

# Protecting Security Systems in a Healthcare Facility from Lightning Induced Transients

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**A** healthcare facility is a multifunctional building or campus that provides health care to citizens and when designated, also provides protection to the population in times of crisis. This includes common functions associated with patient care (e.g. operating rooms, emergency rooms, recovery rooms, etc), but also areas for educational centers, exercise facilities, food service, and other non-patient care activities. Significant amounts of advanced information technology for patient records and accounting functions, laboratories, various imaging systems, (e.g. magnetic resonance imaging (MRI), ultrasounds, x-ray, computerized axial tomography, etc), and security systems are used to meet the mission of a healthcare organization.

Protecting the healthcare facility from environmental conditions is important for service continuity. Lightning is an environmental condition that can cause damage to the facility, the equipment, and rare cases, people. Because of the criticality of the healthcare facility and the risks associated with a lightning protection system (LPS) is required for most U.S. healthcare facilities.

Equipotential bonding is the fundamental principle concept within a LPS. All components of the facility, including the LPS, the

electrical system, the mechanical structure of the facility, and all external components and structures should be effectively bonded to provide a level of immunity from lightning induced transients [1,2,3]. External components include roof top mounted equipment (e.g. HVAC exchangers, communication receivers, etc), and ground level equipment (e.g. security components, parking lights, automatic gates, etc). External structures include remote power stations, remote MRI facilities, and remote security and parking offices.

When a LPS is installed, surge protective devices (SPDs) are required at the service entrance for the electrical distribution system and all communication systems [3]. SPDs are recommended to be deployed throughout the facility in a staged approach [4]. SPDs deployed in a staged or cascade approach have a SPD installed at the service entrance location, SPDs installed at distribution or branch locations, and SPDs installed at point of use equipment. SPDs should be sized in accordance with their location within the lightning protection zone (LPZ) (Figure 1) [1].

## HEALTHCARE POWER SYSTEM

The electrical distribution system of a healthcare facility is complex. It is comprised of at least two power sources, power control devices, and separate infrastructure equipment (Figure 2). Normal power is typically provided by the local utility while emergency power is provided by on-site generators [2]. Within the healthcare facility, electrical power is divided between the essential electrical system and the non-

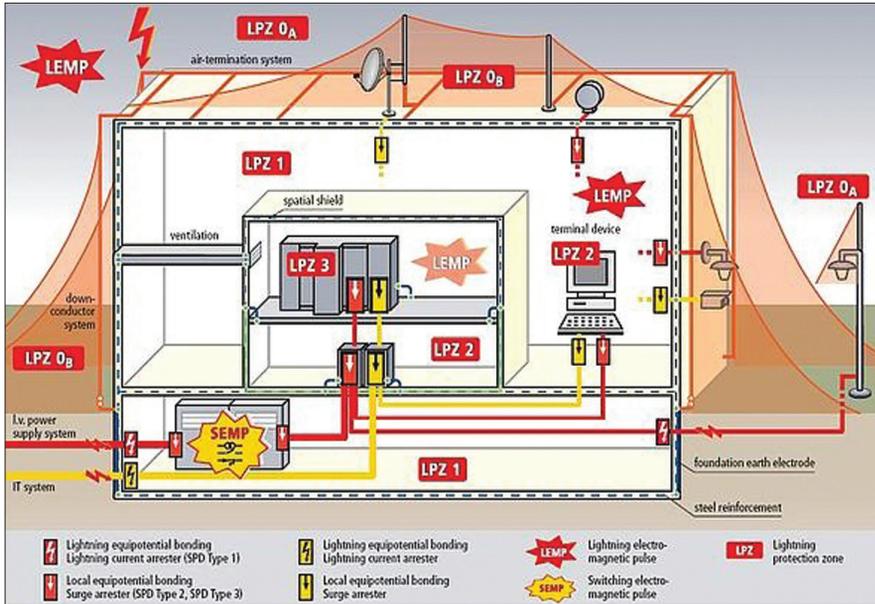


Figure 1. Lightning protection zone concept [1].

essential electrical system. The essential electrical system comprises the equipment system, the life safety branch and the critical branch of the emergency system, and is intended only for those systems intended for life safety [2]. This includes the equipment needed for emergency egress, which includes the security system.

