CITEL

SURGE PROTECTION FOR DATACENTER

TECHNICAL NOTE

Version 1.0

citel.fr

INTRODUCTION

Since the rise of modern computing in the mid-20th century, the demand for data storage, processing, and transmission has grown exponentially. In 2024, global data volume is expected to surpass 180 zettabytes (180x1015 GB), with data centers at the heart of this digital expansion.

By 2025, there will be over 8,000 large-scale data centers, consuming nearly 2% of global electricity—a figure rising with the growth of AI, cloud computing, and edge technologies.

To operate reliably, these facilities require careful planning, high-performance infrastructure, and advanced cooling and power systems. Despite this, they remain vulnerable to power failures, cyber threats, and hardware breakdowns, leading to financial losses and service disruptions. Proactive risk management is key to ensuring long-term stability.

As the backbone of global digital infrastructure, data centers power cloud platforms, AI analytics, and real-time communication. With average energy use of 32 megawatts per site—enough to power a town of 25,000—uninterrupted operation is essential. Yet growing threats like power surges, lightning, and grid instability raise a critical question: how can risks be identified and mitigated to ensure optimal protection?

ESSENTIAL STANDARDS AND PROTECTION STRATEGIES

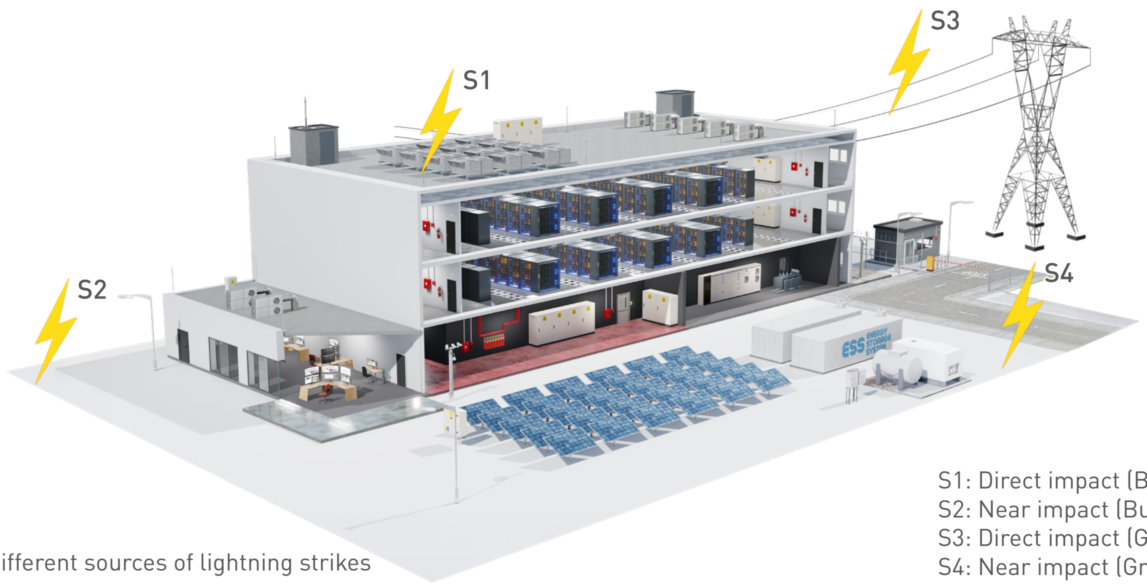
One significant risk in Data Center is the negative impact of lightning strikes and electrical surges. While the likelihood of a direct lightning strike on the plant's structure (scenario S1 in Figure 1) is relatively low —depending on the location and exposure — such an event can still induce partial lightning currents of several thousand amperes into the system's wiring.

More commonly, lightning strikes occur in the vicinity of the power plant (S2), near overhead lines (S4), or within the upstream distribution grid (S3). In these cases, surge voltages can be fed into the system through inductive and/or resitive coupling or an increase in ground potential.

KEY STANDARDS

The IEC 62305 series – „Protection against lightning" is an internationally recognized series of standards that defines the principles for protecting structures, electrical systems, and people from lightning effects. This standard provides the foundation for designing comprehensive lightning protection systems (LPS), including external and internal protection measures.

The IEC 61643 series – „Low-voltage surge protective devices" focuses on the performance, testing, selection, and application of SPDs (Surge Protective Devices) used in low-voltage power and signaling systems. It includes requirements for devices protecting against transient overvoltages caused by lightning and switching events in AC, DC, PV, and telecommunication systems. This series of standards ensures coordinated surge protection across all levels of electrical installations.



