# DEB NEWSLETTER

DIVISION OF ENGINEERING AND BUILDINGS

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## Lightning Protection Systems

### Introduction

Although not included in the currently adopted building code applicable to Commonwealth of Virginia projects (2015 Virginia Uniform Statewide Building Code), lightning protection systems are covered by various industry standards to include the Lightning Protection Institute Standard 175 (LPI-175) which covers design, inspection and certification of systems, National Fire Protection Association Standard 780 – Standard for the Installation of Lightning Protection Systems, Underwriters Laboratories Standard 96 (UL 96) Standard for Lightning Protection Components and UL 96A – Standard for Installation Requirements for Lightning Protection Systems. The Construction and Professional Services Manual (CPSM) requires an UL 780 Risk Assessment analysis for construction of new buildings and requires a lightning protection system when the analysis recommends a system. Main factors included in an analysis are building type and construction materials, environmental exposure, occupants, and building contents.


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First, let's consider a few definitions that are important to this article's understanding.

- **"Ground"** is defined in NEC 2014 as **"the earth"**.
- **"Grounded"** is defined as solidly connected to earth (electrical continuity from object to earth).
- **"Lightning"**: The discharge of electricity into the atmosphere either as cloud-to-cloud or cloud-to-earth typically driven by a difference in ionic charge (+ or -) or potential (voltage) difference between the bodies (clouds, earth).
- **"Lightning Protection System"** (LPS): An assembly of components including but not necessarily limited to aerials (lightning rods), electrical conductors (wires, cables, building steel), component connectors and grounding electrodes (driven rods, buried wire rings/loops) that is designed, installed, inspected and maintained to provide a safe conductive path to earth from lightning strikes on a protected building, tower or other structure to help preserve life and property. Properly designed and applied LPSs also include protection from lightning strike voltage entering a building through electrical, electronic, communication and data systems. Surge protectors achieve this vital function to protect from lightning strike voltage that may get onto a line connected to the building. This energy can travel for miles under the right circumstances so this protection helps ensure protection from more than just a local storm.

## Statistics, Facts and Misnomers

At any given time there are approximately 1,800 thunderstorms in progress around the world. Lightning strikes from these storms can carry up to 100 million volts in a single bolt with 10,000 volts at the earth interception level often cited. Air surrounding a bolt can reach 50,000˚F. UL maintained statistics show about $1 billion per year damage to buildings is caused by lightning. Other data bases put this number even higher, up to $4 billion. Fatality numbers also vary greatly depending on the data base referenced. Current estimates range from 20 to 80 fatalities per year. Final cause-of-death certification language affects these figures as cause of death could be listed as heart failure even if caused by a lightning strike.

An LPS neither attracts nor repels a lightning strike. A proper LPS receives the strikes and routes them harmlessly into the earth, discharging the dangerous electrical currents. Lightning doesn't just strike the tallest objects around but rather is an equal opportunity striker. It has been demonstrated that lightning is attracted to pointed well-grounded metal objects typically at a close range but not as lightning bolts are forming in the atmosphere.

## System Design

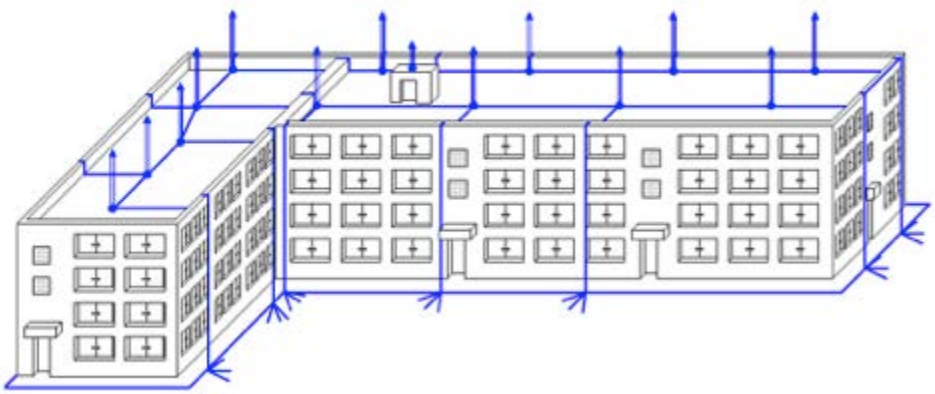
An LPS must be designed, installed and maintained properly to be effective. System inspection and certification helps ensure that the system meets the first two criteria when new and can be an aid to the owner to ensure the system is maintained properly. The LPS industry is becoming more integrated into the building development process through recognition of owners, design professionals and building codes and standards that an LPS offers benefits where deployed.

