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Telecommunications Infrastructure Standard for Data Centers Addendum 2- Additional Guidelines for Data Centers

TIA-942-2

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TELECOMMUNICATIONS INFRASTRUCTURE STANDARD FOR DATA CENTERS ADDENDUM 2 – ADDITIONAL GUIDELINES FOR DATA CENTERS

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FOREWORD

TIA standards documents are developed within the Technical Committees of the TIA and the standards coordinating committees of the TIA standards board. Members of the committees serve voluntarily and without commission. The companies that they represent are not necessarily members of the TIA. The standards developed within the TIA represent a consensus of the broad expertise on the subject. This expertise comes from within the TIA as well as those outside of the TIA that have an expressed interest. The viewpoint expressed at the time that this standard was approved was from the editors' experience and the state of the art at that time. Users are encouraged to verify that they have the latest revision of the standard.

This Addendum has been prepared by the TR-42.1 subcommittee and approved by TR-42.1 and the TR-42 Engineering Committee and the American National Standards Institute (ANSI).

There are no annexes in this Addendum.

1 SCOPE

This Addendum specifies revised requirements for temperature and humidity in data centers to harmonize with environmental guidelines developed by ASHRAE. These revised requirements should reduce energy consumption for heating, ventilation, and air conditioning; and should provide more flexibility in maintaining temperature and humidity in data centers.

This Addendum also amends the cabling types recognized to include and recommend augmented category 6 (category 6A), provides additional guidelines regarding the use of transmission equipment in data centers, and provides revisions to Annex G.

2 NORMATIVE REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this Addendum. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. ANSI and TIA maintain registers of currently valid national standards published by them.

- *ANSI/TIA-568-C.0-2008, Generic Customer-Owned Telecommunications Networks*
- *ANSI/TIA-568-C.2-2008, Balanced Twisted-Pair Telecommunications Cabling and Components Standard*
- *ANSI/TIA-568-C.3-2008, Optical Fiber Cabling Components Standard*
- ASHRAE, *Thermal Guidelines for Data Processing Environments, 2004*
- ASHRAE*, 2008 ASHRAE Environmental Guidelines for Datacom Equipment – Expanding the Recommended Environmental Envelope*

3 DEFINITIONS, ACRONYMS AND ABBREVIATIONS, AND UNITS OF MEASURE

3.1 General

For the purpose of this Addendum the following definitions, acronyms and abbreviations apply.

3.2 Definitions

dew point: The temperature to which air must be cooled (assuming constant air pressure and moisture content) to reach a relative humidity of 100% (i.e., saturation).

dry-bulb temperature: The temperature of air measured by a thermometer freely exposed to the air but shielded from radiation (e.g. sunlight, radiant heat) and moisture.

3.3 Acronyms and abbreviations

ASHRAE American Society of Heating, Refrigerating, and Air-Conditioning Engineers

ESD Electrostatic discharge

4 MODIFICATION TO OPERATING LIMITS

Modifications to the operating limits are based on 2008 ASHRAE *New Environmental Guidelines for Datacom Equipment – Expanding the Recommended Environmental Envelope.*

ASHRAE has determined that electrostatic discharge (ESD) is a function of dew point or absolute humidity and not relative humidity. Thus, the lower operating ranges for humidity have been modified to be based on dew point rather than relative humidity.

Upper limits for relative humidity and dew point have been specified to reduce failures caused by conductive anodic filament growth on printed circuit board laminate materials.

It should be noted that the change from 25 to 27 °C (77 to 81 °F) can have a detrimental effect on acoustical noise and fan power for equipment, because equipment fan utilization can increase dramatically as inlet temperatures increase. Equipment manufacturers should be consulted when considering ambient inlet temperatures near 27 °C (81 °F).

The lower temperature limit has been reduced to improve the efficiency of HVAC systems by avoiding the need to mix hot return air to maintain the previous 20 °C (68 °F) limit. However, it should also be noted that there is a risk of freezing the coil of direct expansion air conditioning units that deliver air temperatures below 20 °C (68 °F).

Table 1 of this addendum summarizes the revised operating temperature and humidity requirements. Clause 5 details the clause changes in ANSI/TIA-942.

Table 1: Revised temperature and humidity requirements for data center spaces

Space	Environmental requirements
Computer rooms, entrance rooms, access provider spaces, and service providers spaces in data centers	• Temperature: 18 – 27 °C (64 – 81 °F) dry bulb o high altitude: reduce maximum dry-bulb temperature 1ºC for every 300m (1.8ºF for every 1000 ft) above 1800 m (5900 ft) altitude • Maximum Relative Humidity (RH): 60% • Maximum dew point: 15 °C (59 °F) • Minimum dew point (lower moisture limit): 5.5 °C (42 °F)[1] • Maximum rate of temperature change: 5 °C (9 °F) per hour
Notes: 1. Dewpoint of 5.5 °C - corresponds to approximately 44% RH at 18 °C (64 °F) and 25% RH at 27 °C (81 °F).	

