resistant. Sections 520.5, 520.10, and 525.3 shall apply as appropriate when the following conditions exist:

(1) Where equipment racks include audio and lighting and/or power equipment
(2) When using or constructing cable extensions, adapters, and breakout assemblies

640.43 Wiring of Equipment Racks. Equipment racks fabricated of metal shall be bonded and grounded. Nonmetallic racks with covers (if provided) removed shall not allow access to Class 1, Class 3, or primary circuit power without the removal of covers over terminals or the use of tools.

Wires, cables, structural components, or other equipment shall not be placed in such a manner as to prevent reasonable access to equipment power switches and resettable or replaceable circuit overcurrent protection devices.

Wiring that exits the equipment rack for connection to other equipment or to a power supply shall be relieved of strain or otherwise suitably terminated such that a pull on the flexible cord or cable will not increase the risk of damage to the cable or connected equipment such as to cause an unreasonable risk of fire or electric shock.

640.44 Environmental Protection of Equipment. Portable equipment not listed for outdoor use shall be permitted only where appropriate protection of such equipment from adverse weather conditions is provided to prevent risk of fire or electric shock. Where the system is intended to remain operable during adverse weather, arrangements shall be made for maintaining operation and ventilation of heat-dissipating equipment.

640.45 Protection of Wiring. Where accessible to the public, flexible cords and cables laid or run on the ground or on the floor shall be covered with approved nonconductive mats. Cables and mats shall be arranged so as not to present a tripping hazard. The cover requirements of 300.5 shall not apply to wiring protected by burial.

640.46 Equipment Access. Equipment likely to present a risk of fire, electric shock, or physical injury to the public shall be protected by barriers or supervised by qualified personnel so as to prevent public access.

Δ ARTICLE 645

Information Technology Equipment

Δ **645.1 Scope.** This article covers equipment, power-supply wiring, equipment interconnecting wiring, and grounding of information technology equipment and systems in an information technology equipment room.

Informational Note: See NFPA 75, *Standard for the Fire Protection of Information Technology Equipment*, which covers the requirements for the protection of information technology equipment and information technology equipment areas.

The term *information technology equipment* (ITE) is also used by UL 60950-1, *Information Technology Equipment — Safety — Part 1: General Requirements*, as well as by international standards, as a more inclusive term for the equipment addressed by Article 645.

Article 645 applies only to equipment and systems, including the associated wiring, located within the ITE room. An ITE room is an enclosed area that contains computer-based business and industrial equipment. It is designed to comply with the special construction and fire protection provisions of NFPA 75 as well as by 645.4.

Small terminals, such as remote telephone terminal units, remote data terminals, personal computers, and cash registers in stores and supermarkets, are not covered by Article 645.

645.3 Other Articles. Circuits and equipment shall comply with 645.3(A) through (I), as applicable.

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

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) above an information technology equipment room:

(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: 800.133(C) and Table 800.154(a)
(6) CATV and radio distribution systems: 800.113(C) and Table 800.154(a)

(C) Bonding and Grounding. The non-current-carrying conductive members of optical fiber cables in an information technology equipment room shall be bonded and grounded in accordance with 770.114.

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 Cables and Equipment. Parts I, II, and III of Article 760 shall apply to fire alarm systems cables and equipment installed in an information technology equipment room. 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 information technology equipment room.

Δ **(F) Cable Routing Assemblies, 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 information technology equipment room. 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 information technology equipment room. Article 645 shall apply to the powering of communications equipment in an information technology equipment room.

Informational Note: See Article 100, Definitions, 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 cables and equipment installed in an information technology equipment room. 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 information technology equipment room. Article 645 shall apply to the powering of community antenna television and radio distribution systems equipment installed in an information technology equipment room.

(H) Optical Fiber Cables. Only optical fiber cables listed in accordance with 770.179 shall be permitted to be installed in an information technology equipment room.

