

ARTICLE

646

Modular Data Centers

Part I. General

Δ **646.1 Scope.** This article covers modular data centers.

Informational Note No. 1: Modular data centers include the installed information technology equipment (ITE) and support equipment, electrical supply and distribution, wiring and protection, working space, grounding, HVAC, and the like, that are located in an equipment enclosure.

Informational Note No. 2: See NFPA 75, *Standard for the Fire Protection of Information Technology Equipment*, which covers the requirements for the protection of information technology equipment and systems in an information technology equipment room.

Informational Note No. 3: See UL 60950-1, *Information Technology Equipment — Safety — Part 1: General Requirements*, and UL 62368-1, *Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements*, for information on listing requirements for both information technology equipment and communications equipment contained within a modular data center.

Informational Note No. 4: *Modular data centers* are sometimes referred to as containerized data centers.

Informational Note No. 5: Equipment enclosures housing only support equipment (e.g., HVAC or power distribution equipment) that are not part of a specific modular data center are not considered a modular data center.

A modular data center (MDC) is similar to an information technology equipment (ITE) room, which is covered under Article 645. The distinction between the two is that the MDC is a preassembled and packaged enclosure delivered with the ITE installed, while the ITE room is built and equipped on site. The MDC can be supplied through the premises wiring system or through a separate MDC enclosure. Data, fire alarm, communications, control, audio, and visual circuits from the MDC typically are brought outside the MDC and into the facility. An MDC is large enough for personnel to enter; therefore, access, working space, and emergency lighting are specifically addressed.

646.3 Other Articles. Circuits and equipment shall comply with 646.3(A) through (M) as applicable. Wherever the requirements of other articles of this *Code* and Article 646 differ, the requirements of Article 646 shall apply.

(A) Spread of Fire or Products of Combustion. Sections 300.21, 770.26, and 800.26 shall apply to penetrations of a fire-resistant room boundary, if provided.

Δ **(B) Wiring and Cabling in Other Spaces Used for Environmental Air (Plenums).** The following sections and tables shall apply to wiring and cabling in other spaces used for environmental air (plenums) within a modular data center space:

- (1) Wiring methods: 300.22(C)(1)
- (2) Class 2, Class 3, and PLTC cables: 722.135(B)

- (3) Fire alarm systems: 760.53(B)(2) and Table 760.154
- (4) Optical fiber cables: 770.113(C) and Table 770.154(a)
- (5) Communications circuits: 800.113(C) and Table 800.154(a)
- (6) CATV and radio distribution systems: 800.113(C) and Table 800.154(a)

Informational Note: Environmentally controlled working spaces, aisles, and equipment areas in an MDC are not considered a plenum.

Δ **(C) Grounding and Bonding.** The non-current-carrying conductive members of optical fiber cables in an MDC shall be grounded in accordance with 770.114. Grounding and bonding of communications protectors, cable shields, and non-current-carrying metallic members of cable shall comply with Part IV of Article 805.

Δ **(D) Electrical Classification of Data Circuits.** Section 725.60(A)(4) shall apply to the electrical classification of listed information technology equipment signaling circuits.

(E) Fire Alarm Equipment. Parts I, II, and III of Article 760 shall apply to fire alarm systems, cables, and equipment installed in an MDC, where provided. Only fire alarm cables listed in accordance with Part IV of Article 760 and listed fire alarm equipment shall be permitted to be installed in an MDC.

Δ **(F) Cable Routing Assemblies and Communications Wires, Cables, Raceways, and Equipment.** Sections 800.110, 800.113, and 800.154 shall apply to cable routing assemblies and communications raceways. Parts I, II, III, IV, and V of Articles 800 and 805 shall apply to communications wires, cables, and equipment installed in an MDC. Only communications wires and cables listed in accordance with 800.179, cable routing assemblies and communications raceways listed in accordance with 800.182, and communications equipment listed in accordance with 800.171 shall be permitted to be installed in an MDC.

Informational Note: See Article 100 for a definition of *communications equipment*.

(G) Community Antenna Television and Radio Distribution Systems Cables and Equipment. Parts I, II, III, IV, and V of Articles 800 and 820 shall apply to community antenna television and radio distribution systems equipment installed in an MDC. Only community antenna television and radio distribution cables listed in accordance with 800.179 and listed CATV equipment shall be permitted to be installed in an MDC.

(H) Surge-Protective Devices (SPDs). Where provided, surge-protective devices shall be listed and labeled and installed in accordance with Part II of Article 242.