Leading reasons for the acceptance of LPSs include:

- Satisfies related safety requirements of insurers and Federal/State/Local government regulators.
- Fortifies technology reliability through protection (I.T. and all electronic systems).
- Improves sustainability goal achievement through preserving property by protection. (Note: The "greenest" assets are often those that don't need to be, or aren't, replaced.)
- Code and Standard Compliance: Although not included as a requirement of the VUSBC, new state (VA) buildings are subject to an NFPA 780 Hazard/Risk Analysis and when the analysis recommends an LPS then an LPS is required to be part of the design.
- Cost of a LPS on a new building is typically 1% or less of the building's cost. While not insignificant, the return based on a saved structure or I.T. system far outweighs the cost. Remember, it is a "risk" analysis.

Consider this concept:

If one can accept the premise (supported by years of evolving technical analysis) that an LPS neither attracts nor repels lightning strikes on a protected structure and that lightning strikes are simply seeking the earth/ground path of least resistance in order to discharge and are going to occur regardless the presence of an LPS, then picture the following: Envision a "net" created by a taut draping over the various lightning protection components of aerials and self-protecting metal components on the roof a facility. The "net" is connected by multiple down conductors/cables to various grounding electrodes such as driven rods or bare copper wire rings buried in a loop or ring around the protected facility. Whatever the charge, plus or negative, that is in the earth at the time of attracting a lightning strike is the same as the charge in the "net" because they are connected electrically to an equipotential state by the down conductors and grounding electrodes, i.e. there is no difference in voltage or charge between the earth and the "net". If and when a lightning strike occurs then a properly designed, installed and maintained LPS will catch the strike effectively in the "net", discharge the bolt through effective connection to ground and safely discharge the energy into the earth. Existing design and component standards specify material, installation arrangement and spacing requirements, component sizing and other details that have proven successful in performing their purpose to effectively perform as illustrated in this concept if there are no holes in the net (poor design, installation or maintenance).



## Codes, Standards and Risk Protection

Sustainability concerns have become a part of design and construction considerations. Hazard risk analyses that are readily available and reasonably usable introduce best-practice and standard-of-care metrics to the building design and ownership practice and obligations relative to lightning protection. The LPS industry has come forward with various standards and organizations to support and provide professional backbone. Influential and recognized organizations active in support of the LPS industry include the following, all of which maintain personnel, websites and literature available to anyone interested in LPS information and lightning related damage; and were vitally important to some information used in this article:

- **Lightning Protection Institute** – Standard 175 (design, inspection and certification); the inspection program offers an LPI Master Installation Certificate
- **National Fire Protection Association** – Standard 780; the NFPA inspection program offers a Master Label Certificate
- **Insurance Information Institute**
- **Underwriters Laboratories** – Standards 96, and 96A

Interested parties are encouraged to visit the websites of these organizations to become familiar with the services, information and wealth of knowledge available.

## Dormitory Occupant Load and Plumbing Fixture Calculations

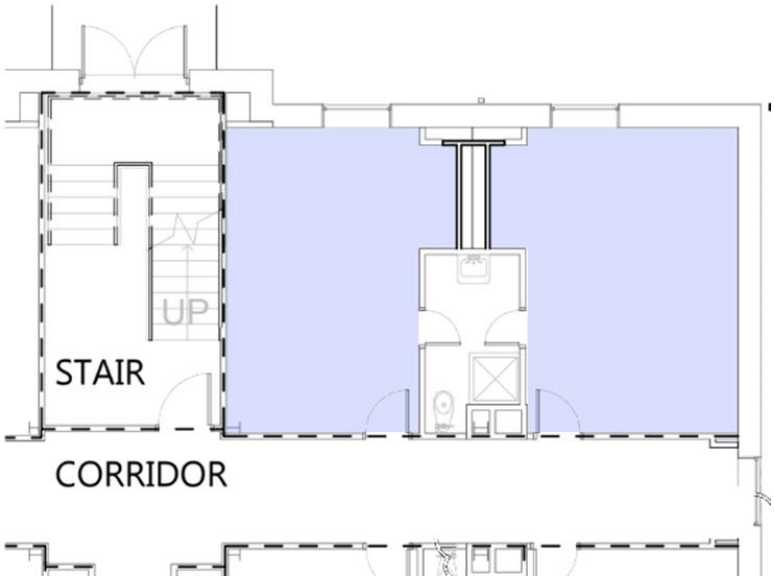
From the 2015 International Building Code Commentary:

> *"The table occupant loads are based on the stereotypical configuration of spaces. For example, the dorm requirements were written based on dormitories with sleeping rooms with two to four students, a gang bathroom and a meeting/study lounge on each floor."*

Many dormitories today only have two occupants per room and room sizes range widely. However, some dormitories use double bunk beds when needed. This is why dormitory occupant loads are calculated per VCC Table 1004.1.2 as dormitories, so the ratio of plumbing fixtures and the widths of egress components are not under-designed for maximum occupancy. Table 1004.1.2 Residential occupant loads are used for hotels, assisted living facilities, etc. Although dorms are R-2 use groups (VCC 310.4), the function of dormitories is listed separately in Table 1004.1.2 and is to be used for dormitory occupant load calculations.

