Protection from touch and step voltages for sports grounds

White Paper

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The necessity of lightning protection systems for playing fields and sports grounds as well as the neighbouring spectator galleries is increasingly publicly discussed. Recent damage and the increased thunderstorm frequency (**Figure 1**) underline that adequate protection measures are required. Lightning strikes to floodlights, spectator galleries, fences or even playing fields pose a high risk to sportspersons and spectators. Persons who are directly hit by lightning or stand next to lightning current carrying parts and carry partial lightning currents themselves as a result of flashover may be seriously injured or may even die. Persons who are not directly hit by lightning, but stand next to the point of strike (potential gradient area) bridge a life-threatening voltage difference with their legs (step voltage) or by touching other persons. This results in injuries such as ventricular fibrillation, cardiac arrhythmia and injuries caused panic. 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)

This article also applies to sports grounds.
Therefore, experts defined organisational guidelines for behaviour and warning notices which preventively warn of lightning hazards. If hazards are recognised in time, dangerous areas can be left and buildings or designated shelters can be sought. Additional lightning protection measures reduce the risk of injuries in critical environments such as floodlights, metal fences and 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]) or by the German Committee for Lightning Protection and Research (ABB) (e.g. "Überlegungen zum Blitzschlag an dem Sportplatz in Wald-Michelbach am 08.08.2008" [Considerations concerning the lightning strike to the sports ground in Wald-Michelbach on 08/08/2008]). Supplement 2 of the latest German DIN EN 62305-3 standard describes how to install fixed protection systems on buildings, lighting systems or spectator galleries.

Lightning protection for buildings / lightning equipotential bonding

Covered stands, locker rooms and club houses 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 (EN62305-3) is at least required for these types of building. For uncovered spectator galleries, 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 gallery, flagpoles or scoreboards. The resulting potential differences lead to uncontrolled flashover which causes fire and endangers persons and animals in close proximity. To prevent this, these parts must be conductively interconnected. **Figure 2** shows the connection of a lightning protection system to the 230/400 V power supply system at

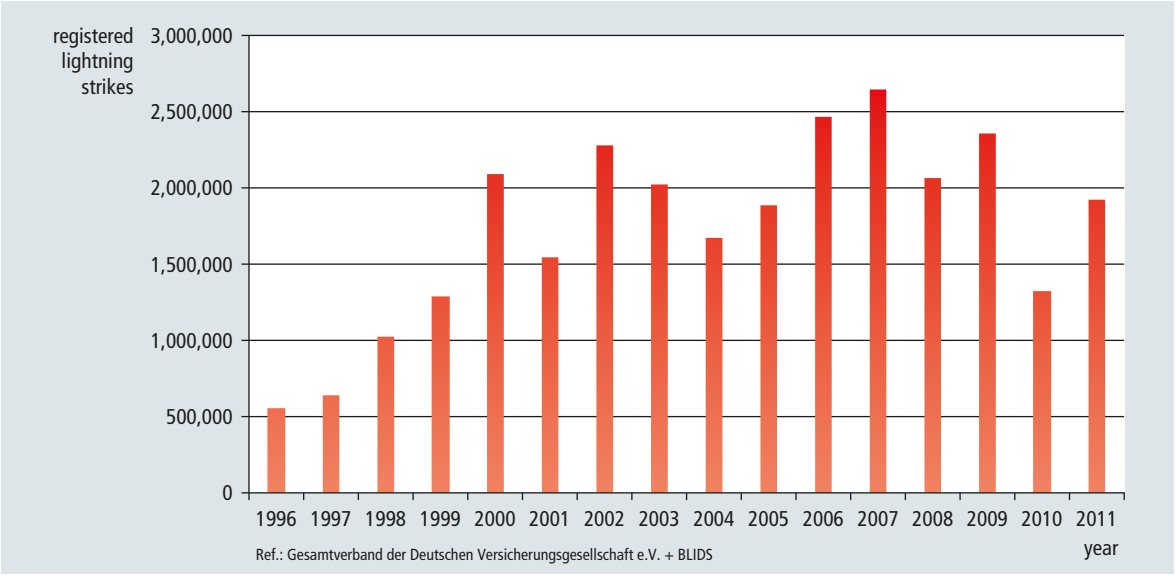

Figure 1 Number of lightning strikes registered in Germany from 1996 to 2011

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Figure 2 Lightning equipotential bonding by means of DEHNventil M

Figure 3 DEHNconductor HVI light Conductor

the entry point of the main low-voltage distribution board by means of a DEHNventil combined arrester. The associated lightning equipotential bonding system for metal and electronic systems additionally prevents fire in these structures.