(I) Lighting. Lighting shall be installed in accordance with Parts I through XIV of Article 410.

(J) Power Distribution Wiring and Wiring Protection. Power distribution wiring and wiring protection within an MDC shall comply with Parts I, II, and III of Article 210 for branch circuits.

(K) Wiring Methods and Materials. Wiring methods and materials shall comply with the following:

- (1) Unless modified elsewhere in this article, wiring methods and materials for power distribution shall comply with Chapter 3. Wiring shall be suitable for its use and installation and shall be listed and labeled.

Exception: This requirement shall not apply to wiring that is part of listed and labeled equipment.

- (2) The following wiring methods shall not be permitted:
 - a. Integrated gas spacer cable: Type IGS (Article 326)
 - b. Concealed knob-and-tube wiring (Article 394)
 - c. Messenger-supported wiring (Article 396)
 - d. Open wiring on insulators (Article 398)
 - e. Outdoor overhead conductors over 600 volts (Article 395)
- (3) Wiring in areas under a raised floor that are constructed and used for ventilation as described in 645.5(E) shall be permitted to use the wiring methods described in 645.5(E) if the conditions of 645.4 are met.
- (4) Installation of wiring for remote-control, signaling, and power-limited circuits shall comply with Part II of Article 725.
- (5) Installation of optical fiber cables shall comply with Part V of Article 770.
- (6) Alternate wiring methods as permitted by Article 645 shall be permitted for MDCs, provided that all of the conditions of 645.4 are met.

(L) Service Equipment. For an MDC that is designed such that it can be powered from a separate electrical service, the service equipment for control and protection of services and their installation shall comply with Parts I, V, VI, and VII of Article 230. The service equipment and their arrangement and installation shall permit the installation of the service-entrance conductors in accordance with Parts I and IV of Article 230. Service equipment shall be listed and labeled and marked as being suitable for use as service equipment.

(M) Disconnecting Means. An approved means shall be provided to disconnect power to all electronic equipment in the MDC in accordance with 645.10. There shall also be a similar approved means to disconnect the power to all dedicated HVAC systems serving the MDC that shall cause all required fire/smoke dampers to close.

Δ 646.4 Applicable Requirements. All MDCs shall be listed and labeled and comply with 646.3(M) and 646.5 through 646.9 or comply with this article.

Informational Note: See UL Subject 2755, Outline of Investigation for Modular Data Centers, for information on listing requirements for MDCs.

An MDC must be listed and labeled. An evaluation of the equipment, installed wiring, lighting, and work space is conducted as part of the listing. Any field-installed wiring — including supply circuits and data circuits — is required to comply with the appropriate NEC® article.

Δ 646.5 Nameplate Data. A permanent nameplate shall be attached to each equipment enclosure of an MDC and shall be plainly visible after installation. The nameplate shall include the following information, as applicable:

- (1) Supply voltage, number of phases, frequency, and full-load current. The full-load current shown on the nameplate shall not be less than the sum of the full-load currents required for all motors and other equipment that may be in operation at the same time under normal conditions of use. Where unusual type loads, duty cycles, and so forth, require over-sized conductors or permit reduced-size conductors, the required capacity shall be included in the marked full-load current. Where more than one incoming supply circuit is to be provided, the nameplate shall state the preceding information for each circuit. For listed equipment, the full-load current shown on the nameplate shall be permitted to be the maximum, measured, 15-minute, average full-load current.

Informational Note No. 1: See 430.22(E) and 430.26 for duty cycle requirements.

- (2) For MDCs powered by a separate service, the short-circuit current rating of the service equipment provided as part of the MDC.

Informational Note No. 2: This rating may be part of the service equipment marking.

- (3) For MDCs powered by a separate service, if the required service as determined by Parts III and IV of Article 220 is less than the rating of the service panel used, the required service shall be included on the nameplate. As an alternative to the feeder and service load calculations required by Parts III and IV of Article 220, feeder and service load calculations for new, future, or existing loads shall be permitted to be used if performed by qualified persons under engineering supervision.

Informational Note No. 3: Branch circuits supplying ITE loads are assumed to be loaded not less than 80 percent of the branch-circuit rating with a 100 percent duty cycle.

- (4) Electrical diagram number(s) or the number of the index to the electrical drawings.
- (5) For MDC equipment enclosures that are not powered by a separate service, feeder, or branch circuit, a reference to the powering equipment.
- (6) Manufacturer's name or trademark.