S1: Direct impact (Building)
S2: Near impact (Building)
S3: Direct impact (Grid)
S4: Near impact (Grid)

Figure 1: Different sources of lightning strikes

LIGHTNING PROTECTION ZONES

In the framework of IEC 62305, a comprehensive lightning protection system is organized into clearly defined zones that work together to shield a data center from both direct strikes and secondary surge effects. The outer protection zone establishes a perimeter around the facility using air terminals and the rolling sphere method; this zone intercepts the full force of a lightning strike, directing the high-energy surge safely to ground and preventing the strike from reaching the building's structure. Just inside this boundary lies the intermediate (or inter) zone, where the intensity of a lightning event is reduced yet still capable of inducing electromagnetic pulses and transient overvoltages. In this inter zone, additional measures—such as secondary surge protective devices, proper grounding, and bonding practices—are employed to attenuate any residual energy before it can affect sensitive electronic systems within the data center. Together, these layers provide a coordinated defense: the outer zone handles the most severe surges at the entry point, while the intermediate zone mitigates remaining disturbances to ensure the uninterrupted operation and safety of critical IT infrastructure.

Outer zone LPZ 0

LPZ 0_A: Hazard due to direct lightning strikes

LPZ 0_B: Protected against direct lightning strikes

Inner zones

LPZ 1: Surge currents are limited by current sharing or SPDs at the zones

LPZ 2: Surge currents are further limited by current sharing or SPDs at the zones

LPZ 3: Only low-energy residual voltage peaks remain, which are filtered out at this transition.

