Low voltage surge protective devices – Part 21: Surge protective devices connected to telecommunications and signalling networks – Performance requirements and testing methods.*

[IEC 62305-3] IEC 62305-3 (2010), *Protection against lightning – Part 3: Physical damage to structures and life hazard.*

3 Definitions

3.1 Terms defined elsewhere

The definitions contained in the references apply to this Recommendation. Some of them are reproduced here for convenience.

3.1.1 earth conductor [b-ITU-T Handbook]: A conductor or group of conductors connecting the earth electrode to the earth collector. In the case of partly buried connections, this definition is valid only for the sections which are electrically insulated from the ground, the sections in contact with the ground forming part of the earth electrode.

3.1.2 earthing network [ITU-T K.112]: The part of an earthing installation that is restricted to the earth electrodes and their interconnections.

3.1.3 one-port SPD [b-IEC 61643-11]: SPD having no intended series impedance.

NOTE – A one port SPD may have separate input and output connections.

3.1.4 two-port SPD [b-IEC 61643-11]: SPD having a specific series impedance connected between separate input and output connections.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 commissioning: Acceptance of the whole installation that is carried out when all the work has been finished and the installation complies with the design criteria.

3.2.2 final inspection: Inspection that is carried out when all the work has been finished.

3.2.3 follow-up inspection: Inspection performed during the construction work in order to verify the compliance of the installation with the design criteria.

NOTE – Follow-up inspection is normally required for parts of the installation that are not accessible afterwards (e.g., earthing network).

3.2.4 routine inspection: Inspection that is carried out at regular intervals during the operational life of the installation.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AC Alternating Current

DC Direct Current

LPL Lightning Protection Level

MET Main Earthing Terminal

MOV Metal Oxide Varistor

RBS Radio Base Station

SPD Surge Protective Device

5 Conventions

None.

6 General

In order to ensure the validity and reliability of the lightning protection and earthing system, its assessment and maintenance should be carried out throughout the entire lifetime of the radio base station. According to the different requirements during the construction period and the operation period, the assessment can be divided into two categories: commissioning and routine inspections.

Effective management procedures also have to be implemented for conformance assessment, such as documentation management and a periodic inspection schedule. Moreover, the conformance assessment shall be implemented by skilled professionals and the measuring equipment (e.g., earthing resistance meter) shall have a valid calibration.

6.1 Commissioning

During the construction period, a systemic assessment should be performed to ensure that the lightning protection and earthing system satisfies the requirements of design, which is regarded as the acceptance of the project. The follow-up inspection shall be applied to the concealed works (e.g., embedded electrodes). After the installation, a final inspection shall be exerted for all the components.

The primary aspects needed to be considered for commissioning an RBS include:

– the installation shall conform to the project requirements;

– the applied materials and devices are in good condition and capable of performing their designed functions;

– the construction technology and quality of the supplies are adequate for environmental suitability and service life.

The RBS shall be commissioned to start its operation only if both the results of the follow-up and final inspections comply with the requirements.

6.2 Routine inspection

During the operating period, regular and periodic inspections are fundamental for the reliable maintenance of all the components in the lightning protection and earthing system, which is regarded as routine inspection. The interval between consecutive routine inspections needs to consider the nature of RBS and environmental factors. An unordered inspection may need to be performed at some emergency conditions. The property owner shall be informed of all observed faults and they shall be repaired without delay.

The primary aspects that need to be considered in routine inspections include:

– all components of the lightning protection and earthing system are in good condition and capable of performing their designed functions, and that there is no corrosion;

– any recently installed equipment or constructions are incorporated into the lightning protection and earthing system;

– any remaining effect caused by lightning flashes or natural calamities (e.g., flood, earthquake) or nearby constructions shall be assessed and removed.

Any problem detected during the routine inspections must be corrected in order to make sure that the installation complies with the requirements of the inspection.

Figure 1 shows a flowchart of the conformance assessment process according to this Recommendation.