646.6 Supply Conductors and Overcurrent Protection.

A permanent nameplate is required on each enclosure to indicate the required supply and the full-load current. The full-load

current is not necessarily determined with all equipment operating simultaneously as indicated in 646.5(1). The MDC is considered a continuous load; therefore, supply conductors must be sized for 125 percent of the marked full-load current.

(A) Size. The size of the supply conductor shall be such as to have an ampacity not less than 125 percent of the full-load current rating.

Informational Note No. 1: See the 0–2000-volt ampacity tables of Article 310 for ampacity of conductors rated 600 V and below.

Informational Note No. 2: See 430.22(E) and 430.26 for duty cycle requirements.

(B) Overcurrent Protection. Where overcurrent protection for supply conductors is furnished as part of the MDC, overcurrent protection for each supply circuit shall comply with 646.6(B) (1) through (B)(2).

(1) Service Equipment — Overcurrent Protection. Service conductors shall be provided with overcurrent protection in accordance with 230.90 through 230.95.

(2) Taps and Feeders. Where overcurrent protection for supply conductors is furnished as part of the MDC as permitted by 240.21, the overcurrent protection shall comply with the following:

- (1) The overcurrent protection shall consist of a single circuit breaker or set of fuses.
- (2) The MDC shall be marked “OVERCURRENT PROTECTION PROVIDED AT MDC SUPPLY TERMINALS.”
- (3) The supply conductors shall be considered either as feeders or as taps and be provided with overcurrent protection complying with 240.21.

646.7 Short-Circuit Current Rating.

(A) Service Equipment. The service equipment of an MDC that connects directly to a service shall have a short-circuit current rating not less than the available fault current of the service.

(B) MDCs Connected to Branch Circuits and Feeders. Modular data centers that connect to a branch circuit or a feeder circuit shall have a short-circuit current rating not less than the available fault current of the branch circuit or feeder. The short-circuit current rating of the MDC shall be based on the short-circuit current rating of a listed and labeled MDC or the short-circuit current rating established using an approved method.

Exception: This requirement shall not apply to listed and labeled equipment connected to branch circuits located inside of the MDC equipment enclosure.

Informational Note: See UL 508A-2018, *Standard for Industrial Control Panels, Supplement SB*, for an example of an approved method.

(C) MDCs Powered from Separate MDC System Enclosures. Modular data center equipment enclosures, powered from a

separate MDC system enclosure that is part of the specific MDC system, shall have a short-circuit current rating coordinated with the powering module in accordance with 110.10.

Informational Note: See UL 508A-2018, *Standard for Industrial Control Panels, Supplement SB*, for an example of an approved method for determining short-circuit current ratings.

646.8 Field-Wiring Compartments. A field-wiring compartment in which service or feeder connections are to be made shall be readily accessible and comply with the following:

- (1) Permit the connection of the supply wires after the MDC is installed
- (2) Permit the connection to be introduced and readily connected
- (3) Be located so that the connections may be readily inspected after the MDC is installed

646.9 Flexible Power Cords and Cables for Connecting Equipment Enclosures of an MDC System.

(A) Uses Permitted. Flexible power cords and cables shall be permitted to be used for connections between equipment enclosures of an MDC system where not subject to physical damage.

Informational Note: One example of flexible power cord usage for connections between equipment enclosures of an MDC system is between an MDC enclosure containing only servers and one containing power distribution equipment.

(B) Uses Not Permitted. Flexible power cords and cables shall not be used for connection to external sources of power.

Informational Note: Examples of external sources of power are electrical services, feeders, and premises branch circuits.

(C) Listing. Where flexible power cords or cables are used, they shall be listed as suitable for extra-hard usage. Where used outdoors, flexible power cords and cables shall also be listed as suitable for wet locations and shall be sunlight resistant.

(D) Single-Conductor Cable. Single-conductor power cable shall be permitted to be used only in sizes 2 AWG or larger.

Part II. Equipment

646.10 Electrical Supply and Distribution. Equipment used for electrical supply and distribution in an MDC, including fittings, devices, luminaires, apparatus, machinery, and the like, shall comply with Parts I and II of Article 110.

646.11 Distribution Transformers.

(A) Utility-Owned Transformers. Utility-owned distribution transformers shall not be permitted in an MDC.

