Division of Engineering & Buildings

DEB Newsletter #78

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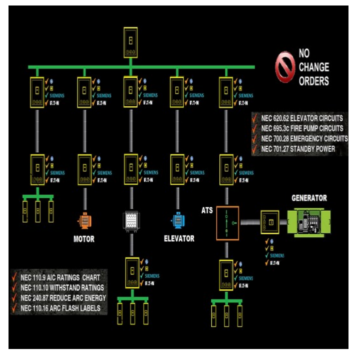
Electrical Analyses

There are three types of analyses required for electrical work required to ensure proper and safe operation of electrical distribution systems. Each of these studies serves a different purpose and should be performed at different times in the design process

Selective Coordination:

Selective coordination is intended to localize outages to the circuit or equipment affected during a fault condition. The study includes all other over current protection devices ahead of potential fault locations. When done correctly, the fault will prevent opening of breakers and/or fuses upstream of the load to include mains and protection of multi-tapped busses and feeders. This enables other branch circuits or feeders to remain active that are fed from the same source, panel, or distribution systems. This is especially important for life safety, medical, and building access systems.



Fault current (Short-Circuit) Analysis:

Listed overcurrent protective devices are rated for the maximum current they are capable of interrupting safely. This is known as the Ampere Interrupting Capacity (AIC) Rating. Above this current, the overcurrent device may fail by creating excessive heat, mechanical failure, becoming bonded closed, or creating a physical hazard due to flying debris or arc-flash.

A fault current analysis is used to determine the maximum current the distribution system can deliver to overcurrent protective devices in a distribution system. Once the maximum current available is determined by the study, all overcurrent devices will be appropriately rated to ensure they will not exceed their rating in any fault. It is critical that the device ratings exceed the available fault current based on the study.

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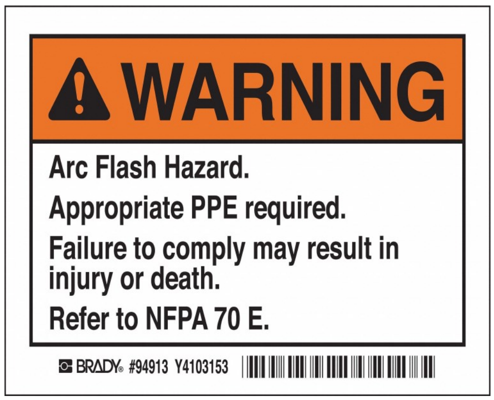
Also in this issue:

Announcements:

When electrical equipment shorts out, or there is a fault at the equipment bus, arcs form based on the available fault current and voltage present. Arcs generate electromagnetic forces (sometimes explosive in nature), light, heat, and can include hot metal vapors and debris expelled from the device or equipment. This presents an inherent risk to personnel where electrical power is present.

Arc-Flash Analysis:

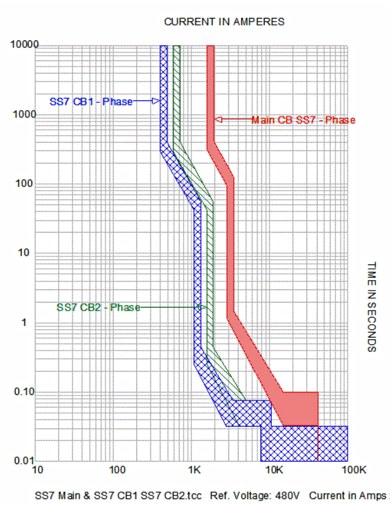
The level of risk is determined in an arc flash analysis using available fault current, voltage, and physical conditions to determine the amount of energy capable of being produced. The potential energy is in units of calories per square centimeters (Cal/CM2). While obscure to many, this information combined with safety protocols from NFPA 70E (NEC) and other safety publications will inform a technician the safe distances from the equipment (flash boundaries) and the level of personal protective equipment required to safely service the equipment.



Once the arc-flash hazards are determined, arc-flash notices should be permanently placed on equipment using labels and indelible means. The minimal requirements for equipment labeling are provided in NEC 110.16. As with all codes, this is the minimum standard and additional information may be provided as desired to enhance the safety of personnel.

Additional Information

Studies provided to DEB are required to be performed by a Virginia registered professional engineer. This may be the A/E of record or by another registered engineer delegated review by the A/E of record. Requirements for state projects are indicated in the Construction Professional Service Manual Section 4.1.2.18. The means and methods to conduct these studies shall comply to industry standards such as IEEE, equipment manufacturers, or trade organizations.



