General instructions on lightning protection for shelters

White Paper

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About 1.5 million lightning incidents are registered in Germany each year. Lightning is fascinating to watch, but also extremely dangerous. Annually, thunderstorms kill people and animals and destroy material assets. Especially people exposed in the open such as golfers and hikers are at risk. Severe lightning injuries and fatalities are reported each year from all over the world, especially on golf courses. For this reason, shelters are vital to protect golfers from lightning interference. In the following, general instructions on lightning protection measures for shelters will be provided.

Shelters, for example on golf courses, must not only protect golfers from storm and rain, but also from lightning interference. For this reason, there is no question that shelters must be equipped with a lightning protection system. Golf course operators have a high duty of care towards their members / golfers. The liability of, for example golf course operators, is based on their duty to implement safety precautions. *"Golf course operators have a duty towards each golf course user to avoid all impending or existing hazards unless this is impossible or unreasonable for the golf course operator. This duty includes both organisational and structural measures. The number, equipment, size and position of lightning-proof shelters heavily depend on the size, location and design of the relevant golf course. Lightning-proof shelters must comply with the latest applicable technical requirements. Limitation of liability due to a lack or insufficient number of lightning-proof-shelters or their insufficient equipment, for example in the form of a relevant notice or a written agreement on limitation of liability, shall be excluded."* (translation of page 7 of the 6/2010 edition of the German "Golfmanager" magazine, author: Daniel Witaschek)

Shelters

Shelters should not be installed at exposed locations (on hills, at the edge of a forest, underneath isolated trees) and near hedges and branches within a radius of about 3 m.

Shelters are only lightning-proof if

- They are equipped with an adequate lightning protection system including potential control
- Conductive systems (e.g. electrical cables) are integrated in the equipotential bonding system and
- Suitable measures are taken to prevent touch voltages

Lightning protection

Frequently, a lightning protection system is simply called a lightning rod. As shown in **Figure 1**, the lightning protection system of a shelter consists of a rooftop air-termination system (air-termination conductor and / or rod), wall-mounted down conductor (down conductor wire) and earth-termination system (commonly an earth rod). The function of a lightning

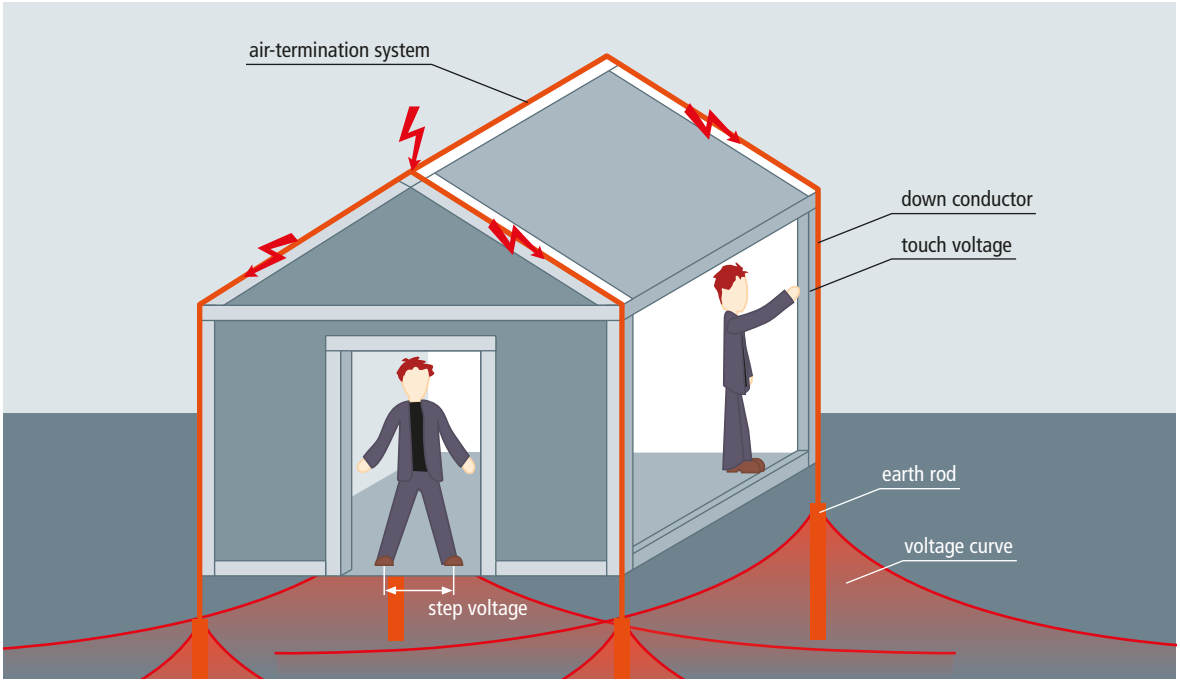

Figure 1 Risk due to touch and step voltage

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rod is to intercept lightning and to safely conduct it to the ground to prevent dangerous sparking, thus protecting the structure from fire and mechanical destruction. The formation of a high lightning voltage in the ground, also referred to as potential gradient area, endangers persons in the shelter. This life-threatening voltage may flow into the feet of a person standing on the ground. It is therefore also referred to as step voltage. Moreover, persons must maintain an adequate safety distance from the lightning rod to prevent dangerous touch voltages (**Figure 1**).

