EPO or No—A Consideration of NEC Articles 645.10 and 685

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Most people in the electrical design and construction industry are inclined to associate a data center or critical environment with an emergency power off (EPO). But what every designer doesn't know is that an EPO is not always required in a data center.

Article 645 in the 2005 edition of the *National Electrical Code* discusses the requirements for information technology equipment. It is important to note that NEC chapters 1 through 4 are required for the design of electrical distribution systems. Chapters 5, 6 and 7 are for special conditions that apply to special occupancies and equipment—occupancies such as hospitals, garages, bulk fuel storage and classified areas, and yes, IT equipment. These spaces typically require a significant number of additional requirements in order to be code-compliant.

If the electrical distribution system designer follows the requirements of chapter 1 through 4 only, the EPO is not a required part of the electrical distribution system. The electrical engineer or system designer must be aware of the special provisions that Article 645 allows in reference to the installation of power and communication cables under the raised floor before deciding to omit the EPO for the electrical distribution system.

NEC Article 645 of has a number of special provisions that the electrical system designer should consider before deciding to install an EPO.

There are many advantages to complying with Article 645, but the two main advantages are the following:

1. Listed IT equipment power cables, communication cables and interconnecting cables and associated boxes, connectors, plugs and receptacles are not required to be secured as required in the NEC articles 1 through 4.

2. Non-plenum-rated cables are allowed under the raised floor.

The first item is a huge issue for the typical data center and other critical environments. During its life, the typical data center will see many changes in its IT equipment. With the continual evolution of servers, routers and mass storage devices, and the changing power and HVAC densities due to the propagation of the blade server in data centers, cable changes are inevitable and regular. This continuing change of the location of IT equipment would be significantly more restrictive if the IT power and communication cables and associated boxes, connectors and plugs had to be tied down to comply with other section of the NEC.

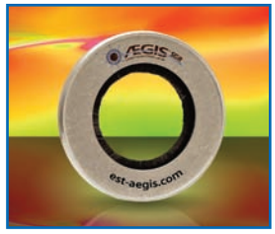
The typical data center raised floor also acts as a means of distributing air from the computer room air-conditioning (CRAC) units through perforated tiles and across the racks of servers on top of the raised floor. Because the raised floor is used to distribute air, this area is a plenum. In typical air plenums, the data cables need to be plenum-rated.

Article 645, if all parts are adhered to, allows for non-plenum-rated cable. In addition to the requirement of an EPO, the raised floor must be served from a dedicated mechanical system. This is required so the air does not exchange with the rest of the building. If there is a fire inside of the data center, the toxic fumes produced by nonmetallic wiring methods will only affect the data center room and equipment, because the data center is not occupied by people on a regular basis. Additionally, ventilation in the underfloor area must be for the data center only and be provided with smoke detection so that air circulation will stop when fire or combustion is detected.

Most data center maintenance personnel are not big fans of the EPO stations required by this section of the NEC for critical IT environments. These devices can be a single point of failure. We have all heard the stories of an inadvertent disconnect by untrained personnel, or the stacks of boxes pilled up along the entrance that trip the critical service offline.

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If an electrical engineer or system designer chooses to abide by Article 645, there is an exception for not requiring EPO. Paragraph 645.10 provides an exception to installations that qualify under the provisions of Article 685, "Integrated Electrical Systems."

NEC Article 685 is utilized when an orderly shutdown is necessary to ensure safe operation. Conditions of maintenance and supervision are required to ensure that only qualified personnel service the equipment. In addition, effective safeguards acceptable to the AHJ are required. The NEC indicates that for some industrial processes, the sudden loss of power to critical equipment provides for an unacceptable level of risk. In these cases, an orderly shutdown is required to prevent severe damage to equipment and to mitigate risk to personnel. The NEC further states that "orderly shutdown" is common in nuclear power plants, paper mills and other hazardous facilities.

> The major advantage to complying with 645 is that listed IT equipment cables are not required to be secured as with other NEC sections.