5 MODIFICATIONS TO ANSI/TIA-942

Modifications to the text of ANSI/TIA-942 are described below – deleted text is struck through added text is underlined.

5.1 RF Interference

5.1.1 Computer room

Clause 5.3.3 shall be modified as follows:

Computer room doors should provide access to authorized personnel only. Additionally, access to the room shall comply with the requirements of the AHJ. For additional information on monitoring computer room access, see annex G.

Radio sources (e.g. wireless LAN antennas, cellular telephones, handheld radios, etc.) may interfere with proper operation of the information technology and telecommunications equipment. Consult with the information technology and telecommunications equipment manufacturers regarding the use of or restriction of wireless and radio systems in the computer room.

5.1.2 Entrance room

Clause 5.4.4 shall be modified as follows:

Access to the entrance room shall be controlled by the data center owner or their agent.

Radio sources (e.g. wireless LAN antennas, cellular telephones, handheld radios, etc.) may interfere with proper operation of the information technology and telecommunications equipment. Consult with the information technology and telecommunications equipment manufacturers regarding the use of or restriction of wireless and radio systems in the entrance room.

5.2 Lighting

5.2.1 Computer room

The first paragraph in clause 5.3.4.5 shall be revised as follows:

Lighting in human-occupied spaces shall be a minimum of 500 lux ~~(50 footcandles)~~ in the horizontal plane and 200 lux ~~(20 footcandles)~~ in the vertical plane, measured 1 m (3 ft) above the finished floor in the middle of all aisles between cabinets. It is recommended that the three-level lighting protocol described in Annex J be used to control lighting levels.

5.2.2 Entrance room

The first paragraph in clause 5.4.8.6 shall be revised as follows:

Lighting in human-occupied spaces shall be a minimum of 500 lux ~~(50 footcandles)~~ in the horizontal plane and 200 lux ~~(20 footcandles)~~ in the vertical plane, measured 1 m (3 ft) above the finished floor in the middle of all aisles between cabinets. It is recommended that the three-level lighting protocol described in Annex J be used to control lighting levels.

5.3 Environmental operational parameters

5.3.1 Computer room

The requirements in clause 5.3.5.3 shall be revised as follows:

The temperature and humidity shall be controlled to provide continuous operating ranges for temperature and humidity:

- dry-bulb temperature: ~~20° C (68° F) to 25° C (77° F)~~ 18 °C (64 °F) to 27 °C (81 °F);
- ~~relative~~ maximum relative humidity: ~~40% to 55~~ 60%;
- ~~maximum~~ dew point: ~~21° C (69.8° F)~~ 5.5 °C (42 °F) to 15 ° C (59 °F);
- maximum rate of change: 5 °C (9 °F) per hour;
- reduce maximum dry-bulb temperature 1 °C / 300 m (1.8 °F/1000 ft) above 1800 m (5900 ft) altitude;
- humidification and dehumidification equipment may be required depending upon local environmental conditions.

5.3.2 Entrance room

The requirements in clause 5.4.8.11 shall be revised as follows:

The temperature and humidity shall be controlled to provide continuous operating ranges for temperature and humidity:

- dry-bulb temperature: ~~20° C (68° F) to 25° C (77° F)~~ 18 °C (64 °F) to 27 °C (81 °F);

- ~~relative~~ maximum relative humidity: ~~40% to 55~~ 60%;
- ~~maximum~~ dew point: ~~21° C (69.8° F)~~ 5.5 °C (42 °F) to 15 °C (59 °F);
- maximum rate of change: 5 °C (9 °F) per hour;
- reduce maximum dry-bulb temperature 1 °C / 300 m (1.8 °F/1000 ft) above 1800 m (5900 ft) altitude;
- humidification and dehumidification equipment may be required depending upon local environmental conditions.

5.4 Recognized Media

5.4.1 Horizontal cabling

Clause 6.2.4 shall be revised as follows:

Due to the wide range of services and site sizes where horizontal cabling will be used, more than one transmission medium is recognized. This Standard specifies transmission media, which shall be used individually or in combination in the horizontal cabling.