Effective lightning protection measures that protect golfers, hikers, etc. from lightning interference can be taken for shelters with a relatively low effort. In addition to technical measures, it is equally important that golfers know what to do during a thunderstorm. In an upcoming thunderstorm, they should seek shelter immediately and stay there until the thunderstorm has disappeared.

The following considerations are based on commonly used wood shelters.

Prevention of touch voltages

To prevent dangerous high touch voltages, an adequate safety distance must be maintained between the lightning rod and the persons in the shelter. In a shelter of about 3 m x 3 m with an eaves height of 3 m and the lightning rod shown in **Figure 2**, 10 cm wooden beams are required.

If the shelter has a minimum height of about 3 m, the safety distance from the rooftop lightning rod (air-termination conductor or rod) is maintained. However, it is more difficult to keep an adequate distance from the outer walls. Therefore, the wall / wall construction where the lightning rod (down conductor wire) is led to the ground must have an adequate wall thickness (**Figure 2**). To connect the lightning rod to the ground, earth rods (metal rods of a defined length, material suitable for the local conditions) are commonly used. On each down conductor, the earth rods are vertically buried in the ground at a depth of about 6 m to 9 m depending on the type of ground (**Figures 2 to 5**).

Log-structured shelters usually have the above mentioned wall thickness. However, the situation is quite different when it comes to shelters with thin wood walls. In this case, the down conductors must be installed directly at the outer edges near the wall construction to ensure the maximum wall thickness (**Figure 2**). As an alternative, an isolated lightning protection system* can be used.

(* Extensive expert knowledge is required. For this reason, please contact a certified lightning protection specialist (for example, in Germany VDE-certified (Verband der Elektrotechnik Elektronik Informationstechnik) or VDB-certified (Verband Deutscher Blitzschutzfirmen e.V.) lightning protection experts).

Another possibility to maintain the safety distance required to protect shelters in case of a lightning strike is to use highly insulating lightning rods, for example CUI Conductors from

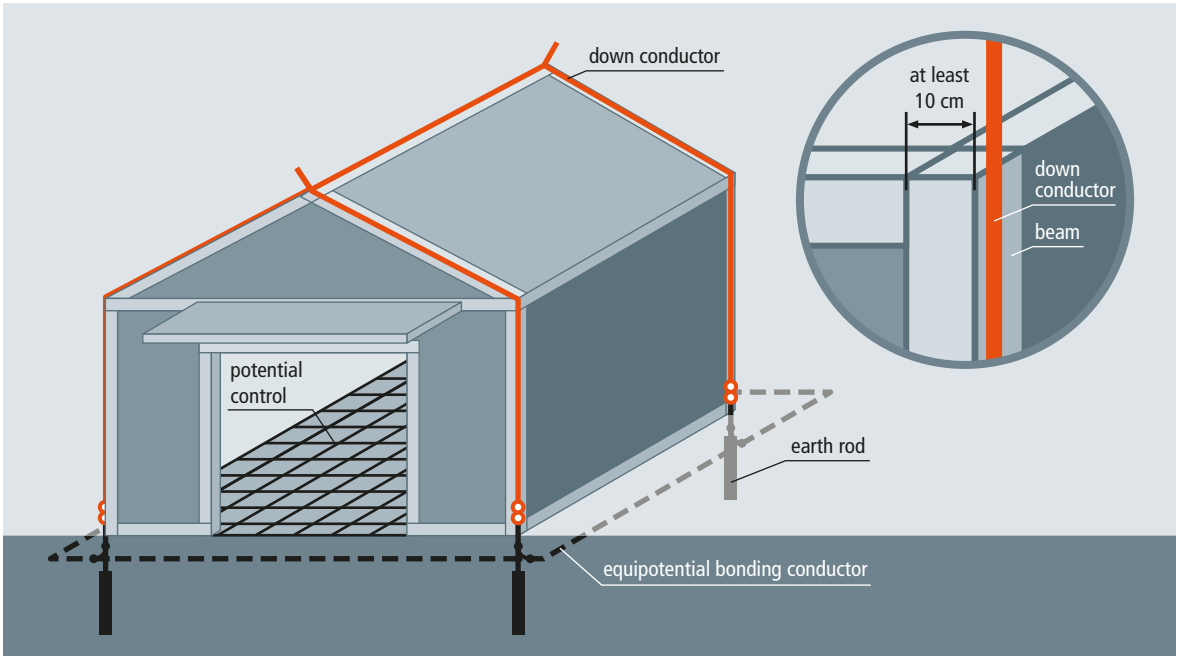

Figure 2 Installation of a down conductor at the side beams to ensure that the separation distance is maintained

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DEHN (**Figure 3**). This is particularly required for shelters that are even smaller than those described above.