Because power and HVAC systems are the major means of support of all data centers and critical environments, very careful deliberation should be given to whether or not to comply with the additional requirements of Article 645. The prerequisites for these relaxed NEC codes are found in NEC 2005, Article 645.4, which states that the article shall apply, provided than several conditions are met. Again, this is an optional code article. Depending on your system application, the electrical distribution system engineer can elect to abide by the requirements or not.

In addition to the above requirements for a disconnecting means, other particular requirements of Article 645 include:

1. Equipment that can be installed in the room must be listed as IT equipment.

2. A separate HVAC system is provided that is dedicated to the IT equipment and is separated from the other areas of occupancy. Any HVAC system that serves other occupancies shall be permitted to also serve the information technology room if fire and smoke dampers are provided at the point of penetration of the room boundary.

3. The room is occupied only by those personnel required for maintenance and fictional operation of the critical environment.

4. The room is separated from other occupancies by fire-resistant-rated walls, floors and ceilings with protected openings.

After reading all of this, you still may be wondering why the NEC would provide for a means of so easily disconnecting power in a critical environment. After all, there is so much design and money spent to improve reliability and availability of the systems. Any down-

time can be very expensive. You have to remember that the main intent of the NEC is to protect people and property, not to ensure the most uptime for your facility. The main intent of the special requirements detailed in Article 645 for data centers is to protect fire personnel from being injured or electrocuted. When emergency responders enter a data center or other critical environment, they need to have a fast and simple method of ensuring that the electrical system is dead. Without the EPO, the fireman may trip the main breaker as it is done in a normal building. In a critical environment, the tripping of a main breaker may just turn on the backup generators, change the position of a static transfer switch or just kick in the batteries on a UPS system. The fire personnel do not have the time to study complex one-line diagrams in order to disable the electrical system in an emergency situation.

Additionally, Article 645 is proposed to diminish the spread of smoke and fire. Article 645 is intended to reduce the spread of fire and smoke by requiring fire-resistant walls and separate independent HVAC systems for IT rooms and data centers as well as smoke detection under the raised floor.

As stated above, the major advantage when complying with Article 645 is that listed IT equipment cables are not required to be secured as required in other sections of the NEC. Each branch circuit conductor for data processing equipment must have an ampacity not less than 125% of the total connected load, NEC 645.5.

In addition to hard wiring IT equipment, you can connect data processing equipment to a branch circuit by either a flexible cord or a cord set assembly, as long as the flexible cord is no longer than 15 ft., with an attachment plug and the cord set assembly. Additionally, where run on the surface of the floor, it must be protected against physical damage.

The electrical contractor can install receptacles and run power cables, communications cables, connecting cables and interconnecting cables under raised floors. But you can do this only if the construction meets these conditions:

1. The raised floor must be of suitable construction and the area under the floor must be accessible.

2. You must also install the branch circuits for receptacles or hard-wired equipment in one of the following types of raceway: rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit, electrical metallic tubing, electrical nonmetallic tubing, metal wireway, nonmetallic wireway, surface metal raceway with metal cover, nonmetallic surface raceway, flexible metal conduit, liquidtight flexible metal conduit, liquidtight flexible nonmetallic conduit, Type MI cable, Type MC cable, or Type AC cable. These supply conductors shall be installed in accordance



Human error is often the source of unintended shutdown; EPO devices are often the culprits.

When an electrical system designer chooses to abide by Article 645, there is an exception for not requiring EPO; paragraph 645.10 provides an exception that qualifies under Article 685.

ASHRAE Details Energy-Saving Measures

An update on measures that have shown to yield significant energy reductions will be presented at ASHRAE's 2007 Winter Meeting in Dallas in a seminar, "Achieving 50% and Beyond Approach to Net Zero Energy Use in Buildings Part 1." It takes place from 7:45 a.m. to 9:15 a.m. on Jan. 29, and is followed by Part 2 from 10:45 a.m. to 12:15 p.m.

Achieving that goal will require more than simply substituting or adopting new technologies and systems. It will acquire changes in design practice in which the design team converts energy strategies into building plans, sections, details and construction.

The guidance is being developed by ASHRAE in cooperation with the American Institute of Architects, the Illuminating Engineering Society of North America and the U.S. Green Building Council, through a series of Advanced Energy Design Guides for the commercial building sector.