Recognized cables, associated connecting hardware, jumpers, patch cords, equipment cords, and zone area cords shall meet all applicable requirements specified in ~~ANSI/TIA/EIA-568-B.2~~ ANSI/TIA/EIA-568-C.2 and ~~ANSI/TIA/EIA-568-B.3~~ ANSI/TIA-568-C.3.

The recognized media are:

- 100-ohm balanced twisted-pair cable (~~ANSI/TIA/EIA-568-B.2~~ ANSI/TIA/EIA-568-C.2) – category 3, category 5e, category 6, category 6A, with category 6A recommended~~, category 6 recommended (ANSI/TIA/EIA-568-B.2-1)~~;
- multimode optical fiber cable, either 62.5/125 micron or 50/125 micron (~~ANSI/TIA/EIA-568-B.3~~), 50/125 micron 850 nm laser optimized multimode fiber is recommended (~~ANSI/TIA/EIA-568-B.3~~ ANSI/TIA-568-C.3);
- single-mode optical fiber cable (~~ANSI/TIA/EIA-568-B.3~~ ANSI/TIA-568-C.3).

The recognized coaxial media are 75-ohm (734 and 735 type) coaxial cable (Telcordia Technologies GR-139-CORE) and coaxial connector (ANSI T1.404). These cables and connectors are recommended to support specific applications per annex A.

Channels constructed from recognized cables, associated connecting hardware, jumpers, patch cords, equipment cords, and zone area cords shall meet the requirements specified in ~~ANSI/TIA/EIA-568-B.1~~, ANSI/TIA-568-C.0, ~~ANSI/TIA/EIA-568-B.2~~ ANSI/TIA/EIA-568-C.2, ~~ANSI/TIA/EIA-568-B.3~~ ANSI/TIA-568-C.3 and ANSI T1.404 (DS3).

NOTES

1) Crosstalk between individual, unshielded twisted-pairs may affect the transmission performance of multipair copper cables. Annex B of ANSI/TIA/EIA-568-B.1 provides some shared sheath guidelines for multipair cables.

2) See subclause 6.2.3 for horizontal cabling distance limitations.

5.4.2 Backbone cabling

Clause 6.3.4 shall be revised as follows:

Due to the wide range of services and site sizes where backbone cabling will be used, more than one transmission medium is recognized. This Standard specifies transmission media, which shall be used individually or in combination in the backbone cabling.

Recognized cables, associated connecting hardware, jumpers, patch cords, equipment cords, and zone area cords shall meet all applicable requirements specified in ~~ANSI/TIA/EIA-568-B.2~~ ANSI/TIA/EIA-568-C.2 and ~~ANSI/TIA/EIA-568-B.3~~ ANSI/TIA-568-C.3.

The recognized media are:

- 100-ohm balanced twisted-pair cable (~~ANSI/TIA/EIA-568-B.2~~ ANSI/TIA/EIA-568-C.2) – category 3, category 5e, category 6, category 6A, with category 6A recommended~~, category 6 recommended (ANSI/TIA/EIA-568-B.2-1)~~;
- multimode optical fiber cable, either 62.5/125 micron or 50/125 micron (~~ANSI/TIA/EIA-568-B.3~~), 50/125 micron 850 nm laser optimized multimode fiber is recommended (~~ANSI/TIA/EIA-568-B.3~~ ANSI/TIA-568-C.3);
- single-mode optical fiber cable (~~ANSI/TIA/EIA-568-B.3~~ ANSI/TIA-568-C.3).

The recognized coaxial media are 75-ohm (734 and 735 type) coaxial cable (Telcordia Technologies GR-139-CORE) and coaxial connector (ANSI T1.404). These cables and connectors are recommended to support specific applications per annex A.

Channels constructed from recognized cables, associated connecting hardware, jumpers, patch cords, equipment cords, and zone area cords shall meet the requirements specified in ~~ANSI/TIA/EIA-568-B.1~~, ANSI/TIA-568-C.0, ~~ANSI/TIA/EIA-568-B.2~~ ANSI/TIA/EIA-568-C.2, ~~ANSI/TIA/EIA-568-B.3~~ ANSI/TIA-568-C.3 and ANSI T1.404 (DS3).

NOTES

1) Crosstalk between individual, unshielded twisted-pairs may affect the transmission performance of multipair copper cables. Annex B of ANSI/TIA/EIA-568-B.1 provides some shared sheath guidelines for multipair cables.

2) Annex C of ANSI/TIA/EIA-568-B.1 provides a brief description of a number of other backbone cables that have been used in telecommunications. These cables, as well as others, may be effective for specific applications. Although these cables are not part of the requirements of this Standard, they may be used in addition to the minimum requirements of this Standard.

3) See subclause 6.3.5 for backbone cabling distance limitations.