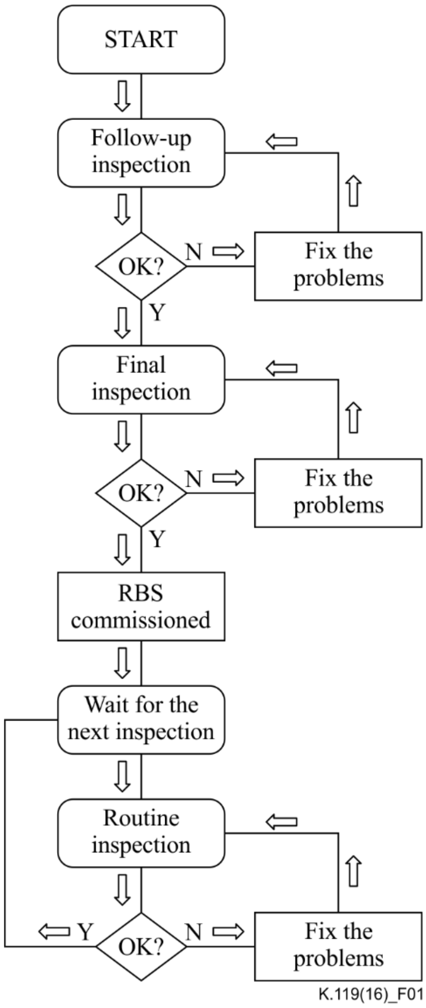


Figure 1 – Flowchart of the conformance assessment process

7 Constitution of the lightning protection and earthing system of RBSs

Depending on the function and installation location, the lightning protection and earthing system of an RBS can be partitioned as follows:

– air-termination and down conductor system;

– earthing system;

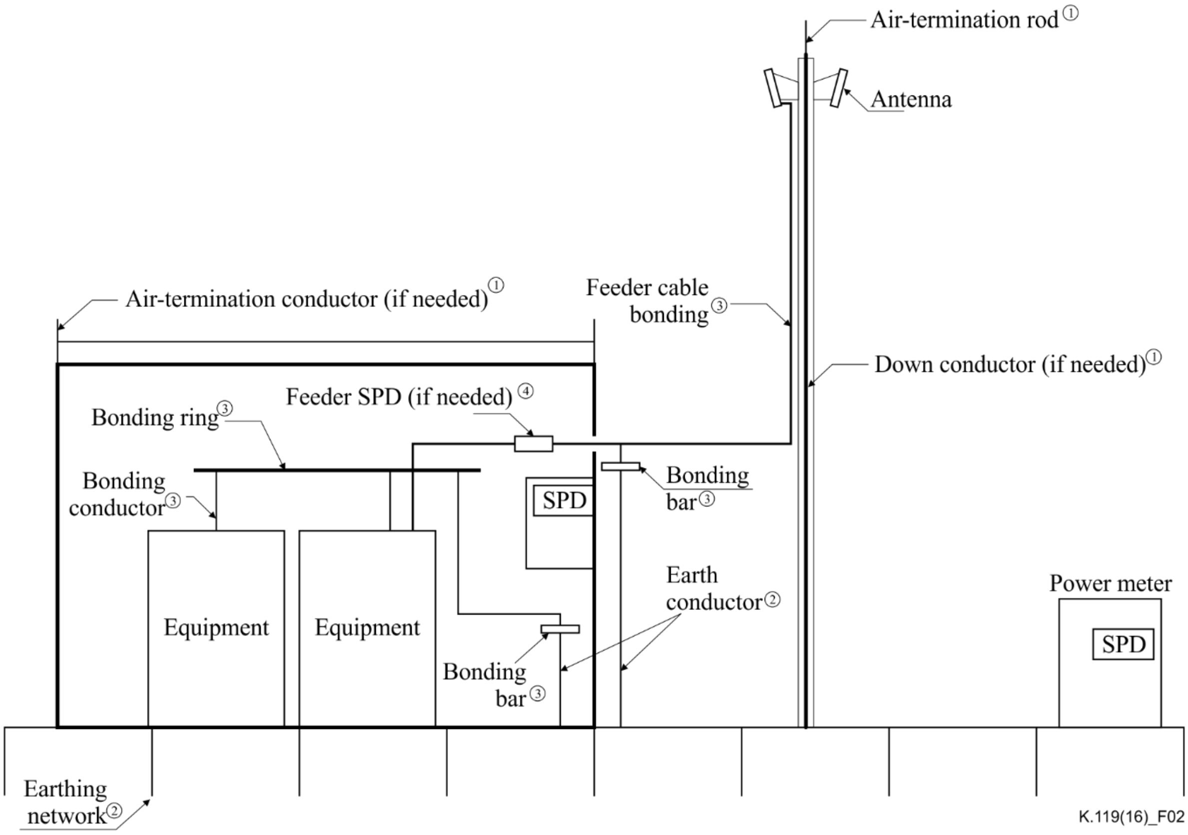
– equipotential bonding network;

– surge protective devices (SPDs).