Electrical power provided to the security system is required to be connected to the equipment branch of the essential electrical system in a healthcare facility [2]. When a LPS is installed, SPDs are required to provide protection to the electrical system and critical processes in a staged approach. (Figure 2, Item 1) [4,5]. When the generators are located outside, additional SPDs are needed to provide protection (Figure 2, Item 2) [5]. The cascading of SPDs throughout the facility provides a complete and effective approach to reducing transient overvoltages from affecting equipment and processes.

**HEALTHCARE SECURITY SYSTEM**

A security system for healthcare facilities can consist of numerous cameras and other detection and monitoring devices (Figure 3). Security systems require operation specific cameras, recording devices, uninterruptible power supplies (UPS) for back-up power, precision HVAC equipment, and SPDs.

The preferred method of recording devices uses stand alone digital video recorders (DVRs). DVRs are commonly provided in rackmount enclosures for ease of connection, ability to maintain required environmental conditions, and overall security. Monitors are provided remotely within the security center.

Connection of cameras to the security center’s DVR(s) can be accomplished by a wired or wireless infrastructure. While the wireless infrastructure is advancing, it is still hindered by the inability of wireless frequencies to penetrate reinforced structures of a healthcare facility. The preferred connection for security systems is the wired infrastructure, with a growing popularity towards Category 5e and Category 6 infrastructures.

Point of use protection should be provided within the environmental controlled rackmount system. Using a rackmount SPD topology can provide convenient installation of surge protection that will protect the DVR, the environmental system, and any accompanying Ethernet communication systems. Using rackmount topology

for Ethernet protection is advisable over discrete devices as it provides easy installation and ensures that all grounds for remote cameras and other devices are bonded together.

**POWERING AND PROTECTING REMOTE CAMERAS**

All security cameras require power and communication circuitry to communicate to the security office. Powering a security camera is achieved with 12 VDC or 24 VDC from an external power supply. The external power supply of security cameras are typically hardwired to the electrical distribution panel as they are more tamper resistant than connecting to NEMA 5-15R receptacles. Video transmission to the security central office and control of the pan, tilt, zoom (PTZ) functions of the camera are accomplished through Ethernet

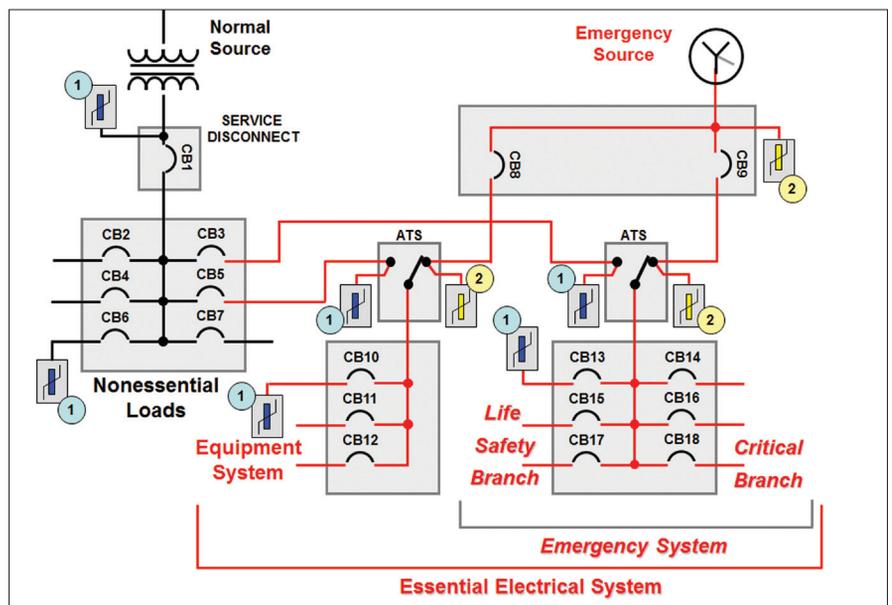


Figure 2. Healthcare AC power system.