5.5 Site selection

This paragraph in clause F.2 shall be revised as follows:

The computer room should be located away from sources of EMI and RFI such as x-ray equipment, radio transmitters, and transformers. ~~Sources of EMI & RFI should be at a distance that will reduce the interference to 3.0 volts/meter throughout the frequency spectrum.~~

The recommended location of the data center should be a MICE $M_1I_1C_1E_1$ environment (ANSI/TIA-568-C.0). Note: alternatively, the computer room should be designed to create a MICE $M_1I_1C_1E_1$ environment.

5.6 New Annex J (Informative) Lighting in Data Centers

It is recommended that a three-level lighting protocol be used in data centers depending on human occupancy.

Level 1: When nobody is scheduled to be in the data center space, the lighting level should be just high enough that security personnel (stationed outside the unoccupied data center spaces) can monitor the space with surveillance cameras.

Level 2: Motion detectors should be used to automatically initiate a higher level of lighting once access is detected. Sufficient lighting should be provided to allow safe passage through the space and to permit identification via security cameras.

Level 3: When the space is occupied for the purpose of working on equipment or cabling lighting should be a minimum of 500 lux ~~(50 footcandles)~~ in the horizontal plane and 200 lux ~~(20 footcandles)~~ in the vertical plane, measured 1 m (3 ft) above the finished floor in the middle of all aisles between cabinets. It is permissible to divide the space in zones and activate level 3 lighting only in selected zones. In this case all other zones should provide level 2 lighting for human safety reasons.

5.7 Architectural tiering

The recommendations in clause G.4.2 shall be revised as follows:

5.7.1 Tier 2 (architectural)

Insert at end of G.4.2.2 Tier 2 (architectural):

The site selection specifications for a Tier 2 data center are provided in table 9. Additionally, the recommended site selection criteria that exceed these specifications are:

- greater than 91 m (300 ft) from an inland waterway
- greater than 0.8 km (½ mile) from a coastal waterway
- greater than 91 m (300 ft) from major highway traffic arteries
- less than 80 km (50 miles) from a major metropolitan area.

The architectural and security specifications for a Tier 2 data center are provided in table 9. Additionally, the recommended vehicle parking criteria that exceed these specifications are:

- physically separated visitor and employee parking areas (potentially with a common entry)
- physically separated visitor parking and loading docks (potentially with a common entry)
- visitor parking should be 9.1 m (30 ft) from the data center perimeter walls with physical barriers to prevent vehicles from driving closer
- the main building entrance security checkpoint should be manned
- if there is an access floor, the understructure should have stringers (horizontal support members)
- the data center should have a security counter
- generator and fuel storage areas should not be adjacent to computer rooms and be at least 1.5 m (5 ft) away from publicly accessible areas.

5.7.2 Tier 3 (architectural)

Insert at end of G.4.2.3 Tier 3 (architectural):

The site selection specifications for a Tier 3 data center are provided in table 9. Additionally, the

recommended site selection criteria that exceed these specifications are:

- greater than 0.8 km (½ mile) from an inland waterway
- greater than 8 km (5 miles) from a coastal waterway
- greater than 273 m (900 ft) from major highway traffic arteries
- greater than 1.6 km / 1 mile and less than 48 km / 30 miles from a major airport.

The architectural and security specifications for a Tier 3 data center are provided in table 9. Additionally, the recommended vehicle parking criteria that exceed these specifications are:

- visitor parking should be 18.3 m (60 ft) from the data center perimeter walls with physical barriers to prevent vehicles from driving closer
- the main building entrance security checkpoint should be manned
- doors to computer, electrical, and mechanical rooms should be not less than 1.07 m (3.5 ft) wide
- the security counter should have a barrier between the visitors and the security personnel
- generator and fuel storage areas should not be adjacent to computer rooms and be at least 9 m (30 ft) away from publicly accessible areas.

5.7.3 Tier 4 (architectural)

Insert at end of G.4.2.4 Tier 4 (architectural):

The site selection specifications for a Tier 4 data center are provided in table 9. Additionally, the recommended site selection criteria exceed these specifications are:

- greater than 1.6 km (1 mile) from an inland waterway
- greater than 32 km (20 miles) from a coastal waterway
- greater than 1.6 km (1 mile) from major highway traffic arteries
- greater than 8 km (5 miles) and less than 48 km (30 miles) from a major airport.