(I) Cables Not in Information Technology Equipment Room. Cables extending beyond the information technology equipment room shall be subject to the applicable requirements of this *Code*.

Δ **645.4 Special Requirements for Information Technology Equipment Room.** The alternative wiring methods to Chapter 3 and Parts I and II of Article 725 for signaling wiring and Parts I and V of Article 770 for optical fiber cabling shall be permitted where all of the following conditions are met:

(1) Disconnecting means complying with 645.10 are provided.
(2) A heating/ventilating/air-conditioning (HVAC) system is provided in one of the methods identified in the following:
   a. A separate HVAC system that is dedicated for information technology equipment use and is separated from other areas of occupancy
   b. An HVAC system that serves other occupancies and meets all of the following:
      (i) Also serves the information technology equipment room
      (ii) Provides fire/smoke dampers at the point of penetration of the room boundary
      (iii) Activates the damper operation upon initiation by smoke detector alarms, by operation of the disconnecting means required by 645.10, or by both

Informational Note No. 1: See NFPA 75-2020, *Standard for the Fire Protection of Information Technology Equipment*, Chapter 11, Section 11.1, 11.1.1, 11.1.2, and 11.1.3, for further information.

(3) All information technology and communications equipment installed in the room is listed.
(4) The room is occupied by, and accessible to, only those personnel needed for the maintenance and functional operation of the installed information technology equipment.
(5) The room is separated from other occupancies by fire-resistant-rated walls, floors, and ceilings with protected openings.

Informational Note No. 2: See NFPA 75-2020, *Standard for the Fire Protection of Information Technology Equipment*, Chapter 6, for further information on room construction requirements.

(6) Only electrical equipment and wiring associated with the operation of the information technology room is installed in the room.

Informational Note No. 3: HVAC systems, communications systems, and monitoring systems such as telephone, fire alarm systems, security systems, water detection systems, and other related protective equipment are examples of equipment associated with the operation of the information technology room.

Use of the wiring methods permitted by Article 645 is based on the construction of the ITE room meeting the requirements in NFPA 75. For such ITE rooms, Article 645 contains wiring method installation requirements — for example, requirements for wiring methods in the space beneath the raised floor used for environmental air of an ITE room — that are less stringent than those in Chapter 3 for the same type of space.

Application of these modified requirements is contingent on the ITE room construction and equipment meeting all six conditions specified in 645.4. If any one of the six conditions is not met, wiring methods installed in the ITE room must follow the applicable requirements of Chapter 3, Parts I and II of Article 725 for signal wiring, and Parts I and V of Article 770 for optical fiber cabling.

645.5 Supply Circuits and Interconnecting Cables.

(A) Branch-Circuit Conductors. The branch-circuit conductors supplying one or more units of information technology equipment shall have an ampacity not less than 125 percent of the total connected load.

Δ **(B) Power-Supply Cords.** Information technology equipment shall be permitted to be connected to branch circuits by power-supply cords that comply with the following:

(1) Power-supply cords shall not exceed 4.5 m (15 ft).
(2) Power-supply cords shall be listed and a type permitted for use on listed information technology equipment or shall be constructed of listed flexible cord and listed attachment plugs and cord connectors of a type permitted for information technology equipment.

(3) Plugs and receptacles used to connect the power-supply cords shall be listed and identified for the system voltage and current applied.

Informational Note No. 1: See UL 60950-1, *Safety of Information Technology Equipment — Safety — Part 1: General Requirements*; or UL 62368-1, *Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements*, for one method of determining if cords are of a permitted type.

Informational Note No. 2: See ANSI/NEMA WD-6, *Wiring Devices — Dimensional Specifications*, which identifies plug and receptacle configurations L25-30P and L25-30R for 240 Vac and L26-30P and L26-30R for 240/415 Vac.