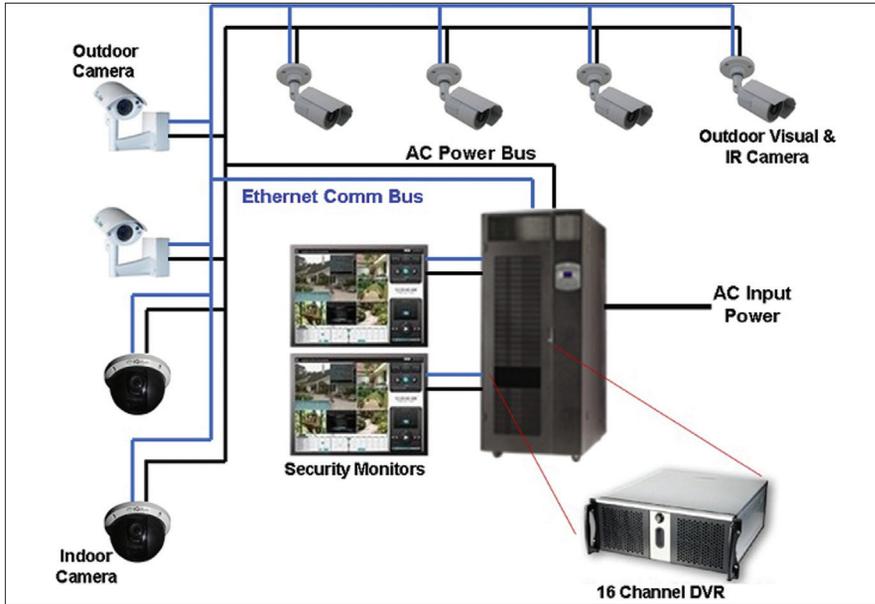


Figure 3. Overview of a security system.

communications.

Protection from lightning induced transients is required on the Ethernet and AC power lines (Figure 5). Security cameras installed in outdoor LPZO or indoor LPZ1 environments requires the same level of protection as those installed at the service entrance locations [1]. For AC power SPDs the minimum required surge current handling

capability is 20 kA of 8/20  $\mu$ s current per mode [3]. Ethernet communication SPDs are required to have a minimum surge current handling capability is 10 kA of 8/20  $\mu$ s current per mode [3]. Security cameras installed in indoor applications also need SPDs for protection, but the current handling capability is less demanding.

Protection of the Ethernet sys-

tem can be troublesome if two basic fundamental rules are not followed. First, SPDs are required to attenuate lightning induced transients and allow Ethernet signals to pass without attenuation. Effective lightning transient mitigation for Ethernet systems is best achieved through using hybrid model that incorporates components that are capable of diverting high-energy transients, and components that capable of attenuating or diverting low-energy transients (Figure 6).

Gas discharge tubes (GDT) are effective components for reducing high-energy transients. Additional attenuation of lightning induced transients is achieved by thyristors (CR). When properly designed, positive temperature coefficient (PTC) resistors provide effective isolation between the GDT and the thyristor thereby allowing devices with differing specifications to work in conjunction with each other. PTC resistors are also effective at minimizing transient currents that may be caused by differing ground potentials between the central security office equipment and security cameras. Additional components may be required to ensure that Ethernet signals are not attenuated.

Secondly, if a shielded Ethernet cable is provided, the shield should not connect solidly to ground at the DVR (source) and the security camera (load). To eliminate circulating ground currents, a solid connection to ground should occur at the DVR, but be isolated at the security camera [6]. The shield of the Ethernet cable can be connected to a ground connection at the security camera if is achieved through a high-frequency connection (Figure 6). A high-frequency connection of the shield to ground is accomplished by either a discrete capacitor (C), through the parasitic capacitance of a GDT, or other components.

**CONCLUSION**

Advanced technology continues to be deployed throughout the healthcare system to meet various newly imposed regulations. Advanced technology is not only used to improve patient outcomes, but also to improve emergency



Figure 4. Rackmounted SPDs.