Prevention of step voltages

Dangerous high step voltages resulting from a lightning strike to the lightning rod of a shelter or a nearby lightning strike must be prevented in shelters. There are two options:

a) Prevention of dangerous step voltages by insulating the floor

This means that the floor must be covered by e.g. a 5 cm asphalt layer. As an alternative, a wood floor can be used that maintains a sufficient distance from the ground to ensure adequate ventilation and that remains dry in any circumstance. Moreover, adequate measures must be taken to prevent that plants grow through the shelter (**Figure 4**).

b) Prevention of step voltages by means of potential control

Another protection measure is potential control, namely the integration of a finely meshed metal grid (e.g. reinforcement steel mat laid in concrete or a buried meshed earth electrode with a mesh size smaller than 0.25 m x 0.25 m) directly in the ground below the standing surface of persons. To ensure a long service life of this metal grid, it is advisable to use 10 mm round conductors made of stainless steel (V4A) (e.g. material number AISI/ASTM 316 Ti). These round conductors are installed max. 0.1 m below the ground surface at intervals of less than 0.25 m x 0.25 m

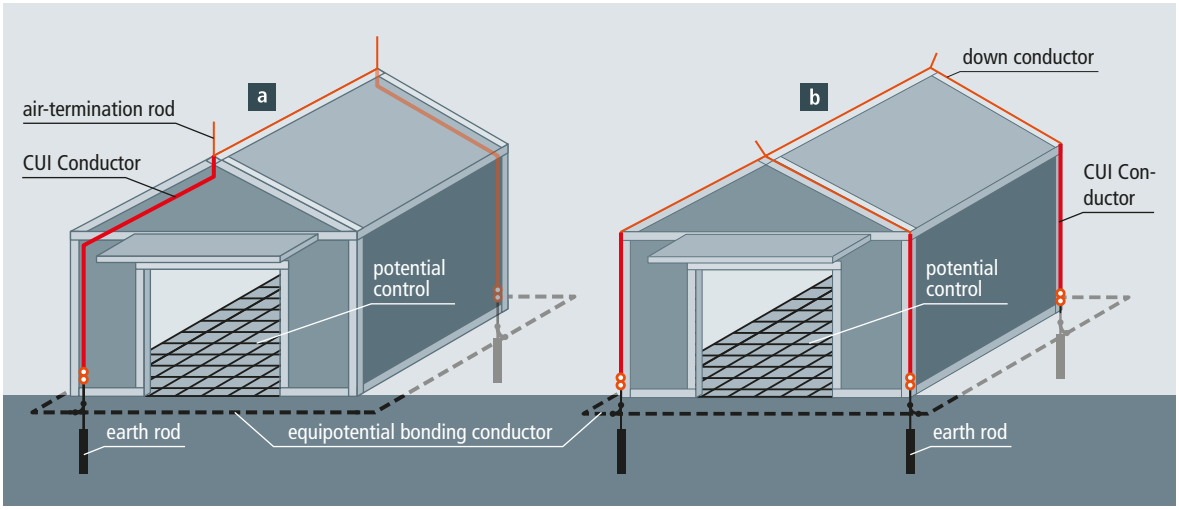

Figure 3 Installation of a high-voltage-resistant CUI Conductor: a) in case of a small shelter with two air-termination rods; b) in case of insufficient wall thicknesses