(C) Interconnecting Cables. Separate information technology equipment units shall be permitted to be interconnected by means of listed cables and cable assemblies. The 4.5 m (15 ft) limitation in 645.5(B)(1) shall not apply to interconnecting cables.

(D) Physical Protection. Where exposed to physical damage, power-supply cords, branch-circuit supply conductors, and interconnecting cables shall be protected.

(E) Under Raised Floors. Where the area under the floor is accessible and openings minimize the entrance of debris beneath the floor, power-supply cords, communications cables, connecting cables, interconnecting cables, cord-and-plug connections, and receptacles associated with the information technology equipment shall be permitted under a raised floor of approved construction. The installation requirement shall comply with 645.5(E)(1) through (E)(3).

Δ **(1) Installation Requirements for Branch-Circuit Supply Conductors Under a Raised Floor.**

(a) The supply conductors shall be installed in accordance with 300.11.

(b) In addition to the wiring methods of 300.22(C), the following wiring methods shall also be permitted:

(1) Rigid metal conduit
(2) Rigid nonmetallic conduit
(3) Intermediate metal conduit
(4) Electrical metallic tubing
(5) Electrical nonmetallic tubing
(6) Metal wireway
(7) Nonmetallic wireway
(8) Surface metal raceway with metal cover
(9) Surface nonmetallic raceway
(10) Flexible metal conduit
(11) Liquidtight flexible metal conduit
(12) Liquidtight flexible nonmetallic conduit
(13) Type MI cable
(14) Type MC cable
(15) Type AC cable
(16) Associated metallic and nonmetallic boxes or enclosures
(17) Type TC power and control tray cable

Branch-circuit conductors installed under the raised floor of an ITE room using any of the wiring methods listed are required to conform to the specific article for the wiring method used.

See also

300.11(A), which requires raceways, cables, and boxes to be securely fastened in place, even though they are installed below a raised floor

Δ **(2) Installation Requirements for Power-Supply Cords, Data Cables, Interconnecting Cables, and Grounding Conductors Under a Raised Floor.** The following cords, cables, and conductors shall be permitted to be installed under a raised floor:

(1) Power-supply cords of listed information technology equipment in accordance with 645.5(B).
(2) Interconnecting cables enclosed in a raceway.
(3) Equipment grounding conductors.
(4) Where the air space under a raised floor is protected by an automatic fire suppression system, in addition to wiring installed in compliance with 722.135(B), Types CL2R, CL3R, CL2, and CL3 and substitute cables, including CMP, CMR, CM, and CMG, installed in accordance with 722.135(E) shall be permitted under raised floors.
(5) Where the air space under a raised floor is not protected by an automatic fire suppression system, in addition to wiring installed in compliance with 722.135(B), substitute cable Type CMP installed in accordance with 722.135(E) shall be permitted under raised floors.
(6) Listed Type DP cable having adequate fire-resistant characteristics suitable for use under raised floors of an information technology equipment room.

Informational Note: See CSA "Vertical Flame Test-Cables in Cable Trays" as described in CSA C22.2 No. 0.3, *Test Methods for Electrical Wires and Cables, for one* method of defining resistance to the spread of fire where the damage (char length) of the cable does not exceed 1.5 m (4 ft 11 in.) or "UL Flame Exposure, Vertical Flame Tray Test" in UL 1685, *Standard for Safety for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*. The smoke measurements in the test method are not applicable.

Supply cords of ITE are permitted to be run through holes in a raised floor to connect to receptacles located below the raised floor. Openings in a raised floor through which cords and cables are run must be made so the cords and cables are not subject to abrasion. Allowing cords through openings in a raised floor is an amendment to the general prohibition of this practice found in 400.12.

Other than branch-circuit conductors and power supply cords, interconnecting cables used under raised floors are required to be enclosed in a raceway, be listed as Type DP (data processing) cables, or be of the appropriate cable type permitted by 645.5(E)(2)(4).