The architectural and security specifications for a Tier 4 data center are provided in table 9. Additionally, the recommended vehicle parking criteria that exceed these specifications are:

- visitor parking should be 45.7 m (150 ft) from the data center perimeter walls with physical barriers to prevent vehicles from driving closer
- the data center should not be in a multi-tenant occupancy building
- all building entrance security checkpoints should be manned
- if there is an access floor system any access floor panels should be all steel computer grade with concrete fill
- the security counter should have a bullet-proof barrier between the visitors and the security personnel
- the security office and security equipment rooms should have bullet resistant walls and doors
- generator and fuel storage areas should not be adjacent to computer rooms and be at least 19 m (60 ft) away from publicly accessible areas.

5.8 General mechanical requirements – Environmental air

The recommendations in clause G.6.1.1 shall be revised as follows:

The mechanical system should be capable of achieving the following computer room environmental parameters:

Temperature: ~~20°C to 25°C (68°F to 77°F)~~ 18 °C (64 °F) to 27 °C (81 °F).

Normal set points:

~~22°C (72°F)~~ 24 °C (75 °F)

Control ± ~~1°C (1.8°F)~~ 2 °C (3.6 °F)

Relative Humidity: ~~40% to 55%~~ 30% to 60%

~~Normal set points:~~

~~45% RH~~

~~Control ± 5%~~

Coordinate cooling system design and equipment floor plans so that airflow from cooling equipment travels in a direction parallel to the rows of cabinets/racks.

Print rooms should be isolated rooms with separate air conditioning system so as not to introduce contaminants such as paper and toner dust into the remainder of the data center.

5.9 Annex G Tiering Reference Guide

Tables 9, 10 and 11 of annex G shall be revised as follows:

1 **Table 9: Tiering reference guide (architectural)**

	TIER 1	TIER 2	TIER 3	TIER 4
ARCHITECTURAL				
Site selection				
Proximity to flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map	no requirement	not within the 50-year flood hazard area	Not within 100-year flood hazard area ~~or less~~ and greater than 91 m (300 ft) from 50-year flood hazard area	~~Not less the~~ greater than 91 m (300 ft) from 100-year flood hazard area
Proximity to coastal or inland waterways	no requirement	no requirement	~~Not less than~~ greater than 91 m (300 ft)	~~Not less than~~ greater than 0.8 km (1/2 mile)
Proximity to major highway traffic arteries	no requirement	no requirement	~~Not less than~~ greater than 91 m (300 ft)	~~Not less than~~ greater than 0.8 km (1/2 mile)
Proximity to major airports	no requirement	no requirement	~~Not less than~~ greater than 1.6 km (1 mile) ~~or greater~~ and less than 48 km (30 miles)	~~Not less than~~ greater than 8 km / 5 miles ~~or greater~~ and less than 48 km (30 miles)
Proximity to major metropolitan area	no requirement	no requirement	~~Not greater~~ less than 48 km (30 miles)	~~Not greater~~ less than 16 km (10 miles)
Parking				
Separate visitor and employee parking areas	no requirement	no requirement	yes (physically separated ~~by fence or wall~~ with separate entries)	yes (physically separated by fence or wall with separate entries)
Separate from loading docks	no requirement	no requirement	yes (physically separated with separate entries)	yes (physically separated by fence or wall with separate entries)
Proximity of visitor parking to data center perimeter building walls	no requirement	no requirement	9.1 m (30 ft) minimum separation with physical barriers to prevent vehicles from driving closer	18.3 m (60 ft) minimum separation with physical barriers to prevent vehicles from driving closer
Multi-tenant occupancy within building	no restriction	Allowed only if occupancies are non-hazardous	Allowed if all tenants are data centers or telecommunications companies	Allowed if all tenants are data centers or telecommunications companies