Figure 2 shows the parts of an RBS where it can be seen that each part has its main function and need to coordinate with the other parts. The malfunction or degradation of any part can affect the overall performance and even lead to a hazardous result. The common important components belonging to each part are listed in Table 1.

NOTE – The lightning protection and earthing system of roof-top RBSs can also be partitioned into the above 4 parts, although the layout of an external system may have some differences.

Correspondingly, the assessment of conformance can be partitioned into the itemized evaluation for each part through visual inspection, measurement, analysis and other applicable methods.



① air-termination and down conductor system ② earthing system
③ equipotential bonding network ④ SPDs

Figure 2 – Typical layout of RBS consisting of all the important constituent parts

Table 1 – The constituent parts and the corresponding components

Parts	Components
Air-termination and Down conductor system	Air-termination rod or mesh Down conductors
Earthing system	Earthing network Earth conductor
Equipotential bonding network	Internal equipotential bonding (e.g., bonding conductor for equipment and devices) External equipotential bonding (e.g., bonding of the tower and feeder cable outside the equipment room)
Surge protective devices (SPDs)	Electric power SPDs Signal and communication SPDs

8 Air-termination and down conductor system

The air-termination and down conductor system is intended to intercept direct lightning flashes to the antennae or structure and conduct the lightning current from the point of strike to earth.

8.1 Requirements for commissioning

The following items shall be verified for commissioning:

– The height, position, size and materials of an air-termination and down conductor system should conform to the design and the corresponding requirements regulated in [ITU-T K.112].

– Inspect and ensure that the antennae, the structure and other outdoor installations are protected by an air-termination rod (mesh). If needed, after the installation of antennae, a height indicator is used to determine the actual height of the air-termination rod and antennae to estimate the validity of protection for direct strikes. The estimation method shall refer to [ITU-T K.112].

– The down conductors should be away from sewage tubes and drains when they are installed below the earth surface. The down-conductor section that is above the earth surface shall be protected against mechanical damage.

– Inspect the reliability of welding and anticorrosion for all welding points or connecting points. For the welding of flat steel conductors, the minimum overlap length should be not less than twice the width of the flat steel conductor. For the welding of round steel conductors, the minimum overlap length should be not less than 10 times the diameter of the round steel conductor. The anticorrosion protection of the connecting points or welding points can achieved be wrapping these connections with waterproof tape or coating them with anticorrosion paint, silica gel or asphalt. If they are buried in concrete, the follow-up acceptance should apply and the anticorrosion can be ignored. If a down conductor is partially inserted into the earth, anticorrosion and anti-rust measures must be taken for the part 50 cm above the earth surface and the part 50 cm below the earth surface.

– If the down conductors of the building can be shared for a roof-top RBS, the validity of down conductors should conform in accordance with [ITU-T K.112] through consulting the design documentation of the building.

8.2 Requirements for routine inspections

The routine inspections are recommended to be performed before lightning season. The following items shall be verified:

– The connection conditions of the air-termination and down conductor system should be inspected periodically, especially for the points of welding or bonding. If there is evidence of breaks, looseness, mechanical damage or corrosion, corrective measures should be implemented as soon as possible. When the corroded part is greater than one third of the cross-section area of the down conductor, the down conductor shall be replaced.

– If the down conductors are concealed, the measurement of the bonding resistance shall be performed and the measured value shall be below 0.2 Ω. More detailed information about the measurement method is provided in [IEC 62305-3; Annex E].

– Any extraneous installation (e.g., TV antenna, metal lines) must not be hanged or connected to the tower, which should be inspected by maintainers frequently.

9 Earthing system

The earthing system is intended to disperse the lightning current into the earth and provides a basic equipotential platform for the interconnected structures and installations in an RBS.

9.1 Requirements for commissioning

9.1.1 General

When a building and an earthing network is to be constructed for an RBS, the follow-up inspection shall be carried out in order to assure that the earthing network and its connections comply with the project requirements. This is important as because of the configuration of the earthing electrodes these are no more accessible once they are buried in the soil.

When the RBS is installed in a rented building, the validity of building foundation should conform to [ITU-T K.112] through consulting the documentation of the building. Moreover, prior to connecting earth conductors to the building steelwork, the overall electrical continuity of the steelwork shall be verified. The measured resistance between parts of the steelwork used as a part of the earthing system shall be below 0.2 Ω.

When earthing resistances need to be measured, the measuring method should refer to Annex A of [ITU-T K.112].