(3) Installation Requirements for Optical Fiber Cables Under a Raised Floor. The installation of optical fiber cables shall comply with either of the following:

(1) Where the air space under a raised floor is protected by an automatic fire suppression system, optical fiber cables installed in accordance with 770.113(C), Types OFNR,

OFCR, OFNG, OFCG, OFN, and OFC shall be permitted under raised floors.

(2) Where the air space under a raised floor is not protected by an automatic fire suppression system, only optical fiber cables installed in accordance with 770.113(C) shall be permitted under raised floors.

Δ **(F) Securing in Place.** Power-supply cords; communications cables, connecting cables, interconnecting cables, and associated boxes, connectors, plugs, and receptacles that are listed as part of, or for, information technology equipment shall not be required to be secured in place where installed under raised floors.

Informational Note: See 300.11 for securement requirements for raceways and cables not listed as part of, or for, information technology equipment.

(G) Abandoned Supply Circuits and Interconnecting Cables. The accessible portion of abandoned supply circuits and interconnecting cables shall be removed unless contained in a raceway.

(H) Installed Supply Circuits and Interconnecting Cables Identified for Future Use.

(1) Cable Identification Means. Supply circuits and interconnecting cables identified for future use shall be marked with a tag of sufficient durability to withstand the environment involved.

(2) Cable Tag Criteria. Supply circuit tags and interconnecting cable tags shall have the following information:

(1) Date identified for future use
(2) Date of intended use
(3) Information relating to the intended future use

645.10 Disconnecting Means. An approved means shall be provided to disconnect power to all electronic equipment in the information technology equipment room or in designated zones within the room. There shall also be a similar approved means to disconnect the power to all dedicated HVAC systems serving the room or designated zones and to cause all required fire/smoke dampers to close. The disconnecting means shall comply with either 645.10(A) or (B).

Exception: These requirements shall not apply to installations complying with Article 685.

(A) Remote Disconnect Controls.

(1) Emergency Access. Remote disconnect controls shall be located at approved locations readily accessible in case of fire to authorized personnel and emergency responders.

(2) Disconnect Identification. The remote disconnect means for the control of electronic equipment power and HVAC systems shall be grouped and identified. A single means to control both systems shall be permitted.

(3) Fire/Smoke Zone Isolation. Where multiple zones are created, each zone shall have an approved means to confine fire or products of combustion to within the zone.

Δ **(4) System Operation Continuity.** Additional means to prevent unintentional operation of remote disconnect controls shall be permitted.

Informational Note: See NFPA 75, *Standard for the Fire Protection of Information Technology Equipment*, for further information.

Typically, the circuit supplying the ITE and the circuit supplying the HVAC system will be controlled through separate disconnecting means. However, operation of these disconnecting means can be accomplished through the use of a single remote control, such as one pushbutton. The disconnecting means is required to disconnect the conductors of each circuit from their supply source and close all required fire/smoke dampers. (See the definition of the term *disconnecting means* in Article 100.) The disconnecting means is permitted to be remote-controlled switching devices, such as relays, with pushbutton stations at the principal exit doors.

Δ **(B) Critical Operations Data Systems.** Remote disconnecting controls shall not be required for critical operations data systems when all of the following conditions are met:

(1) An approved procedure has been established and maintained for removing power and air movement within the room or zone.
(2) Qualified personnel are continuously available to advise emergency responders and to instruct them of disconnecting methods.
(3) A smoke-sensing fire detection system is in place.

Informational Note: See *NFPA 72, National Fire Alarm and Signaling Code*, for further information.

(4) An approved fire suppression system suitable for the application is in place.
(5) Cables installed under a raised floor, other than branch-circuit wiring, and power cords are installed in compliance with 645.5(E)(2) or (E)(3), or in compliance with Table 645.10(B).

Only those data systems designated as critical in function based on the definition of *critical operations data system* found in Article 100, are permitted to implement the provision for not installing the remote disconnect control covered in 645.10(A).