2
3

4

	TIER 1	TIER 2	TIER 3	TIER 4
Building construction				
Type of construction (IBC 2006)	no restriction	no restriction	Type IIA ~~-1hr~~, IIIA ~~-1hr~~, or VA ~~-1hr~~	Type IA or 1B ~~II-FR~~
Fire resistive requirements				
Exterior bearing walls	Code allowable	Code allowable	1 Hour minimum	4 Hours minimum
Interior bearing walls	Code allowable	Code allowable	1 Hour minimum	2 Hour minimum
Exterior nonbearing walls	Code allowable	Code allowable	1 Hour minimum	4 Hours minimum
Structural frame	Code allowable	Code allowable	1 Hour minimum	2 Hour minimum
Interior non-computer room partition walls	Code allowable	Code allowable	1 Hour minimum	1 Hour minimum
Interior computer room partition walls	Code allowable	Code allowable	1 Hour minimum	2 Hour minimum
Shaft enclosures	Code allowable	Code allowable	1 Hour minimum	2 Hour minimum
Floors and floor-ceilings	Code allowable	Code allowable	1 Hour minimum	2 Hour minimum
Roofs and roof-ceilings	Code allowable	Code allowable	1 Hour minimum	2 Hour minimum
Meet requirements of NFPA 75	no requirement	yes	yes	yes
Miscellaneous Building components				
Vapor barriers for walls and ceiling of computer room	no requirement	yes for walls, no requirement for ceiling	yes	yes
~~Multiple~~ Building entrances with security checkpoints	no requirement	no requirement	yes (primary building entrance manned)	Yes (primary building entrance manned)
Access floor panel construction (when provided)	no requirement	no requirement	computer grade all steel	Computer grade all steel or computer grade steel with concrete fill~~ed~~
Understructure (when access floor is provided)	~~na~~ no requirement	no requirement	bolted stringer	bolted stringer with 1.2 m x 1.2 m (4 ft x 4 ft) basket weave pattern
Ceilings within computer room areas (when provided)				
Ceiling Construction	no requirement	no requirement	If provided, suspended with clean room class 10M-100M perforated tiles	Suspended with clean room class 100 non-perforated vinyl coated gypsum board tiles
Ceiling Height (above raised access floor if provided)	2.6 m (8.5 ft) minimum	2.7 m (9.0 ft) minimum	3 m (10 ft) minimum (not less than 460 mm (18 in) above tallest piece of equipment	3 m (10 ft) minimum (not less than 600 mm (24 in) above tallest piece of equipment)

5

6

	TIER 1	TIER 2	TIER 3	TIER 4
Roofing				
Class	no restrictions	Class A	Class A	Class A
Type	no restrictions	no restrictions	Non-redundant with non-combustible deck (no mechanically attached systems)	double redundant with concrete deck (no mechanically attached systems)
Wind uplift resistance	Minimum Code requirements	FM I-90	FM I-90 minimum	FM I-120 minimum
Roof Slope	Minimum Code requirements	Minimum Code requirements	1:48 (1/4 in per foot) minimum	1:24 (1/2 in per foot) minimum
Doors and windows				
Fire rating	Minimum Code requirements	Minimum Code requirements	Minimum Code requirements (not less than 3/4 hour at computer room)	Minimum Code requirements (not less than 1 1/2 hour at computer room)
Door size	Minimum Code requirements and not less than 1 m (3 ft) wide and 2.13 m (7 ft in) high	Minimum Code requirements and not less than 1 m (3 ft) wide and 2.13 m (7 ft) high	Minimum Code requirements (not less than 1 m (3 ft) wide into computer, electrical, & mechanical rooms) and not less than 2.13 m (7 ft) high	Minimum Code requirements (not less than 1.2 m (4 ft) wide into computer, electrical, & mechanical rooms) and not less than 2.13 m (7 ft) high
~~Single person interlock, portal or other hardware designed to prevent piggybacking or pass back~~	~~Minimum Code requirements~~	~~Minimum Code requirements – preferably solid wood with metal frame~~	~~Minimum Code requirements – preferably solid wood with metal frame~~	~~Minimum Code requirements – preferably solid wood with metal frame~~
~~No exterior~~ Windows on perimeter of computer room	~~no requirement~~ Allowed with minimum Code required fire rating	~~no requirement~~ Allowed with minimum Code required fire rating	~~Yes~~ Interior windows allowed with minimum 1-hour fire rating, no exterior windows allowed	~~Yes~~ Interior windows allowed with minimum 1-hour fire rating, no exterior windows allowed
~~Construction provides protection against electromagnetic radiation~~	~~no requirement~~	~~no requirement~~	~~yes~~	~~yes~~
Entry Lobby	~~no requirement~~	~~yes~~	~~yes~~	~~yes~~
Physically separate from other areas of data center	no requirement	yes	yes	yes
Fire separation from other areas of data center	Minimum Code requirements	Minimum Code requirements	Minimum Code requirements (not less than 1 hour)	Minimum Code requirements (not less than 2 hour)
Security counter	no requirement	no requirement	yes	yes (physically separated)
Single person interlock, portal or other hardware designed to prevent piggybacking or pass back	no requirement	no requirement	yes	yes