New dormitories are generally not barracks style, as they have been in the past, because students (and parents of students) are demanding more space and comfort, while the universities are accommodating to increase enrollment. Taking that into account, state buildings will apply the VCC Table 1004.1.2 as follows.

The number of occupants for dormitories shall be computed at the rate of one occupant per 50 net SF for residential rooms. All other spaces with different functions (assembly with fixed seats, business areas, storage, etc.) shall be calculated in accordance with VCC 1004. The remaining area shall be calculated at one person per 200 SF gross. In the example below, the area in blue is calculated at 1:50 net SF, and the rest (corridor, stair, and bathroom) would be calculated at 1:200 gross.




Required plumbing fixtures shall be provided in accord with VCC Table 2902.1 for the number of Residential, Business, Assembly, Storage, and Mercantile occupants. It is not required to provide plumbing fixtures for the occupants in the gross remaining areas (1 occupant per 200 SF).

Per the 2015 Virginia Existing Building Code (VEBC), Alteration Level 2 and 3 projects do not need to increase plumbing fixture counts if the occupant load is not increasing more than 20% on a story (VEBC 603.10).

Refer to CPSM 4.1.2.1, Buildings at Colleges and Universities, for more information. Consult with your project's assigned DEB lead reviewer prior to getting too far into the design process to confirm the occupant load calculations and plumbing fixture counts are correct.

## VCCO Update

**Brittney Breisch** with the College of William and Mary recently passed the Virginia Construction Contracting Officer (VCCO) certification examination.

**Virginia Construction Contracting Officers** are state and local government employees who have completed the necessary training and successfully passed a multi-part examination focused on state procurement law, policy and procedures. VCCOs perform several keys functions in delivering projects including the procurement of professional services; the receipt, opening and review of bids; and in some cases the approval of CO-8 forms for recommending the award of construction contracts.

## The *Transmittal for DEB Review Services* (DGS-30-380)

When submitting documents for review by DEB, it is important to include a completed copy of the ***Transmittal for DEB Review Services*** ( aka, Form Number **DGS-30-380** ).

This form was recently improved to:

- accommodate both paper/hard copy and electronic/EDR submittals
- better clarify/summarize the types of documents required for each type of submittal
- Illustrate the typical number of document copies required for each type of submittal

When agencies and their design consultants use this standard transmittal form, it helps the DEB program management/business operations staff properly code and classify the submittals to log them into our database and document management systems and to direct the documents to the appropriate DEB review team.

## DEB Forms Update

The following new or revised DEB forms are now available on the **DGS Forms Center**. It is recommended to download the **DGS-30-000 form**, as it contains hyperlinks to all other forms for quick access. The **DGS-30-000** also provides a brief description of the changes to the recently revised forms.

| Form # | Form Name | aka | Rev. Date (mm/yy) |
|---|---|---|---|
| DGS-30-000 | DEB Forms Master List | | 06/19 |
| DGS-30-199 | Project Planner | CR-1 | 06/19 |
| DGS-30-199 Example | Project Planner - Example | CR-1 - Example | 06/19 |
| DGS-30-380 | Transmittal for DEB Review Services | | 06/19 |

## Jim Frye Retires


After an engineering career that spanned over 58 years, James H. Frye, PE retired from the Division of Engineering and Buildings on May 31, 2019. DEB, along with Jim's family and DEB/BCOM (Bureau of Capital Outlay Management) alumni, honored Jim's many years of service to the Commonwealth of Virginia with a retirement luncheon celebration.

Jim graduated from North Carolina State University in 1961, earning a Bachelor of Science degree in Civil Engineering with a Construction Option. Jim began his career by working for the Highway Department in Fredericksburg, designing bridges and parts of Interstate 95. He then joined a consulting engineering firm in Richmond, St. Clair, Callaway and Frye, where he became a partner and worked for over 25 years.

On April 1, 1992, Jim made a career change to return to serve the Commonwealth of Virginia. He accepted the position of Civil and Structural Review Engineer at DEB/BCOM. During the 25 years that Jim worked for DEB, he contributed significantly sharing his well-honed civil and structural insight. He developed great institutional knowledge, and became an integral part of DEB and a resource to all. Jim reviewed numerous projects, including university buildings, prisons, hospitals, towers, stadiums, courthouses, and parks' facilities.

DEB thanks Jim for his many years of service, his kindness, and his intellect.