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Prohibitions on the use of certain hydrofluorocarbons (HFCs) in specific end-uses in the Commonwealth of Virginia

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On April 23, 2021, the Virginia State Air Pollution Control Board approved regulation 9VAC5 Chapter 145. This regulation prohibits the end-use in the Commonwealth of insulating products that are manufactured using certain HFCs and HVAC and refrigeration equipment that uses certain HFCs. The effective date of the prohibitions was January 1, 2022, unless a later effective date is specified (e.g. new centrifugal chillers may use HFC-134a until January 1, 2024). Further details will be provided in a future DEB Notice.

REFRIGERANTS—SUBSTITUTES ACCEPTABLE SUBJECT TO NARROWED USE LIMITS

End-use	Substitutes	Decision	Narrowed use limits	Further information
Centrifugal chillers (new only)	HFC-134a	Acceptable subject to narrowed use limits	Acceptable after January 1, 2024, only in military marine vessels where reasonable efforts have been made to ascertain that other alternatives are not technically feasible due to performance or safety requirements	Users are required to document and retain the results of their technical investigation of alternatives for the purpose of demonstrating compliance. Information should include descriptions of: • Application in which the substitute is needed; • Substitutes examined and rejected; • Reason for rejection of other alternatives, e.g., performance, technical or safety standards; and/or • Anticipated date other substitutes will be available and qualified and projected time for switching

Occupancy Considerations – Part 2 of 2
Occupant Load Determination

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The *Occupant Load* (OL) of a building or space is defined in the 2018 Virginia Construction Code (VCC) as "the number of persons for which the means of egress of a building or portion thereof is designed." Hence, the OL forms the basis for all egress requirements AND has a direct impact on the requirement for fire suppression and fire alarm systems, the required number of plumbing fixtures, interior finish requirements, and various other design features mandated by the 2018 Virginia Uniform Statewide Building Code.

As critical as this information is, methods for determining the OL of a building vary throughout the design community. The prerequisites to OL determination, including floor area determination and group classification, were discussed previously in Part 1 of this series on occupancy considerations. Refer HERE. This second and final installment of the series aims to provide a clear and rational approach to determining the OL.

The following terms are frequently utilized in code-related discussions but are sometimes misunderstood and misapplied. In an effort to clarify the intent, a working definition for each term has been developed:

- **Occupancy** – The utilization of a building
- **Group** (or sometimes expressed as Occupancy Group) – A specific type or category of occupancy as found in VCC 303 thru 312 (e.g. A-3, B, I-3, R-1, S-2, etc.)
- **Classification** – The assignment of a group to an occupied area of a building
- **Use** – The specific purpose of an occupied area which is subordinate to the applicable group as listed in the sub-sections of VCC 303 thru 312 (e.g. Dance Hall, Library, Correctional Center, etc.)
- **Function** – The manner in which an occupied area is used as tabulated in VCC Table 1004.5.

The example scenario that follows is identical to the previous article and is intended to illustrate an acceptable method for classifying the various groups on a given floor of a building and for determining the OL in accordance with the VCC. The allowable building height and the allowable number of stories will not be addressed here, although it is acknowledged that these are also important design considerations which are closely related to the topic at hand. For simplicity, only a single floor of a fictitious building will be considered.