9.1.2 Requirements for follow-up inspections

The actual implementation of an earthing system shall be plotted as one of the acceptance files which can give an important reference for the subsequent maintenance. After the construction phase, it is nearly impossible to determine the layout and construction of the earthing system. Therefore, the layout should be well documented. This can be done utilizing drawings, descriptions and photographs taken during construction.

The following items should be considered during the period of construction:

– The shape, dimensions and materials of the earthing network should conform to the requirements of design and the corresponding requirements regulated in [ITU-T K.112].

– Inspect the depth of electrodes. The embedded depth and the type of earth electrodes shall be such as to minimize the effects of corrosion, soil drying and freezing and thereby stabilize the conventional earth resistance. The depth of the conductor shall be at least 0.5 m. On bare solid rock or thin soil district, the depth requirement can be relaxed but the electrodes are not permitted to be exposed on the surface of the ground due to rain erosion. On freezing regions, it is recommended that the upper part of a vertical earth electrode within the freezing soil should not be regarded as effective under frost conditions.

– Inspect the separation from other installations. The embedded electrodes shall have a safe separation with other buried installations, such as buried telecommunication cables, power cables, pipes, etc. Table 2 gives the recommended safe distances from common installations. The distance of the buried electrode from the associated structure shall be approximately 1.0 m.

– Inspect the reliability of welding and anticorrosion. For the welding of flat steel conductors, the minimum overlap length should be not less than twice the width of the flat steel. For the welding of round steel conductors, the minimum overlap length should be not less than 10 times the diameter of the round steel. The anticorrosion protection of the connecting points or welding points can be achieved by wrapping these connections with waterproof tape or coating them with anticorrosion paint, silica gel or asphalt.

– Inspect the backfill of ditches. The soil is permitted to backfill only if the electrodes have been accepted by an inspector. The bigger rocks need be screened out from the backfilled soil. The soil shall be tamped down to avoid the sedimentation of the surface. On the district with a large slope or severe soil loss, it is required to cover concrete or grass on the surface of the earthing network to avoid the exposure of electrodes due to rain erosion.

Table 2 – Recommended safe distances from buried installations for earthing electrodes (cm)

Type of installation	Crossover	Horizontal
Low-voltage cable, fibre cable, telecommunication cable serving the RBS (Note)	20	20
High-voltage cable serving the RBS (Note)	50	100
Other metallic installations	Refer to [ITU-T K.111]	
NOTE – All the installations serving the RBS shall be connected to the earthing network though hard wires or SPDs at the entrance; if the installations are placed in pipes, the distance can be disregarded.		

9.1.3 Requirements for the final inspection

– The resistance of the earthing network shall be measured after the installation. The measured value shall satisfy the designed requirement or the regulated value in national regulations, if any.

– The earth conductors shall be installed in a manner that they provide the shortest and most direct path to earth. They shall not be installed in gutters or water spouts, even if they are covered by insulating material.

– The welding and bonding point of earth conductors shall be inspected to ensure the reliability of welding and anticorrosion.

– The section that is above the earth surface shall be protected against mechanical damage.

9.2 Requirements for routine inspections

The earthing system should be inspected and measured periodically. The normal methods are visual inspection and resistance measurement which are described in the following clauses. The inspection is recommended to be performed before lightning season. In normal conditions, the routine inspection should be implemented according to Table 3. The frequency of routine inspections may increase, depending on the following factors:

– the earthing electrodes are made of two or more types of materials;

– the surrounding soil includes chemical components, such as acid, alkali, salt, etc.;

– there are highly corrosive installations, such as strengthening a sewage tank, drainage ditch, industrial plant;

– resistance reducing backfill is used in the earthing system.

9.2.1 Visual inspection

The visual inspection shall include:

– Check whether the surface soil is lost due to rain erosion. When there is the collapse, crack or down punching of soil in the ditches or hollow under the concrete surface, the corresponding preventive and remedial measures should be taken in time.

– Check whether the earth conductors are firm and complete. When there are cases related to broken, looseness, mechanical damage and corrosion, the remedy measures should be implemented as soon as possible. When the corrosion part is beyond one third of the cross-section area, the conductor should be replaced in time.

– When the life of electrodes made of galvanized steel is beyond 15 years, it is recommended to dig out some typical points as samples to estimate the corrosion and reliability condition. The selected points are distributed in different directions and the number shall be not less than 4. According to the inspection results, the efficiency of an earthing network can be estimated. When the corrosion part is beyond one third of the cross-section area of the electrode, the affected earthing electrodes shall be replaced.

9.2.2 Measurement and estimation

– The resistance of the earthing network shall be measured annually. The measured value shall satisfy the designed requirement or the regulated value in national regulations, if any. The test should not be performed on rainy days. The information including apparatus, test layout and weather shall be recorded for subsequent estimations.

