Protection from touch and step voltages for sports grounds

White Paper

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Lightning protection systems for playing fields and sports grounds , including the areas for spectators, are becoming more and more important. Recent damage and the increasing frequency of thunderstorms (**Figure 1**) underline the need for protective measures. When lightning strikes the floodlights, stands, fence or even the playing field, it puts the sportsmen and spectators at great risk. Partial lightning currents from flashover can flow through people standing close to lightning current conducting parts of the sports ground, severely injuring, and maybe even killing, them. People who are not directly hit by lightning, but are standing next to the point of strike (potential gradient area) bridge a life-threatening voltage difference with their legs (step voltage) or by touching other people. This results in injuries such as ventricular fibrillation, cardiac arrhythmia and cardiac arrest. Furthermore, people leaving the grounds in a state of panic may also be injured. Therefore, the German building regulations of some federal states require the following:

Structures where a lightning strike can easily occur or can have serious consequences due to their location, type of construction or use must be equipped with permanently effective lightning protection systems.
(Bavarian Building Regulation (Bay Bo), section 44)

The term "serious consequences" is the measure of necessity here. Experts have defined organisational guidelines and warning notes to draw attention to the risks posed by a lightning strike. If one recognises the danger in good time, one can evacuate the danger area and seek out the designated sheltered areas. Additional lightning protection measures reduce the risk of injury in the critical areas around floodlights, along metal fences and on escape routes. More detailed information on this topic can be found in the publications by the German Association for Electrical, Electronic and Information Technologies (VDE) ("Richtiges Verhalten bei Gewitter" [What to do in a thunderstorm]). Supplement 2 of the latest German DIN EN 62305-3 standard describes how to install fixed protection systems on buildings, lighting systems or spectator stands.

Lightning protection for buildings / lightning equipotential bonding

Club houses and covered stands provide shelter in case of unexpected heavy rain and thunderstorms. A lightning protection system according to class of LPS III as per IEC 62305-3 (EN 62305-3) the minimum requirement here. For uncovered spectator stands, class of LPS II must be used according to Supplement 2 of the German DIN EN 62305-3 standard. In case of a lightning strike, partial lightning currents may also flow through metal fences, parts of the spectator stands, flagpoles or scoreboards. The resulting potential differences are the reason behind uncontrolled flashover which may cause fire and endangers people in close proximity. **Figure 2** shows the lightning equipotential bonding for the power supply system in the low-voltage main distribution board by means of a combined arrester. Just like any additional power cables, IT cables and metal systems entering the structure must also be integrated in the lightning equipotential bonding.