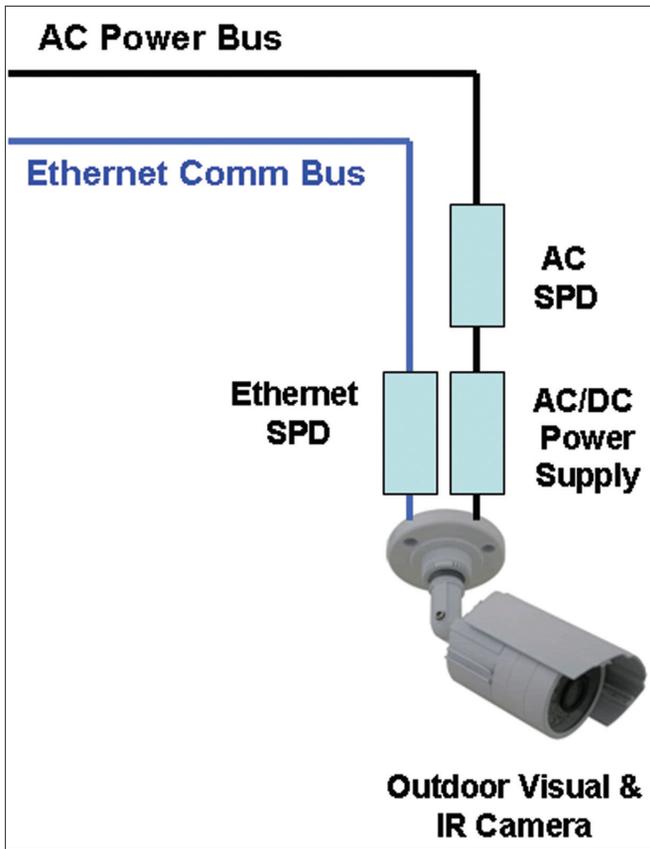


Figure 5. SPD connection at camera.

and security systems within the healthcare facility. Security systems are included as a part of the essential electrical system and should be protected from lightning induced transients. The best protection is provided by proper bonding of the system grounds.

Whenever an LPS is installed, SPDs are also needed to provide effective protection against lightning. AC Power SPDs should be installed on the electrical distribution system, and point of use locations. For security systems, AC Power SPDs should be installed on the incoming AC power of the environmentally controlled rackmount system located in the security office. Ethernet SPDs should be installed on all conductors prior entering/exiting the security system enclosure.

At the remote security cameras, AC Power and Ethernet SPDs should also be installed. Hardwired SPDs provide the best protection against tampering. Equipment located in LPZ0 or LPZ1 should be properly rated to provide adequate protection. Ethernet SPDs require design technologies that

are capable of providing effective transient protection, but not hindering the quality of the video signals or the communication of the control system designed to move the camera or its lens: pan, tilt, zoom (PTZ) functions. If Ethernet cables with shields are used, the shield should use high-frequency grounding techniques to reduce ground loop currents.

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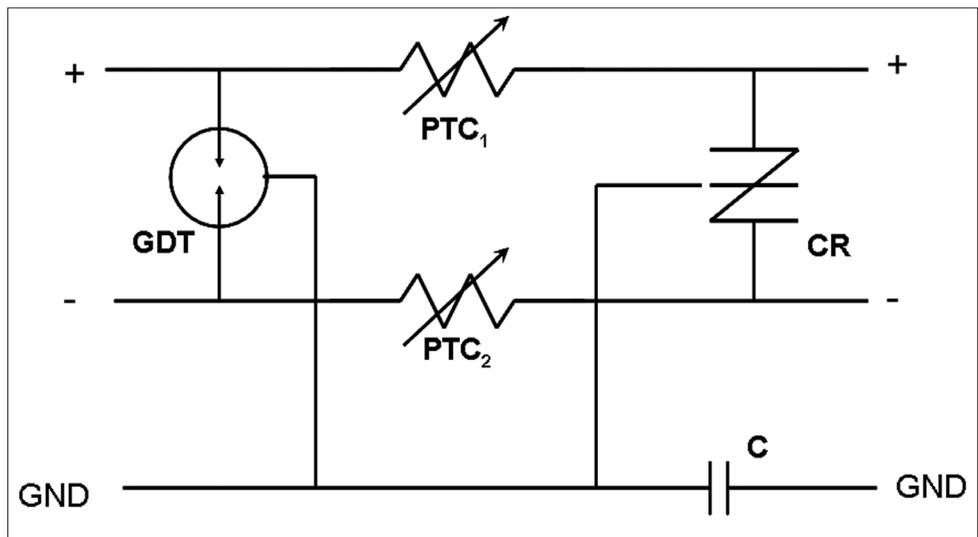


Figure 6. Communication SPDs circuitry.