– When the measured resistance values show larger changes than anticipated in the design, especially when the resistance increases steadily between inspections, additional investigations should be made to determine the reason for the changes.

– If the reason for unexpected changes in the earthing resistance cannot be found, it is recommended to dig out some typical points as samples, in order to estimate the corrosion and reliability condition. If there is evidence of breaks, looseness, mechanical damage or corrosion, the remedy measures should be implemented as soon as possible.

NOTE – The judgement of "large changes" shall consider the circumstance and weather factors (e.g., rainy or dry season), which may influence the measured value.

9.2.3 Assessment for outside threat

When there are the constructions of underground pipelines or foundations in the vicinity of electrodes, the owner of the earthing network needs to determine whether these constructions affect the mechanical reliability and anticorrosion properties. If this risk exists, the appropriate precautions shall be taken through negotiation with the parts involved.

When a natural calamity (e.g., flood, earthquake) occurs nearby, the reassessment should be implemented according to clauses 9.2.1 and 9.2.2.

10 Equipotential bonding network

The equipotential bonding network is intended to provide an optimized equipotential platform for the different metal parts on the basis of the earthing network.

According to its position in the installation, it can be divided into internal and external equipotential bonding networks. The former includes the bonding bar (ring) and bonding conductor for equipment and devices in the machine room. The latter includes the bonding for the tower and feeder cable outside the equipment room.

10.1 Requirements for commissioning

10.1.1 Internal equipotential bonding network

For the first assessment, the following requirements for the internal equipotential bonding network should be considered:

– The configuration, dimensions and materials of internal equipotential bonding network should conform to the requirements of design and related recommendations.

– The cross-section of bonding conductors shall be determined according to the mechanical strength of materials and the maximum expected fault current, if any. Generally, the minimum size for bonding conductors should be 16 mm^2 for mechanical robustness. Smaller size conductors may be used where the conductors are protected against mechanical damage and a coarser size is normally not needed for current-carrying capacity.

– Bonding conductors shall be connected to a bonding bar (ring) constructed and installed in such a way that it allows easy access for inspection. For the parts that are not visible for inspection, the measurement of electrical continuity should be performed.

– Both ends of the bonding conductor should be labelled to indicate the connected equipment or bonding bar. For labelling, use stencilled labels or other permanent labelling methods. The laying of bonding conductors shall be firmly bandaged, neat and straight.

– The size of the wiring terminals shall match with the diameter of bonding conductors. The place where wiring terminals and equipment contact with bonding bars shall be smooth and fastened, without rusting or oxidation. The copper wiring terminals must be mounted and pressed (welded) tightly. When bonding bars are interconnected with bonding conductors via different metal materials, electrochemical corrosion shall be prevented.

– Bare surfaces should be coated with an appropriate antioxidant compound before crimp connections are made. All unplated connectors, braided straps and bus bars should be brought to a bright finish and then coated with an antioxidant before they are connected. Tinned, solder-plated or silver-plated connectors and other plated connection surfaces do not have to be prepared in this manner, but they should be clean and free of contaminants.

– All raceway fittings should be tightened to provide a permanent low-impedance path.

– The same bolt assemblies should not secure multiple connectors.

– Non-conductive coatings (such as paint, lacquer and enamel) on equipment to be bonded or grounded should be removed from threads and other contact surfaces to assure electrical continuity.

– The fibre splice tray should be connected to the main earthing terminal (MET) directly. If an optical fibre has metal strength members, the metal strength members must be bonded to the fibre splice tray. The fibre splice tray should be insulated from other metallic parts in the equipment room.

– The metallic shield of shielded cables shall be connected to equipment metallic frames at both ends. The external conductor of feeder cables shall be connected to the equipment frames.

– The metallic ducts or trays that carry the cabling shall be connected to the equipment metallic frame (or structure) at both ends, as shown in Figure 3.