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	TIER 1	TIER 2	TIER 3	TIER 4
Administrative offices				
Physically separate from other areas of data center	no requirement	yes	yes	yes
Fire separation from other areas of data center	Minimum Code requirements	Minimum Code requirements	Minimum Code requirements (not less than 1 hour)	Minimum Code requirements (not less than 2 hour)
Security office				
Physically separate from other areas of data center	no requirement	no requirement	yes	yes
Fire separation from other areas of data center	Minimum Code requirements	Minimum Code requirements	Minimum Code requirements (not less than 1 hour)	Minimum Code requirements (not less than 2 hour)
180-degree peepholes on security equipment and monitoring rooms	No requirement	Yes	Yes	yes
Dedicated and hardened security equipment and monitoring rooms ~~with 16 mm (5/8 in) plywood (except where bullet resistance is recommended or required)~~	No requirement	~~Recommended~~ Yes	~~Recommended~~ Yes, with 16 mm (5/8 in) plywood lined walls and solid core door	~~Recommended~~ Yes, with 16 mm (5/8 in) plywood lined walls and solid core door
~~Dedicated security room for security equipment and monitoring~~	~~No requirement~~	~~No requirement~~	~~Recommended~~	~~Recommended~~
Operations Center	~~no requirement~~	~~no requirement~~	~~yes~~	~~yes~~
Operations Center physically separate from other areas of data center	no requirement	no requirement	yes	yes
Fire separation from other non-computer room areas of data center	no requirement	no requirement	1 hour	2 hour
Proximity to computer room	no requirement	no requirement	indirectly accessible (maximum of 1 adjoining room)	directly accessible
Restrooms and break room areas	~~Minimum Code requirements~~	~~Minimum Code requirements~~	~~Minimum Code requirements~~	~~Minimum Code requirements~~
Proximity to computer room and support areas	no requirement	no requirement	If immediately adjacent, provided with leak prevention barrier	Not immediately adjacent and provided with leak prevention barrier
Fire separation from computer room and support areas	Minimum Code requirements	Minimum Code requirements	Minimum Code requirements (not less than 1 hour)	Minimum Code requirements (not less than 2 hour)

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	TIER 1	TIER 2	TIER 3	TIER 4
UPS and Battery Rooms				
Aisle widths for maintenance, repair, or equipment removal	no requirement	no requirement	Minimum Code requirements (not less than 1 m (3 ft) clear)	Minimum Code requirements (not less than 1.2 m (4 ft) clear)
Proximity to computer room	no requirement	no requirement	Immediately adjacent	Immediately adjacent
Fire separation from computer room and other areas of data center	Minimum Code requirements	Minimum Code requirements	Minimum Code requirements (not less than 1 hour)	Minimum Code requirements (not less than 2 hour)
Required Exit Corridors				
Fire separation from computer room and support areas	Minimum Code requirements	Minimum Code requirements	Minimum Code requirements (not less than 1 hour)	Minimum Code requirements (not less than 2 hour)
Width	Minimum Code requirements	Minimum Code requirements	Minimum Code requirements and not less than 1.2 m (4 ft) clear	Minimum Code requirements and not less than 1.5 m (5 ft) clear
Shipping and receiving area				
Shipping and receiving area physically separate from other areas of data center	~~no requirement~~ No shipping and receiving area provided	~~Yes~~ no	yes	yes
Fire separation from other areas of data center	~~no requirement~~ Minimum Code requirements if shipping and receiving area present	Minimum Code requirements	1 hour	2 hour
Physical protection of walls exposed to lifting equipment traffic	no requirement	no requirement	yes (minimum 19 mm (3/4 in) plywood wainscot)	yes (steel bollards or similar protection)
Number of loading docks	no requirement	1 per 2500 sq m(25,000 sq ft) of Computer room	1 per 2500 sq m (25,000 sq ft) of Computer room (2 minimum)	1 per 2500 sq m (25,000 sq ft) of Computer room (2 minimum)
~~Loading docks separate from parking areas~~	~~no requirement~~	~~no requirement~~	~~yes~~	~~yes (physically separated by fence or wall)~~
~~Security counter~~	~~no requirement~~	~~no requirement~~	~~yes~~	~~yes (physically separated)~~
Generator and fuel storage areas				
Proximity to computer room and support areas	no requirement	no requirement	If within Data Center building, provided with minimum 2 hour fire separation from all other areas	Separate building or exterior weatherproof enclosures with Code required building separation
Proximity to publicly accessible areas	no requirement	no requirement	9 m (30 ft) ~~minimum~~ or greater separation	19 m (60 ft) ~~minimum~~ or greater separation