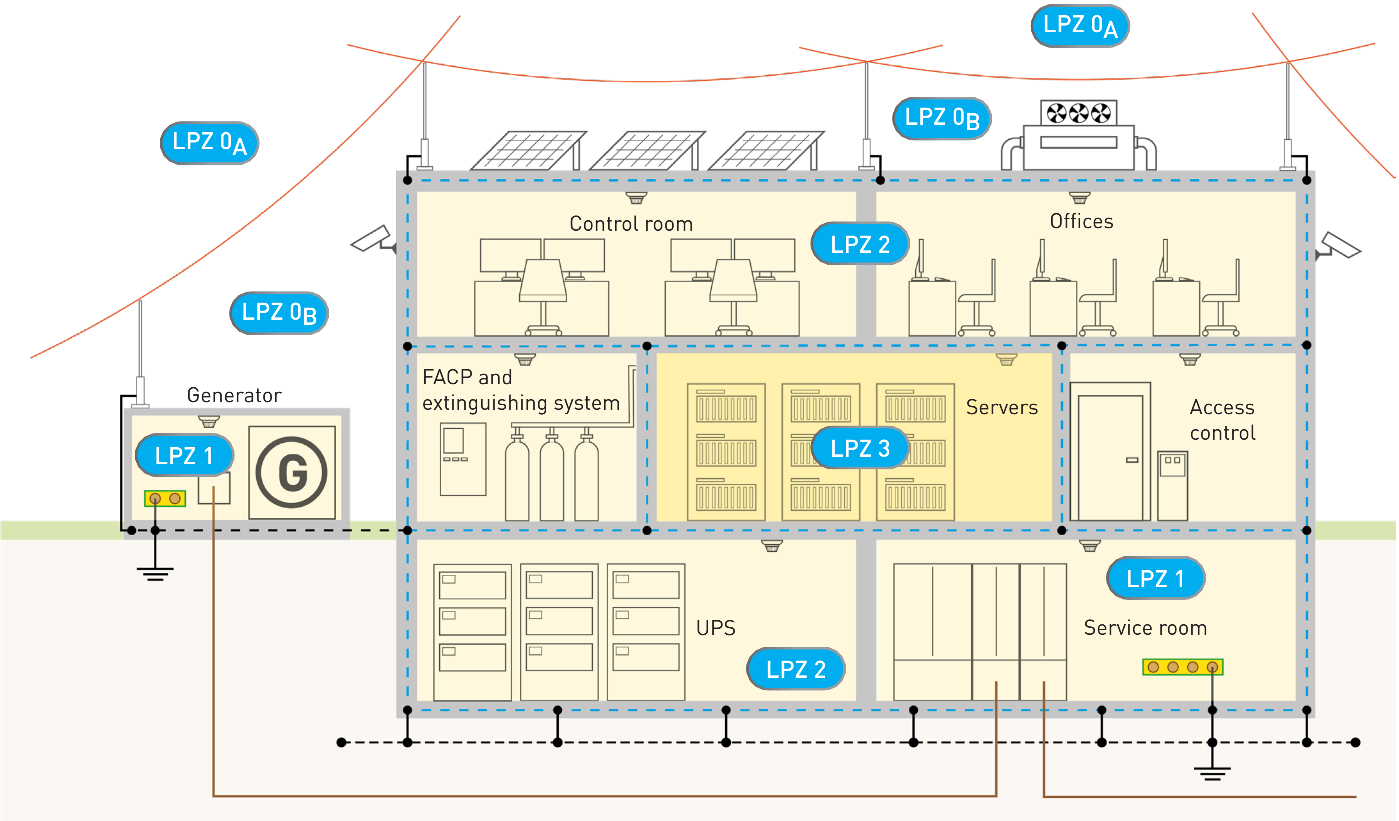


Figure 2: Lightning protection zone concept

GUIDELINES

The design, construction, and operation of data centers are governed by a comprehensive framework of international and regional standards to ensure reliability, security, and efficiency. These standards define essential requirements for power infrastructure, environmental controls, telecommunications, and overall risk management, helping operators to mitigate potential threats to uptime and service continuity.

Data centers must be designed to withstand the risks associated with lightning strikes and surge events. The IEC 62305 series provide a globally recognized framework for lightning protection, ensuring the safety and operational continuity of critical IT infrastructure under extreme conditions.

The IEC 61643 standard defines the requirements, testing, and application of Surge Protective Devices (SPDs) across multiple electrical and electronic systems, including AC power, photovoltaic (PV) installations, DC networks, and telecommunications. SPDs are essential for protecting sensitive equipment from transient overvoltages caused by lightning strikes, switching operations, and grid disturbances. Compliance with IEC 61643 is crucial for ensuring system reliability, equipment longevity, and operational continuity, reducing downtime and preventing costly failures in critical infrastructures.

IEC 61643 SPD Classification by Lightning Protection Zones (LPZ):

- **LPZ 0/1:**

Type 1 SPD (T1): Handles direct/indirect lightning currents, tested with a 10/350µs impulse, with impulse discharge capability (*I*imp) rating, used for AC, PV, DC systems. For data lines: SPD classification D1.