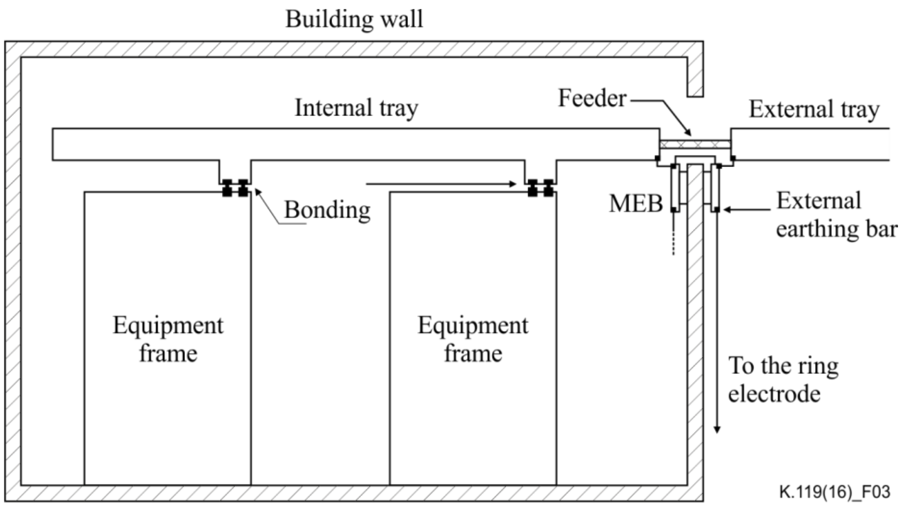


Figure 3 – Lateral view of the RBS showing the bonding between the internal tray and equipment frame

– The metallic ducts and trays shall be electrically continuous for their entire length. The continuity at joints shall be achieved at least in two symmetrically spaced points (e.g., by the use of two bonding clamps on the sides of the tray), as shown in Figure 4.

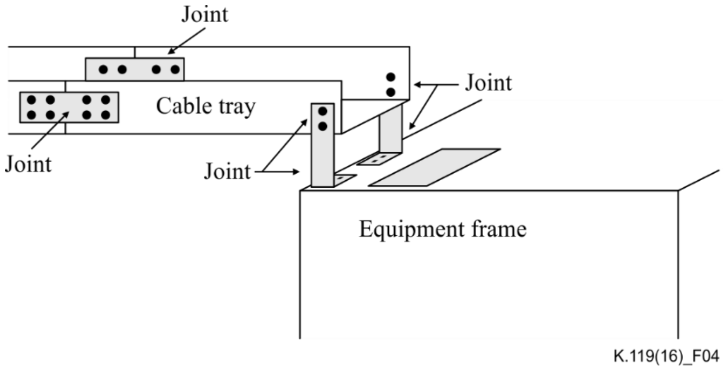


Figure 4 – Details of the electrical continuity in trays and equipment frame

– Two-hole compression-type connectors are preferred for making connections to flat surfaces (such as bus bars, frames, racks or cabinets). The reason for this is to prevent the loosening of connections. Torque and bolt assembly requirements for securing the connector should be as specified by the connector supplier. Nuts, bolts, washers and lock washers should be of high quality bronze or stainless steel alloy or equivalent.

– Connection devices or fittings that depend solely on solder should be avoided. A soldering lug, a screwless (push-in) connector or a quick-connect or other friction-fit connector shall not be used to terminate a bonding or earthing conductor.

10.1.2 External equipotential bonding network

The following requirements for external equipotential bonding networks should be considered for commissioning:

– The facilities and equipment within a metallic shell installed on the tower shall be bonded to the tower directly. If the conductor terminal cannot be connected to the tower directly, it shall be bonded to a bonding bar first and the bonding bar shall be bonded to the tower.

– The feeder cable should be bonded at the top of the tower and at the bonding bar near the feeder window. The connection at the point where they leave the tower (bending point) depends on the length of the horizontal section of the feeder tray, according to [ITU-T K.56].

– The feeder tray shall be continuous and bonded to the tower and to the earthing bar located near the feed-through window of the building.

– All the connections must be mounted and pressed (welded) tightly and the electrochemical corrosion shall be prevented.

– If the conductors supplying power to the tower lights (lighting cable) are installed inside a metallic duct or if they are shielded, the metallic duct or the shield shall be bonded to the bonding bar located near the feed-through window. In both cases, the bonding shall be made by means of a conductor as short as possible.

10.2 Requirements for routine inspections

Visual inspection shall be carried out to verify that:

– there are no loose connections or any accidental breaks in conductors and joints;

– no part of the system has been weakened due to corrosion;

– bonding conductors and cable shields are intact and interconnected;

– appropriate line routings are maintained.

If there are cases related to breaks, looseness, mechanical damage or corrosion, the remedy measures should be implemented as soon as possible.

When there are additions or alterations, it shall be checked that the scheme of the bonding configuration is modified by these additions or alterations. More detailed information about the requirements for bonding configurations are provided by [ITU-T K.112].