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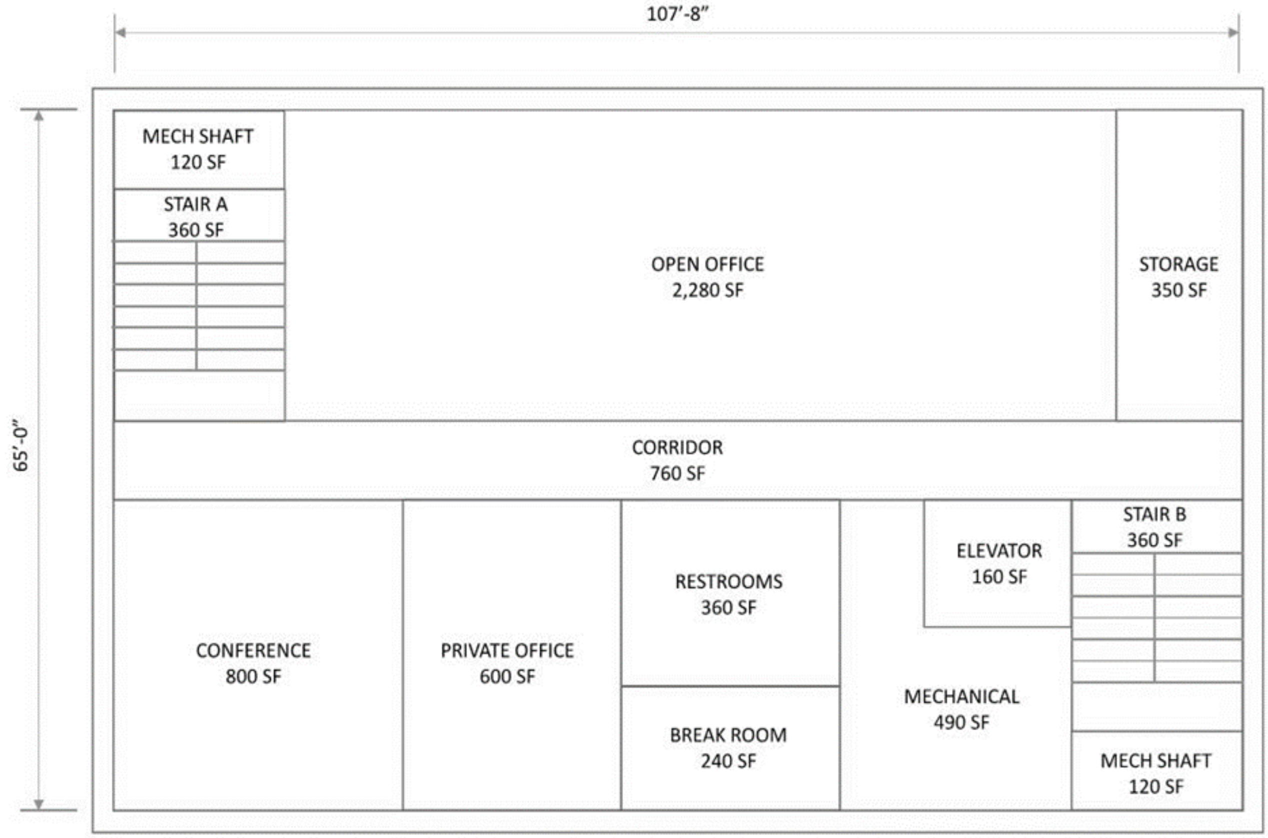

As summarized in Part 1, the process for classifying the occupancy and determining the number of people on a given floor of a building can be broken down into four basic steps: 1) Determine the Gross Floor Area, 2) Classify the Applicable Group(s) on the Floor, 3) Determine the OL in accordance with VCC 1004, and 4) Document the OL on the Drawings. Based on the analysis previously presented, the gross floor area was determined to be 6,759 SF and the most appropriate group classification for this floor was determined to be: Non-separated B, A-3, & S-1 with Accessory S-1. Or, Non-separated B, A-3, & S-1, depending on the construction type classification of the building. With this information, steps 1 and 2 have been completed.

The last two steps of this process are explained in detail in the sections that follow.

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3. Determine the OL in accordance with VCC 1004

The OL determination should typically begin with selection of the appropriate gross Occupant Load Factor (OLF) for the floor or area in consideration per VCC Table 1004.5 – Maximum Floor Area Allowances per Occupant (see below). Refer to the terminology above and recall that the "function" of a space dictates the appropriate OLF. While a space may be classified as a Business group, the function of the space could be one of several categories. Since the example floor primarily functions as a business area, an OLF of 150 gross is therefore selected from the table. The important thing to note here is that a gross OLF is selected first, which will be applied to the entire gross floor area (inclusive of all interior walls, structural elements, stairways, etc.).

TABLE 1004.5 MAXIMUM FLOOR AREA ALLOWANCES PER OCCUPANT

FUNCTION OF SPACE	OCCUPANT LOAD FACTOR[a]
Accessory storage areas, mechanical equipment room	300 gross
Agricultural building	300 gross
Aircraft hangars	500 gross
Airport terminal	
Baggage claim	20 gross
Baggage handling	300 gross
Concourse	100 gross
Waiting areas	15 gross
Assembly	
Gaming floors (keno, slots, etc.)	11 gross
Exhibit gallery and museum	30 net
Assembly with fixed seats	See Section 1004.6
Assembly without fixed seats	
Concentrated (chairs only—not fixed)	7 net
Standing space	5 net
Unconcentrated (tables and chairs)	15 net
Bowling centers, allow 5 persons for each lane including 15 feet of runway, and for additional areas	7 net
Business areas	150 gross
Concentrated business use areas	See Section 1004.8
Courtrooms—other than fixed seating areas	40 net
Day care	35 net

Next, all spaces on the floor or area in consideration which serve a different function (i.e. other than a business area function) are subtracted from the gross floor area and assigned an appropriate OLF based on the actual function. In this example, both the Conference Room and the Break Room serve an assembly function (unconcentrated tables and chairs without fixed seats) and are therefore assigned an OLF of 15 net. Likewise, accessory storage areas and mechanical rooms are assigned an OLF of 300 gross. Refer to Part 1 for an expanded discussion on the group classification of these spaces, which is a separate and distinct consideration.