(B) Non-Utility-Owned Premises Transformers. Non-utility-owned premises distribution transformers installed in the vicinity of an MDC shall be of the dry type or the type filled with a

noncombustible dielectric medium. Such transformers shall be installed in accordance with **Parts I and II** of Article 450. Non-utility-owned premises distribution transformers shall not be permitted in an MDC.

(C) Power Transformers. Power transformers that supply power only to the MDC shall be permitted to be installed in the MDC equipment enclosure. Only dry-type transformers shall be permitted to be installed in the MDC equipment enclosure. Such transformers shall be installed in accordance with **Parts I, II, and III** of Article 450.

646.12 Receptacles. At least one 125-volt ac, 15- or 20-ampere-rated duplex convenience outlet shall be provided in each work area of the MDC to facilitate the powering of test and measurement equipment that may be required during routine maintenance and servicing, without having to route flexible power cords through or across doorways or around line-ups of equipment, or the like.

646.13 Other Electrical Equipment. Electrical equipment that is an integral part of the MDC, including information technology equipment, lighting, control, power, HVAC (heating, ventilation, and air-conditioning), emergency lighting, alarm circuits, and so forth, shall comply with the requirements for its use and installation and shall be listed and labeled.

646.14 Installation and Use. Listed and labeled equipment shall be installed and used in accordance with any instructions or limitations included in the listing.

Part III. Lighting

646.15 General Illumination. Illumination shall be provided for all workspaces and areas that are used for exit access and exit discharge. The illumination shall be arranged so that the failure of any single lighting unit does not result in a complete loss of illumination.

Informational Note: See NFPA 101-2018, *Life Safety Code*, Section 7.8, for information on illumination of means of egress.

646.16 Emergency Lighting. Areas that are used for exit access and exit discharge shall be provided with emergency lighting. Emergency lighting systems shall be listed and labeled equipment installed in accordance with the manufacturer's instructions.

Informational Note: See NFPA 101-2018, *Life Safety Code*, Section 7.9, for information on emergency lighting.

646.17 Emergency Lighting Circuits. No appliances or lamps, other than those specified as required for emergency use, shall be supplied by emergency lighting circuits. Branch circuits supplying emergency lighting shall be installed to provide service from storage batteries, generator sets, UPS, separate service, fuel cells, or unit equipment. No other equipment shall be

connected to these circuits unless the emergency lighting system includes a backup system where only the lighting is supplied by battery circuits under power failure conditions. All boxes and enclosures (including transfer switches, generators, and power panels) for emergency circuits shall be marked to identify them as components of an emergency circuit or system.

Part IV. Workspace

646.18 General. Space about electrical equipment shall comply with 110.26.

646.19 Entrance to and Egress from Working Space. For equipment over 1.8 m (6 ft) wide or deep, there shall be one entrance to and egress from the required working space not less than 610 mm (24 in.) wide and 2.0 m (6½ ft) high at each end of the working space. Doors shall open to the full extent of their designed egress opening and be equipped with listed panic hardware or listed fire exit hardware. A single entrance to and egress from the required working space shall be permitted where either of the conditions in 646.19(A) or (B) is met.

(A) Unobstructed Egress. Where the location permits a continuous and unobstructed way of egress travel, a single entrance to the working space shall be permitted.

(B) Extra Working Space. Where the depth of the working space is twice that required by 110.26(A)(1), a single entrance shall be permitted. It shall be located such that the distance from the equipment to the nearest edge of the entrance is not less than the minimum clear distance specified in Table 110.26(A)(1) for equipment operating at that voltage and in that condition.

646.20 Working Space for ITE.

(A) Low-Voltage Circuits. The working space about ITE where any live parts that may be exposed during routine servicing operate at not greater than 30 volts rms, 42 volts peak, or 60 volts dc shall not be required to comply with the workspace requirements of 646.19.

(B) Other Circuits. Any areas of ITE that require servicing of parts that are greater than 30 volts rms, 42 volts peak, or 60 volts dc shall comply with the workspace requirements of 646.19.

Informational Note No. 1: For example, field-wiring compartments for ac mains connections, power distribution units, and so forth.

Informational Note No. 2: It is assumed that ITE operates at voltages not exceeding 1000 volts.

646.21 Work Areas and Working Space About Batteries. Working space about a battery system shall comply with 110.26. Working space shall be measured from the edges of the battery racks, cabinets, or trays.

646.22 Workspace for Routine Service and Maintenance. Workspace shall be provided to facilitate routine servicing