Isolated air-termination system

According to the latest lightning protection standards, isolated air-termination systems are to be used to protect metal floodlight pylons, parts of the spectator gallery, scoreboards and flagpoles against direct lightning strikes. These parts are conductively connected with sensitive electrical / electronic equipment via electrical lines. Isolated air-termination systems such as the DEHNconductor HVI system (high-voltage-resistant, insulated conductor, **Figure 3**) prevent flashover. Consequently, no lightning currents will travel through the metal floodlight pylons, scoreboards, parts of the spectator gallery and flagpoles, thus preventing dangerous lightning currents from flowing into sensitive electrical systems. **Figure 4** shows a DEHNconductor HVI system installed on a pylon. The height of the air-termination tip depends on the relevant class of LPS, which must be determined in advance. The high-voltage-resistant, insulated down conductor (HVI Conductor) can be directly installed at the pylon in line with the installation instructions using system-specific accessories. Thus, lightning currents do not enter the pylon and the electrotechnical installation.

Lightning protection for floodlights

Floodlights next to the sideline or spectator galleries should be provided with a lightning protection system. The earth-termination systems of the individual pylons should be connected to one another and to the earth-termination systems of the sports buildings (club houses, locker rooms or technical buildings). These additional connections improve equipotential bonding and the efficiency of the individual foundation earth

Figure 4 HVI Conductor installed at a pylon

electrodes. If correctly installed, they form a protected volume in case of a direct lightning strike to the cable routes of the floodlight (**Figure 5**).

Standing surface insulation, touch and step voltage (potential control)

Persons standing directly next to lightning current carrying floodlight pylons, fences, flagpoles or covered stands during a lightning strike bypass high potential differences with their legs (step voltage) or may directly touch conductive structures

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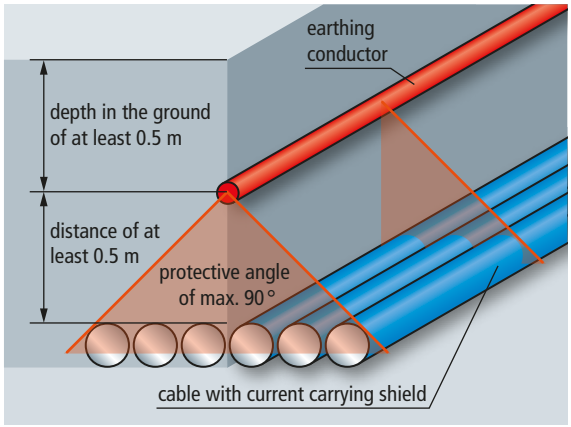

Figure 5 Protected volume for a cable route

(touch voltage). The resulting risk of injury can be reduced by insulating the standing surface (standing surface insulation). This measure reduces the risk of impermissibly high touch and step voltages following a lightning strike. According to IEC 62305 (EN 62305), an insulating asphalt layer of at least 5 cm around these parts is sufficient. As an alternative, CUI Conductors with dielectric strengths ≥ 100 kV (1.2/50 µs) can be used.

Potential control as per Supplement 1 of the German DIN EN 62305-3 standard also allows to reduce step voltages. To this end, additional earthing conductors are buried around the pylons or metal spectator galleries and are interconnected (**Figure 6a**). Consequently, the potential difference in the potential control area is reduced and the lightning current is evenly distributed in the ground. When the distance from the pylon increases, the depth increases as well by 0.5 m (**Figure 6b**). The more evenly the earth electrodes are installed, the lower the potential difference (step voltage). Thus, the risk of injury is considerably reduced.

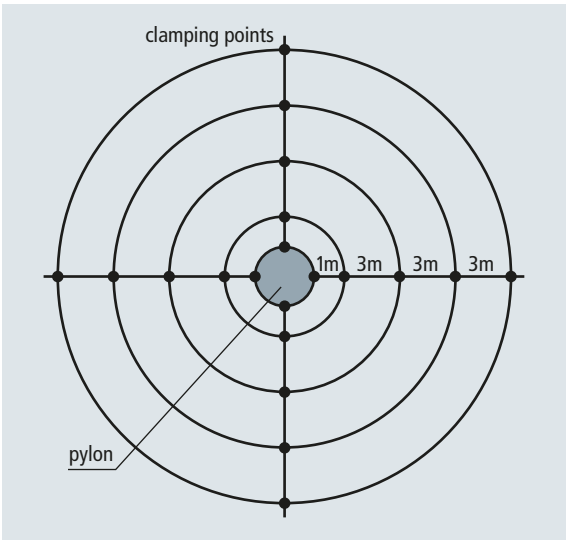

Figure 6a Potential control on a pylon

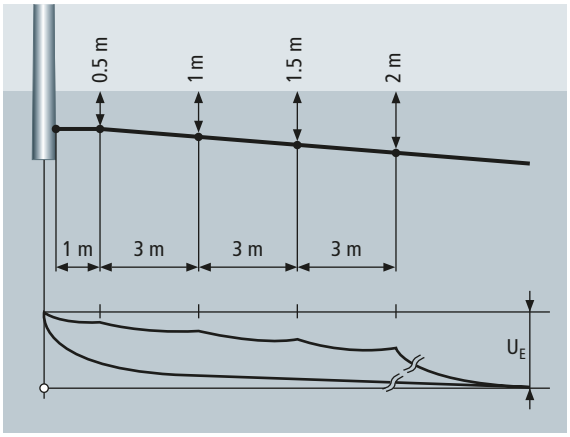

Figure 6b Potential control on a pylon

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