There are cases where the anticipated occupant load of a given space is actually greater than the calculated occupant load based on the applicable OLF from Table 1004.5. In such cases, care must be taken to ensure that the occupant density does not exceed 1 occupant per 7 SF of occupiable floor space per VCC 1004.5.1 and that the maximum of the calculated OL and the actual OL is utilized when determining the design value.

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Finally, the OL is determined by combining the occupants for each space that has been subtracted from the gross floor area with the calculated occupants throughout the remaining gross floor area. In this example, the remaining gross floor area after all spaces with functions other than business areas have been subtracted is as follows: 6,759 SF (Gross Floor Area) - 800 SF (Conference Room) - 240 SF (Break Room) - 490 SF (Mechanical Room) - 350 SF (Storage Room) = 4,879 SF. From here, the OL can thus be determined per VCC 1004.5:

(800 SF / 15 net) + (240 SF / 15 net) + (490 SF / 300 gross) + (350 SF / 300 gross) + (4,879 SF / 150 gross) = 54 + 16 + 2 + 2 + 33 = **107 occupants**.

4. Document the OL on the Drawings

It is critical that the OL is conveyed accurately and concisely on the drawings. It must be clearly demonstrated that the entire gross floor area has been accounted for in the determination of the number of occupants. To this point, a common error identified during the DEB review process is the omission of certain areas that are believed to be unoccupied or not simultaneously used along with adjacent spaces (e.g. restrooms, break rooms, stairs, corridors, etc.) Below is a sample OL chart for the example floor that could be provided:

LEVEL XX **TOTAL AREA=6,999 SF** **GROSS FLOOR AREA = 6,759 SF**						
SPACE	AREA	OCCUPANT LOAD FACTOR	GROUP CLASSIFICATION	NUMBER OF OCCUPANTS		
				Calculated	Actual	Design
Mechanical Shafts	240 SF	-	-	0	0	0
Conference Room	800 SF	15 net	A-3	53.3	32	54
Break Room	240 SF	15 net	B	16	10	16
Mechanical Room	490 SF	300 gross	S-1	1.6	0	2
Storage Room	350 SF	300 gross	S-1	1.2	0	2
Remaining Business Areas	4,879 SF	150 gross	B	32.6	20	33
TOTAL	6,999 SF					107
OCCUPANT LOAD				**107**		

It is acknowledged that there is not a one-size-fits-all approach to OL documentation that applies to every project. However, a thorough presentation of this information on the drawings provides a strong backbone for the remainder of the design and serves as a means by which code compliance is effectively demonstrated.

Final Thoughts

The determination of the OL in a building can be a relatively simple process when it is derived within the framework of the VCC. The presentation of this information on the drawings can also be achieved in a much more concise and streamlined manner than what is commonly encountered on many projects. For instance, it is unnecessary to assign an occupant load to each individual room within an overall occupancy if all such rooms serve the same function (e.g. multiple offices and related support rooms within a Business group). Always remember to account for the entire gross floor area and consider all spaces to be simultaneously occupied. These few tips alone should serve to address the most common issues related to OL determination.

Job Opportunities

DEB is currently looking for qualified applicants for the following positions:

- Capital Outlay Program Reviewer
- State Review Architect
- State Capital Outlay Reviewer
- Program Support Technician

For more information check the DGS Job opportunities on Jobs.Virginia.gov

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DEB Welcomes Dwayne Smith, Jeffrey Barra, and Paula Shifflett

Dwayne Smith is a Professional Engineer and LEED AP who has recently joined the DEB team as a State Review Energy Engineer. Dwayne earned his Bachelor of Science in Mechanical Engineering from the University of Maryland, Baltimore County. Dwayne has over 27 years of experience in the design, project management, and construction administration of engineering projects for the construction and renovation of commercial and residential buildings.

Jeffrey Barra, AIA, VCCO, a Registered Architect with over 40 years of experience, recently joined DEB as a State Review Architect. Most recently, Jeffrey has been working for the Virginia Department of State Police in their Property and Finance Division. Prior to his VSP experience, he was the president and owner of the architectural firm Toano Design, Inc., for over 20 years - his clients included COV agencies. Please refer to the DEB website for the list of agencies that Jeff is now supporting as DEB Lead Reviewer.

Paula Shifflett has joined DEB as a Business Operations Specialist. Paula comes to us from the private sector where she worked for large companies, including Anthem and GE, as well as 15 years running a small business. She has a wide range of accounting and financial reporting experience. Paula holds an Associates Degree in Business Administration with a minor in Information Technology from J Sargeant Reynolds Community College.

VCCO Update

The following individuals recently passed the Virginia Construction Contracting Officer (VCCO) Certification Examination:

- Bill Sheehan - Virginia Community College System
- Berhan Aljiji - University of Virginia