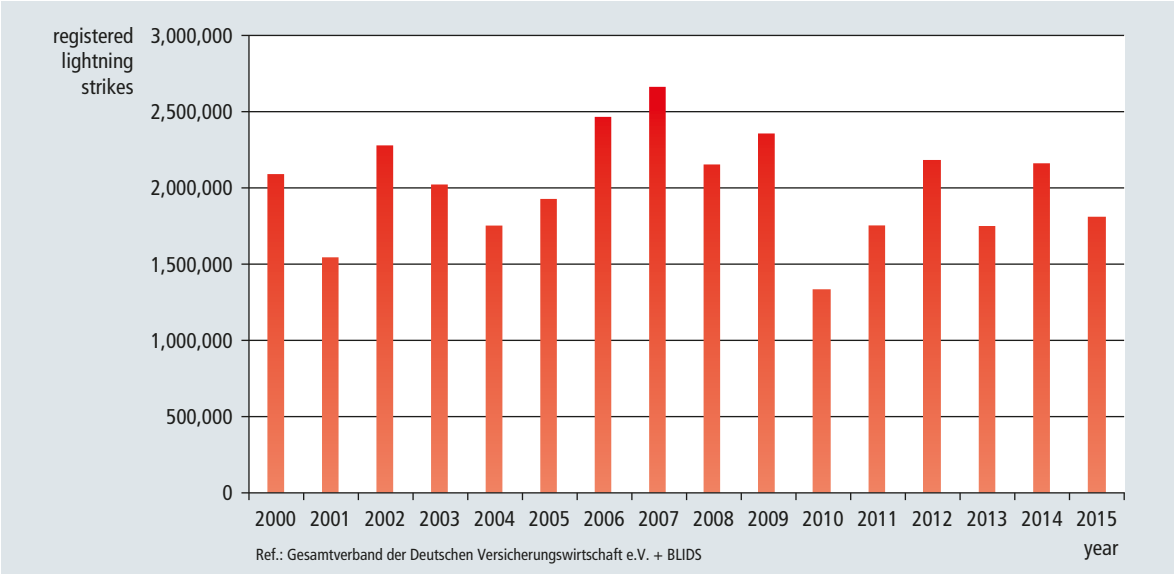

Figure 1 Number of lightning strikes registered in Germany from 2000 to 2015

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Figure 2 Lightning equipotential bonding by means of DEHNventil M

Figure 3 Isolated lightning protection with HVI-light conductor

Figure 4 HVI Conductor installed at a mast

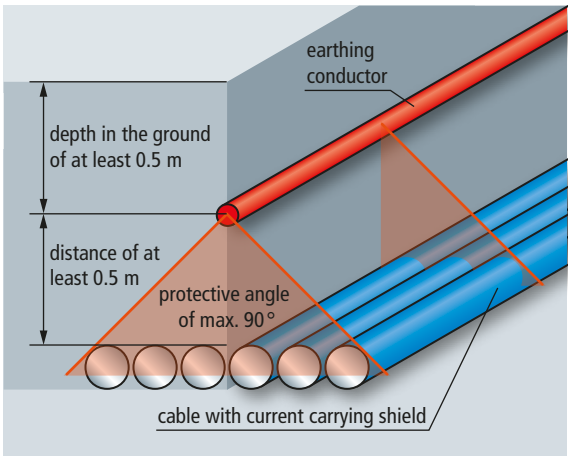

Figure 5 Protected volume for a cable route

Isolated lightning protection

According to the latest lightning protection standards, isolated air-termination and down-conductor systems should be used to protect metal floodlight masts, parts of the spectator stands, scoreboards and flagpoles against direct lightning strikes. Using an insulating HVI conductor (high-voltage-resistant conductor) prevents flashover (**Figure 3**). Consequently, no lightning currents will travel through the metal floodlight masts, scoreboards, parts of the spectator stands and flagpoles, thus preventing touch voltage. **Figure 4** shows a DEHNconductor HVI system installed on a mast. The height of the air-termination tip depends on the relevant class of LPS, which must be determined in advance.

Lightning protection for floodlights (example)

Floodlights on the sidelines or spectator stands should be provided with an isolated lightning protection system. The earth-termination systems of the individual masts should be connected to one another and in direct contact with the earth. These additional connections improve equipotential bonding and reduce the total earth resistance. Furthermore, the protected volume created by this conductor, which is in contact with the soil, protects the cable route from direct strikes and flashover. (**Figure 5**).

Touch voltage at floodlight masts (example)

If lightning were allowed to directly strike metal floodlight masts, flagpoles or scoreboards, touch voltage would form