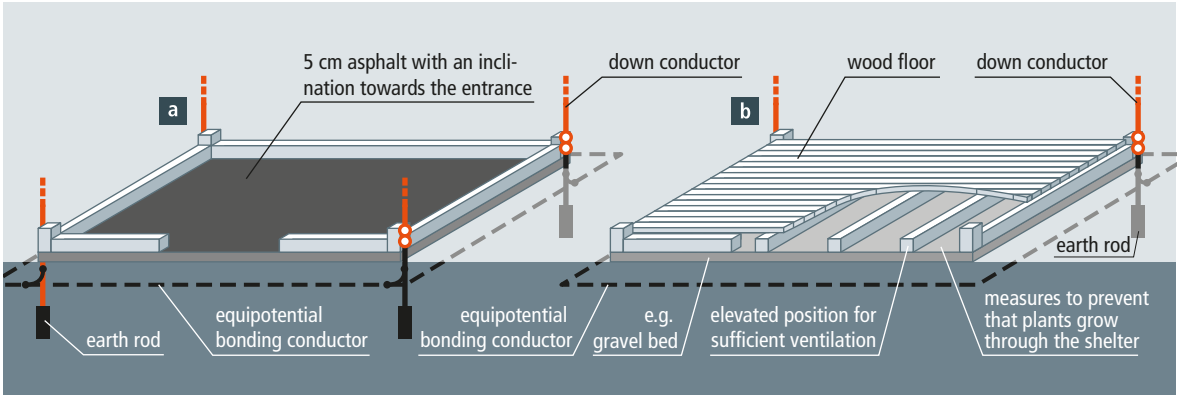

Figure 4 Insulation of the standing surface to prevent step voltage: a) by means of asphalt; b) by means of a wood floor

and must be connected by means of adequate clamps on all junctions and down conductors (**Figure 5**).

Shelters located in the protected volume of an isolated air-termination system

Since an air-termination mast (isolated lightning protection system) installed at a certain safety distance protects the shelter from lightning strikes, potential control must be provided in the shelter (**Figure 6**). Telescopic lightning protection masts with screw-in foundation (Part No. 830 208) from DEHN can be used as air-termination masts. These masts are commonly used for existing shelters where the separation distance from the rooftop air-termination system and the down conductor cannot be maintained due to their small size.

Metal shelters

In metal shelters (roof, walls and floor) golfers are not at risk if they touch the metal construction. An earth-termination system as well as a metal floor or metal grid (potential control) as described before must be installed. Nevertheless, melting of the roof of the shelter must be prevented, in other words the roof material must have a minimum thickness (IEC 62305-3 (EN 62305-3), Table 3, thickness t) to ensure personal protection. If the metal does not have the required thickness, air-termination rods must be installed on the metal roof and must be connected to it in such a way that it can carry lightning currents.

Summary

In general, golfers must stay in shelters for about 30 minutes after they hear the last rumble of thunder. Only then, the thunder cell is far enough away.
Shelters on golf courses or hiking trails require both a lightning rod and adequate measures to reduce the risk of inadmissibly high touch and step voltages. As described above, these measures can be implemented by simple means.

The IEC 62305 (EN 62305) standard series includes fundamentals and an overall lightning protection concept. For more detailed information on lightning protection, please contact approved lightning protection companies or visit *www.dehn-international.com.*

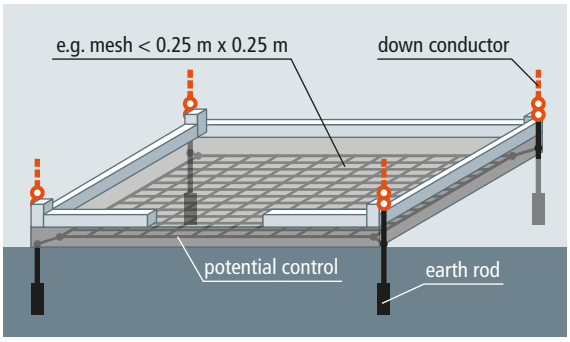

Figure 5 Potential control to reduce step voltage

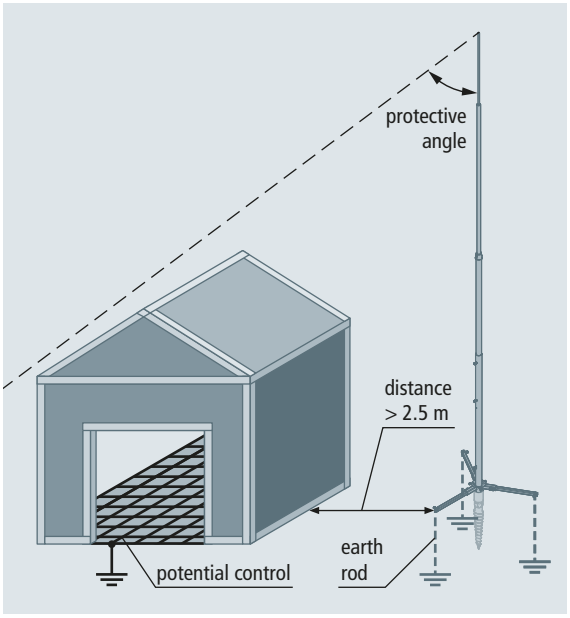

Figure 6 Isolated lightning protection system with telescopic lightning protection mast

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