11 Requirements for surge protective devices (SPDs)

The SPDs are intended to provide an equipotential bonding between the live parts of incoming wires and local earth, in order to ensure that the residual overvoltages are less than the inherent resistibility of the equipment.

11.1 Requirements for commissioning

The following items should be verified for commissioning:

– The capacity, installation position and other parameters of the coordinated SPDs should conform to the requirements of design. The requirements of power and signal SPDs should refer to [IEC 61643-11] and [IEC 61643-21] respectively.

– Inspect the alarm unit or status indicator of SPDs and ensure the validity of the operating state. If the SPDs have no indicators, the protected equipment and circuits shall be inspected for any evidence of equipment malfunction. Special attention should be paid to the effect of SPDs on the transmission performance due to its installation in series with signal or telecommunication circuits.

– The lead and bonding conductor of SPDs shall be made as direct and straight as possible. For power SPDs, the length of lead conductors shall be less than 0.5 m and the length of bonding conductors shall be less than 1.5 m. For Class I and Class II power SPDs, the minimum cross-sectional area of the lead and bonding conductor is 16 mm^2.

– The coaxial SPDs for a feeder cable and other signal SPDs, if they are needed according to [ITU-T K.56], shall be installed near the protected equipment. Their bonding conductors shall be directly connected to the bonding bar of the equipment.

NOTE – In some countries, the bonding conductors of coaxial SPDs are required to be connected to the outdoor bonding bar.

– The lead and bonding conductors shall be connected and fastened via wiring terminals or copper pigtails. When copper pigtails are connected with cable cores, they shall be secured by hydraulic clamps or treated by dip soldering. These conductors shall be laid in order and fixed at racks. The routing shall be short and straight, without loops.

11.2 Requirements for routine inspections

The periodic assessment for SPDs should be implemented at least once per year. For the RBSs with a high risk of lightning strikes, it is recommended that the visual inspection of the coordinated SPDs is integrated into the scope of the routine inspection and maintenance for the equipment.
The following items shall be verified:

– Inspect the alarm unit or status indicator of SPDs. When a failure is displayed, the SPD should be replaced without delay. If an SPD does not have a visual indicator, measurements shall be performed in accordance with the manufacturer's instructions to confirm its operating status, when so required.

– Inspect the operation state of the external disconnectors of SPDs if they exist. When the disconnector is found operated or broken, it should be switched on or replaced immediately. If the disconnector cannot be switched on, the problem shall be fixed or the SPD / disconnector shall be replaced.

– Inspect the connection reliability of the lead and bonding conductors of SPDs. If the conductors are found loose or twisted, the problem shall be fixed.

– It is recommended to implement a periodical test on the DC parameters of SPDs for the voltage-limited SPDs using metal oxide varistors (MOV). The inconformity of test results means that the performance of the SPDs has been compromised and that the SPD should be replaced in time. Appendix I gives the test method and the evaluation criteria.

– When the system is expanded or the equipment is changed, it should be ensured that these alterations would not affect the coordination performance of SPDs.

– For the two-port SPD or one port-SPD with separate input / output terminals, it should be ensured that the current consumption of the downstream equipment does not exceed the rated current capacity of the SPD.

12 Management of the conformance assessment

12.1 File management

When the lightning protection and earthing system of an RBS is put into service, the relevant documentation shall be constructed at the same time. The complete documents about the lightning protection and earthing system shall include:

– design files and acceptance reports

– previous inspection reports

– previous maintenance records

– damage records of equipment, if they exist.

12.2 Interval of routine inspections

The interval between successive routine inspections needs to consider the protection level of the RBS, the nature of its parts and the environmental factors. Where no specific requirements are identified by the authority having jurisdiction, the values of Table 3 are recommended.

Table 3 – Recommended interval of routine inspections (years)

<table>
<tr><th rowspan="2">Component / LPL (Note 1)</th><th rowspan="2">Air-termination and down conductor system (Note 2)</th><th rowspan="2">Earthing system (Note 3)</th><th colspan="2">Equipotential bonding system</th><th rowspan="2">SPDs</th></tr>
<tr><th>Internal</th><th>External (Note 2)</th></tr>
<tr><td>I and II</td><td>2</td><td>2</td><td>2</td><td>2</td><td>1</td></tr>
<tr><td>III and IV</td><td>4</td><td>4</td><td>4</td><td>4</td><td>1</td></tr>
<tr><td colspan="6">NOTE 1 – Normally, the LPL for an RBS is determined during the design period and the relative information can refer to [ITU-T K.56].
NOTE 2 – Considering the difficulty in inspecting high towers, the inspection of external equipotential bonding networks can be integrated into the scope of the routine maintenance for antennae and feeder cables.
NOTE 3 – When there are the special factors described in clause 9.2, the frequency may be increased.</td></tr>
</table>

In addition, an extraordinary inspection needs to be performed under the following conditions:

– when a significant alteration or repair is made to the components of lightning protection and earthing system;

– when an altered equipment or system may affect the whole performance of the lightning protection and earthing system;

– when the natural calamities (e.g., flood, earthquake) or nearby constructions may affect the whole performance of the lightning protection and earthing system;

– when damage due to lightning strikes occurs.