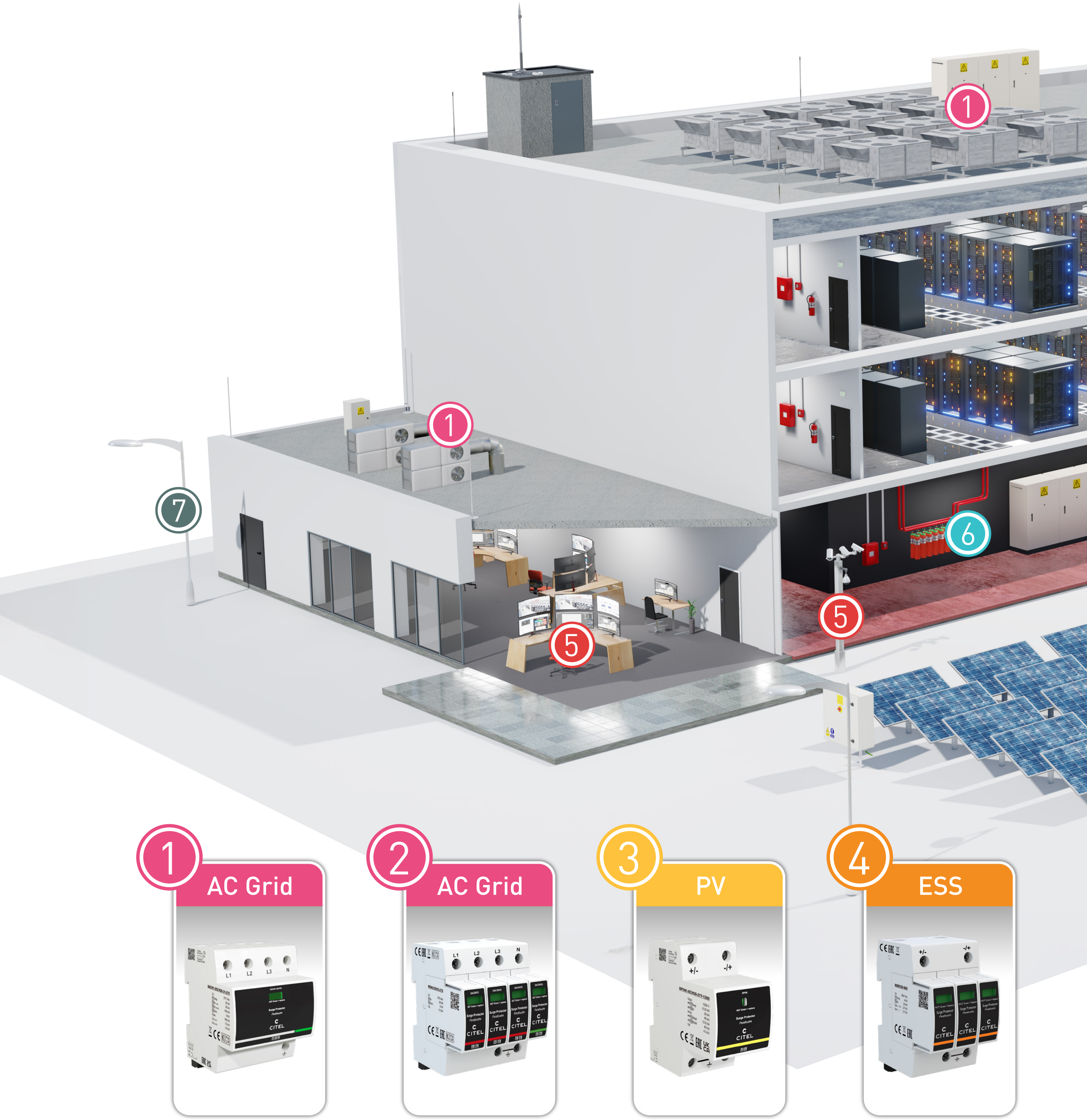
- **LPZ 1/2:**

Type 2 SPD (T2): Protects against coupled surges from switching or nearby strikes, tested with an 8/20µs impulse, rated by Nominal discharge capability (*I*n), used for AC, PV, DC. For data lines: SPD classification C2.