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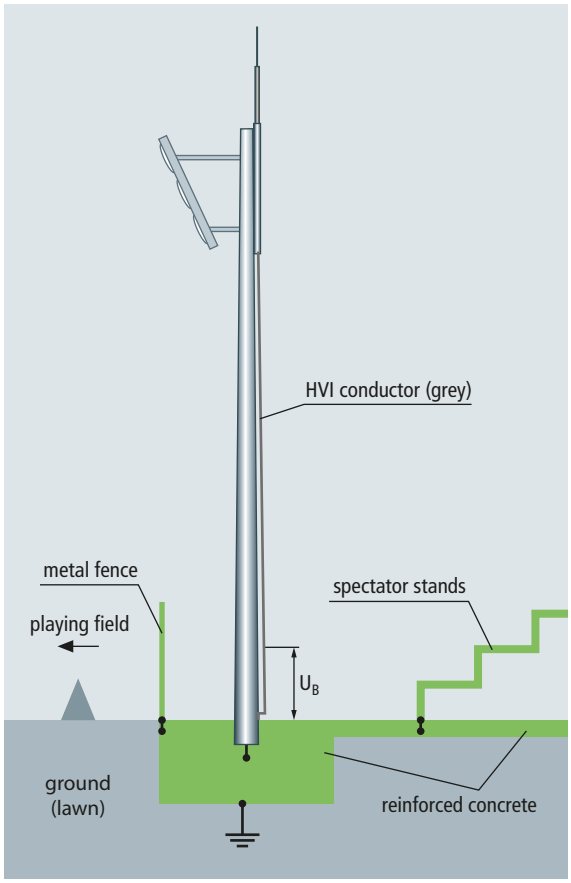

Figure 6 No touch voltage (U_B) due to the use of the grey HVI conductor

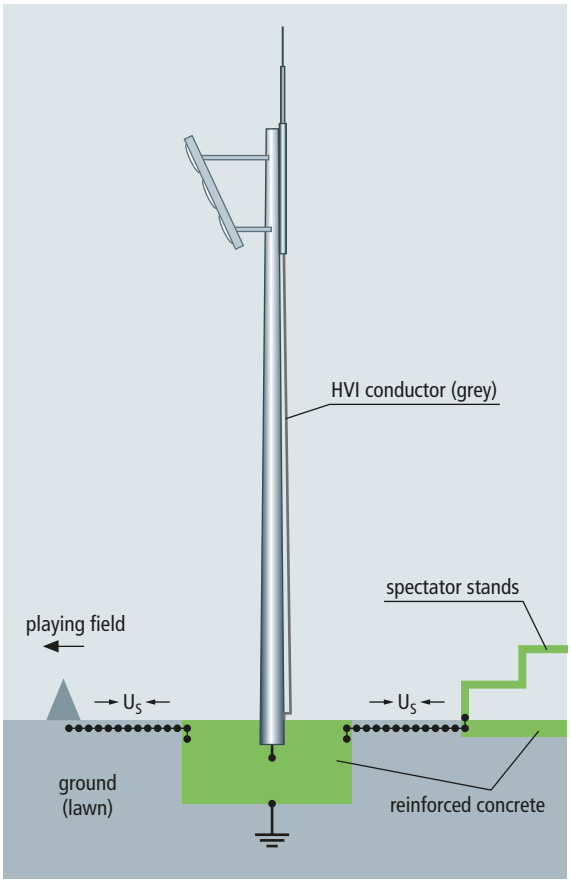

Figure 7 No step voltage (U_S) due to the installation of a special meshed stainless steel network and use of the concrete reinforcement of the spectator stands

as a result of the voltage drop. Other than isolated lightning protection, the only way to provide protection against this is the insulation of the standing surface according to IEC 62305 (EN 62305). In this case, however, it would be impossible to keep the 3 m boundary stated in the standard as so many people are standing side by side. As a result, it is only possible to provide isolated lightning protection using the grey HVI conductor (**Figure 6**). If the masts are not too high, a CUI conductor can be installed instead of a grey HVI conductor. Just like the HVI conductor, the maximum length of the CUI conductor is limited.

Connection of the floodlight mast with the steel reinforcement of the concrete or with the potential-controlling, stainless steel mat is obligatory. The abovementioned measures considerably reduce the risk of injury.

Step voltage close to floodlight masts (example)

Although touch voltage presents the greatest risk, step voltage is no less dangerous. Because, as with touch voltage, in this case isolation is almost impossible, the only possibility remaining is potential control via the steel reinforcements in the concrete or the meshed structures in the ground (**Figure 7**).

The connection of the floodlight mast with the steel reinforcements of the concrete or with the potential-controlling, stainless steel mat is obligatory here, too. This measure considerably reduces the risk of injury.

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