Appendix I

Test of the DC parameters of MOV SPDs

(This appendix does not form an integral part of this Recommendation.)

This test is only suited for voltage-limiting SPDs using metal oxide varistors (MOV) without filtration or current limiting elements. When the voltage-limited SPDs are installed in the low-voltage power distribution system, there is a leakage current in the order of microamperes flowing through SPDs. If the value of the current is relatively high, it means that the SPD performance has degraded and that the SPD should be replaced in time. The comparison of varistor voltages (at 1 mA) can be a supplementary method used for this evaluation.

I.1 Test apparatus

The selected test apparatus could be a lightning protection element tester or other similar apparatus with corresponding functions. Figure I.1 gives a typical example of a lightning protection element tester.

NOTE – Some manufacturers of SPDs provided a dedicated test apparatus for this test.

Figure I.1 – A typical example of apparatus for the test of the DC parameters of MOV SPDs

I.2 Test method

If the SPDs are pluggable, these SPDs can be plugged out for test. If not, disconnect the lead conductors and test each line in order, as showed in Figure I.2.

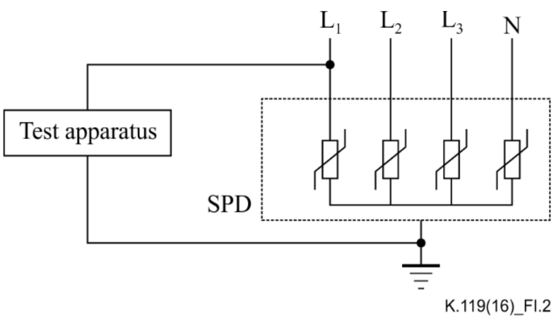


Figure I.2 – Layout for SPD testing

The measured values shall be recorded, in order to assess its evolution in time (from one inspection to the next one) and the performance of the SPDs. Table I.1 gives an example of the form for this measurement.

Table I.1 – Example of form for SPD data

Date	Measured varistor voltage (V)	Measured leakage current (mA)

I.3 Evaluation criteria

For the evaluation criteria described in this clause, varistor voltage U_V is the voltage across the varistor when it conducts a current equal to 1 mA. This value is usually provided by the manufacturer.

The SPD is considered as degraded when at least one of the following conditions is met:

– leakage current.

The leakage current value measured at 75% U_V drifts upward progressively:

– varistor voltages.

The measured varistor voltage (U_V) is not within the permitted range specified by the manufacturer or the measured value drifts downward progressively. If specific information is not provided, the deviation of the measured value should be less than 10% comparing with the initial test value and the corresponding rated varistor voltage. Table I.2 gives typical values of the rated varistor voltages and the corresponding maximum continued operation voltage for usual voltage-limiting SPDs.

Table I.2 – Typical values of varistor voltage and the corresponding maximum continue operation voltage for usual voltage-limiting SPDs (values in Volts)

Rated varistor voltage (U_V)	Maximum AC continue operation voltage (U_C)	Maximum DC continue operation voltage (U_{DC})
82	50	65
100	60	85
120	75	100
150	95	125
200	130	170
220	140	180
240	150	200
270	175	225
360	230	300
390	250	320
430	275	350
470	300	385
500	320	410

Table I.2 – Typical values of varistor voltage and the corresponding maximum continue operation voltage for usual voltage-limiting SPDs (values in Volts)

Rated varistor voltage (U_V)	Maximum AC continue operation voltage (U_C)	Maximum DC continue operation voltage (U_{DC})
620	385	505
680	420	560
750	460	615
780	485	640
820	510	670
910	550	745

Bibliography

[b-ITU-Handbook] ITU-T Handbook (2003), *Handbook on earthing and bonding.*

[b-IEC 61643-11] IEC 61643-11:2008, *Low-voltage surge protective devices. Part 11: Surge protective devices connected to low-voltage power distribution systems – Performance requirements and testing methods.*

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