John Mitchell, P.E., will chair a scoping committee studying ways to achieve building designs as close as is feasible to net zero energy use, defined as "a building which, on an annual basis, uses no more energy than is provided by the building's on-site renewable energy sources." This study will provide the basis for the development of Advanced Energy Design Guides to go 50% and beyond minimum standards for energy use.

The scoping study recently was completed and identified measures that achieve significant energy savings. Some of the measures identified are:

- Improved daylighting and electrical illumination systems
- Reduction of parasitic power requirements in air and water distribution systems
- Separate treatment of ventilation and internal thermal loads
- Improved delivery of conditioning to where it is needed
- Improved part-load performance of HVAC components
- Water-loop heat pump systems.

Speaker will address topics such as: net-zero energy building ideas, case studies, integrated design, daylighting, HVAC and ventilation, distribution systems and architectural perspectives as a bridge to engineering.



IT managers often see EPO devices as a single point of failure forced on them.

with the requirements of 300.11.

The electrical system designer can utilize nonmetallic raceways (i.e. PVC) within the raised-floor area, because this space is not subject to physical damage or required to comply with the environmental airspace requirements of 300.22(C). The use of nonmetallic raceways in an air-handling space is not prohibited, because the air does not move within the rest of the building. If there is a fire inside the data center, the toxic fumes emitted by nonmetallic wiring methods will only affect the data center room, which is typically not occupied.

3. Ventilation in the underfloor area must be for the IT equipment room only, except as provided in 645.4(2). The ventilation system shall be arranged with appropriate smoke detection devices so air circulation will cease after the detection of fire or products of combustion.

4. Openings in raised floors must protect the cables against abrasions and minimize the debris underneath the raised floor.

5. Cables other than indicated in no. 2 above must be listed for use Type DP (data processing) cable, except for: a) interconnecting cables enclosed in a raceway; b) interconnecting cables listed with equipment manufactured prior to July 1, 1994, and installed with that equipment; c) cable type designation Type TC, CL2, CL3, PLTC, NPLF, FPL, OFC, OFN, CM, and CATV. (Conductors with green or green with one or more yellow stripes, insulated 4 AWG and larger, and marked "for use in cable trays" or "CT use" are permitted for equipment grounding (bonding) of the raised floor parts); and d) abandoned cables. (Remove these, unless they are in metal raceways.)

Before designing a data center that conforms with 645, determine the risks and advantages that this NEC article provides and consult the local AHJ.

Before designing a data center that conforms with NEC Article 645, determine the risks and advantages that the section of the NEC provides and evaluate your electrical design with the local AHJ. After this analysis, you may determine that Article 645 is not appropriate for your project.

A wrong choice in design could dramatically affect the operation of the critical environment.

If an "emergency power off" is installed, it is incumbent upon the data center operation staff to only allow trained personnel into the critical environment. cse

New User's Manual for Standard 62.2

ASHRAE published a manual to aid users in designing and constructing homes and apartments that comply with its residential ventilation and indoor air quality standard. The manual was co-developed by the Indoor Air Quality Association.

The User's Manual is the first for ASHRAE Standard 62.2-2004, Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, which provides the minimum requirements necessary to achieve acceptable indoor air quality for dwellings.

"The 62.2 User's Manual will provide HVAC engineers and IAQ consultants with practical information to ensure that ventilation positively affects the indoor environment," Robert G. Baker, IAQA president and ASHRAE member, said. "IAQA was pleased to be a co-sponsor of this dynamic publication."

The manual explains how to comply with all the requirements of the standard, provides examples illustrating specific methods of complying with sections of the standard, and includes background material explaining why many of the requirements of the standard exist, according to Roger Hedrick, who co-authored the book.

The manual is targeted toward builders and subcontractors, but will also be useful for code officials, researchers, and interested homeowners.

"The manual has been developed as a document that will accompany Standard 62.2 and provide guidance for applying its requirements to the design and construction of residential buildings," David Grimsrud, chair of the Standard 62.2 committee, said. "It serves as a guide to clarifying issues for users."

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