Δ **645.11 Uninterruptible Power Supply (UPS).** UPS systems installed within the information technology equipment room and their supply and output circuits shall comply with 645.10, except for the following installations and constructions:

Δ ***TABLE 645.10(B)*** Cables Installed Under Raised Floors

Cable Type	Applicable Sections
Branch circuits under raised floors	645.5(E)(1)
Supply cords of listed information technology equipment	645.5(E)(2)(1), 300.22(C)
Class 2 and Class 3 remote control and PLTC cables in other spaces used for environmental air (plenums)	722.135(B)
Optical fiber cable in other spaces used for environmental air (plenums)	770.113(C) and Table 770.154(a)
Communications wires and cables, cable routing assemblies, and communications raceways in other spaces used for environmental air (plenums)	800.113(C) and Tables 800.154(a), (b), and (c)
Coaxial CATV and radio distribution cables in other spaces used for environmental air (plenums)	800.113(C) and Table 800.154(a)

(1) Installations complying with Parts I and II of Article 685
(2) Power sources limited to 750 volt-amperes or less derived either from UPS equipment or from battery circuits integral to electronic equipment

The disconnecting means shall also disconnect the battery from its load.

Informational Note: See UL 1778, *Uninterruptible Power Systems*, and UL 62368-1, *Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements*, for information on product listings for electronic equipment disconnecting means and backup battery power sources.

645.14 System Grounding. Separately derived power systems shall be installed in accordance with Parts I and II of Article 250. Power systems derived within listed information technology equipment that supply information technology systems through receptacles or cable assemblies supplied as part of this equipment shall not be considered separately derived for the purpose of applying 250.30.

Δ **645.15 Equipment Grounding and Bonding.** All exposed non-current-carrying metal parts of an information technology system shall be bonded to the equipment grounding conductor in accordance with Parts I, V, VI, VII, and VIII of Article 250 or shall be double insulated. Where signal reference structures are installed, they shall be bonded to the equipment grounding conductor provided for the information technology equipment. Any auxiliary grounding electrode(s) installed for information technology equipment shall be installed in accordance with 250.54.

Informational Note: See 250.146(D) and 406.3(E) for information on isolated grounding-type receptacles.

645.16 Marking. Each unit of an information technology system supplied by a branch circuit shall be provided with a manufacturer's nameplate, which shall also include the input power requirements for voltage, frequency, and maximum rated load in amperes.

645.17 Power Distribution Units. Power distribution units that are used for information technology equipment shall be permitted to have multiple panelboards within a single cabinet if the power distribution unit is utilization equipment listed for information technology application.

Power distribution units (PDUs) are specialized electrical distribution equipment used to supply multiple bays of rack-mounted modules installed in an ITE room. Due to the large number of overcurrent protective devices (OCPDs) used in this type of application, PDUs are built with multiple panelboards installed in a single cabinet.

645.18 Surge Protection for Critical Operations Data Systems. A listed surge-protective device (SPD) shall be installed for critical operations data systems in accordance with Part II of Article 242.

645.25 Engineering Supervision. 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 or existing loads shall be permitted to be used if provided by qualified persons under engineering supervision.

An engineered alternative to the load calculations in Parts III and IV of Article 220 recognizes that the loads associated with computer hardware vary according to the operating system and software being used. Therefore, identical pieces of equipment installed in a facility will each have a load based on how that equipment is being used and applied.

The engineered alternative provides for a customized load calculation based on how a facility or a specific industry applies its computer hardware.

645.27 Selective Coordination. Critical operations data system(s) overcurrent protective devices shall be selectively coordinated with all supply-side overcurrent protective devices.

Selective coordination shall be selected by a licensed professional engineer or other qualified persons engaged primarily in the design, installation, or maintenance of electrical systems. The selection shall be documented and made available to those authorized to design, install, inspect, maintain, and operate the system.