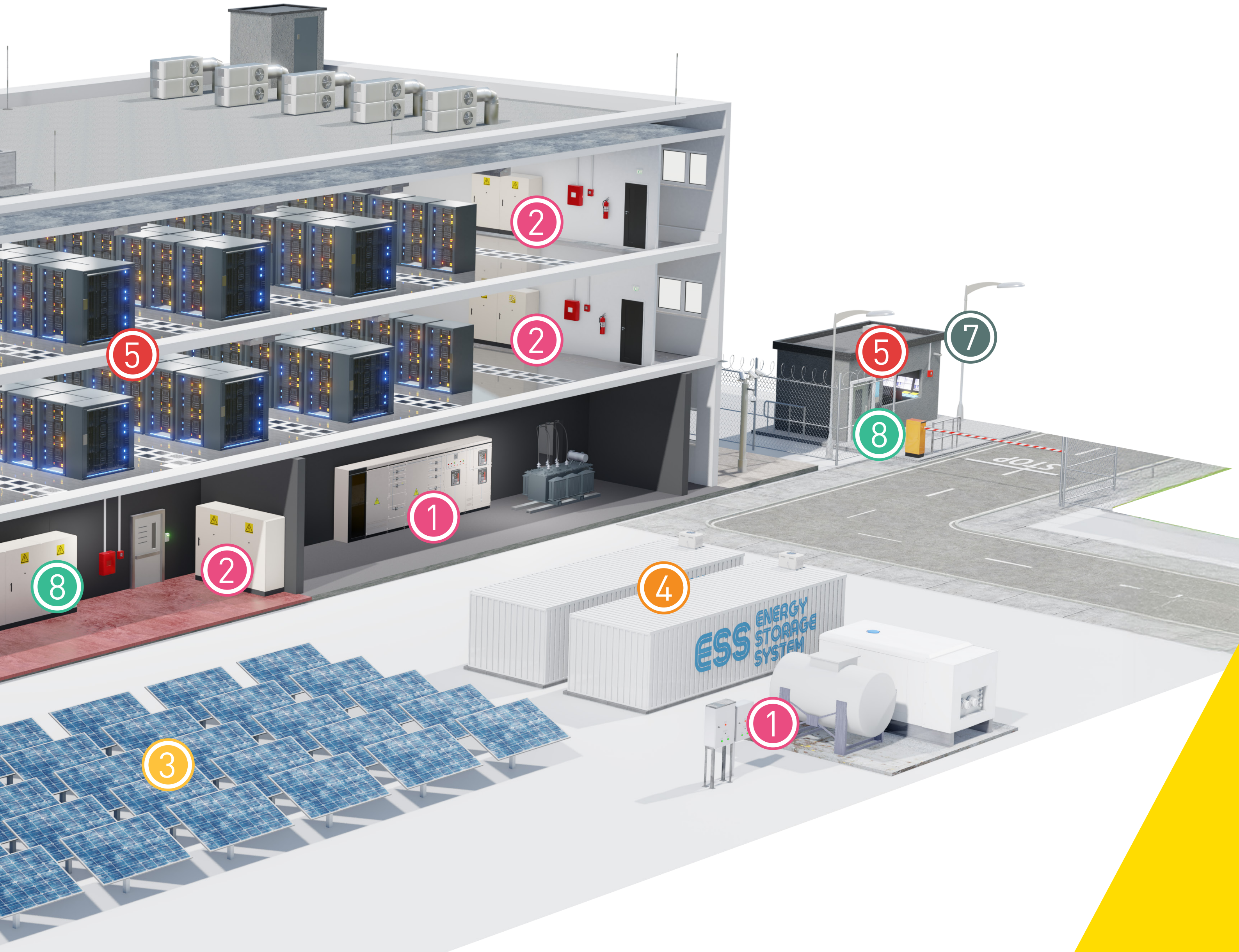
- **LPZ 2/3:**

Type 3 SPD (T3): Provides fine protection for sensitive devices, tested with 1.2/50µs (voltage) and 8/20µs (current) combined waveforms, rated by open-circuit voltage (*U*oc), for AC, PV, DC. For data lines: SPD classification C1.

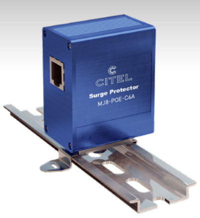
APPLICATION IMAGE



CITEL



5 Ethernet



6 Fire Alarm

7 LED

8 Data

CITEL

DEVICES IN DATA CENTER

A data center is far more than just a collection of racks and servers; it is a highly complex infrastructure designed for reliability, efficiency, and resilience. Modern data centers increasingly integrate photovoltaic (PV) systems to harness clean and sustainable energy, reducing dependence on traditional power sources. Additionally, battery storage systems are implemented to ensure continuous energy availability, enhancing operational security. However, to guarantee uninterrupted power supply under all circumstances, diesel generators remain a critical backup solution, providing emergency power in the event of grid failures or unforeseen disruptions.

To protect all this devices using surge protection devices (SPDs), a layered approach is essential: on the AC-Side, the installation of SPDs at the main distribution boards and and graduated in the sub-distribution boards at the border between the graduated LPZs to clamp down on voltage spikes from lightning strikes, switching impulses, or other disturbances, thereby safeguarding power distribution units and connected IT equipment. Given that a lightning protection system is installed, Type 1 SPDs are required according to IEC 61643-11 to discharge direct or indirect lightning currents safely. For surge protection, Type 2 SPDs are generally sufficient to protect electrical installations from transient overvoltages caused by switching operations or indirect lightning effects. At a minimum, Type 2 SPDs are required in sub-distribution panels to ensure adequate protection downstream in the system. For photovoltaic (PV) systems that supply renewable power, use specially rated DC SPDs to manage high DC voltages and transient surges, ensuring the integrity of inverters and PV arrays; within server racks, deploy rack-mount surge protectors to provide localized defense for sensitive servers and networking gear; for battery backup systems such as those used in UPS installations, integrate SPDs to shield battery management circuit and prolong battery life by preventing surg-induced degradation; and even LED lighting- whose drivers can be vulnerable to voltage spikes- should be protected by incorporating appropriate surge suppression measures, ensuring reliable operation across all critical data center components.

As a leading provider in lightning and surge protection, CITEL leverages extensive research and expertise to offer tailored solutions with best-in-class protection equipment. Our DACN1-25C/VG Typ 1+2+3 SPD, featuring VG technology, is designed for leakage-free and operating current-free performance, ensuring superior protection for all data center components. With a comprehensive SPD product range, CITEL delivers robust and reliable protection against lightning and surge threats.

DACN1-25CVGS-11-275/SC

DACN1-25CVGS-31-275

CITEL

France
Head Office

Sales department

Paris
Tel. : +33 1 41 23 50 23
e-mail : export@citel.fr
Web : www.citel.fr

Factory

Reims
Tel. : +33 3 26 85 74 00

Germany
Bochum
Tel. : +49 2327 6057 0
e-mail : info@citel.de
Web : citel.de

USA
Miramar
Tel : +1 (954) 430 6310
e-mail : info@citel.us
Web : citel.us

China
Office

Shanghai
Tel. : +86 21 58 12 25 25
e-mail : info@citel.cn
Web : citel.cn

India
New Delhi
Tel. : +91 11 400 18131
e-mail : indiacitel@gmail.com
Web : citel.in

Thailand
Bangkok
Tel. : +66 (0) 2 104 9214
Web : citel.fr

U.A.E
Dubai
e-mail : julien.pariat@citel.ae
Web : citel.fr

Colombia
Bogota
e-mail : export@citel.fr
Web : citel.fr