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	TIER 1	TIER 2	TIER 3	TIER 4
Security				
System CPU UPS capacity	~~na~~ no requirement	Building	Building	Building + Battery (8 hour min)
Data Gathering Panels (Field Panels) UPS Capacity	~~na~~ no requirement	Building + Battery (4 hour min)	Building + Battery (8 hour min)	Building + Battery (24 hour min)
Field Device UPS Capacity	~~na~~ no requirement	Building + Battery (4 hour min)	Building + Battery (8 hour min)	Building + Battery (24 hour min)
Dedicated security staffing per shift	No security staffing provided	1 per 3,000 sq m (30,000 sq ft) (~~2~~ 1 minimum)	1 per 2,000 sq m (20,000 sq ft) (~~3~~ 2 minimum)	1 per 2,000 sq m (20,000 sq ft) (3 minimum)
Number of 8 hour security shifts	no requirement	1 (minimum 5 days per week)	2 (7 days per week)	3 (7 days per week)
Security Access Control/Monitoring at:				
Generators	industrial grade lock	intrusion detection	~~intrusion detection~~ card access	~~intrusion detection~~ card access
UPS, Telephone & MEP Rooms	industrial grade lock	intrusion detection	card access	card access
Fiber Vaults	industrial grade lock	intrusion detection	intrusion detection	card access
Emergency Exit Doors	industrial grade lock	monitor	delay egress per code	delay egress per code
Accessible Exterior Windows/openings	no monitoring	intrusion detection (with offsite monitoring during shifts when no security staff is present)	intrusion detection (with offsite monitoring during shifts when no security staff is present)	intrusion detection
Security Operations Center	~~na~~ no requirement	~~na~~ no requirement	card access	card access
Network Operations Center	~~na~~ no requirement	~~na~~ no requirement	card access	card access
Security Equipment Rooms	~~na~~ no requirement	intrusion detection	card access	card access
Doors into Computer Rooms	industrial grade lock	intrusion detection	card or biometric access for in-gress ~~and egress~~	card or biometric access for ingress and egress
Perimeter building doors	~~off site~~ no monitoring	intrusion detection (with offsite monitoring during shifts when no security staff is present)	card access if main entrance; intrusion detection all others	card access ~~if~~ all entrances
Main door ~~from lobby~~ onto computer room floor	industrial grade lock	card access	Single person interlock, portal or other hardware designed to prevent piggybacking or pass back of access credential~~, pre-ferably with biometrics~~	single person interlock, portal or other hardware designed to prevent piggybacking or pass back of access credential, pre-ferably with biometrics
Bullet resistant walls, windows & doors				
Security Counter in Lobby	~~na~~ no requirement	~~na~~ no requirement	Level 3 (min)	Level 3 (min)
Security Counter in Shipping and Receiving	~~na~~ no requirement	~~na~~ no requirement	~~na~~ no requirement	Level 3 (min)

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	TIER 1	TIER 2	TIER 3	TIER 4
CCTV Monitoring				
Building perimeter and parking	no requirement	no requirement	yes	yes
Generators	~~na~~ no requirement	~~na~~ no requirement	yes	yes
Access Controlled Doors	no requirement	yes	Yes	Yes
Computer Room Floors	no requirement	no requirement	Yes	Yes
UPS, Telephone & MEP Rooms	no requirement	no requirement	Yes	Yes
CCTV				
CCTV Recording of all activity on all cameras	no requirement	no requirement	Yes; digital	Yes; digital
Recording rate (frames per second)	~~na~~ no requirement	~~na~~ no requirement	20 frames/secs (min)	20 frames/secs (min)
Structural				
Seismic zone -any zone acceptable although it may dictate more costly support mechanisms	no restriction	no restriction	no restriction	no restriction
Facility designed to seismic zone requirements	no restriction	no restriction	no restriction	In Seismic Zone 0, 1, 2 to Zone 3 requirements. In Seismic Zone 3 & 4 to Zone 4 requirements
Site Specific Response Spectra - Degree of local Seismic accelerations	no	no	with Operation Status after 10% in 50 year event	with Operation Status after 5% in 100 year event
Importance factor - assists to ensure greater than code design	I=1	I=1.5	I=1.5	I=1.5
Telecommunications equipment racks/cabinets anchored to base or supported at top and base	no	Base only	Fully braced	Fully braced
Deflection limitation on telecommunications equipment within limits acceptable by the electrical attachments	no	no	yes	yes
Bracing of electrical conduits runs and cable trays	per code	per code w/ Importance	per code w/ Importance	per code w/ Importance
Bracing of mechanical system major duct runs	per code	per code w/ Importance	per code w/ Importance	per code w/ Importance
Floor loading capacity superimposed live load	7.2 kPa (150 lbf/sq ft).	8.4 kPa (175 lbf/sq ft)	12 kPa (250 lbf/sq ft)	12 kPa (250 lbf/sq ft)
Floor hanging capacity for ancillary loads suspended from below	1.2 kPa (25 lbf/sq ft)	1.2 kPa (25 lbf/sq ft)	2.4 kPa (50 lbf/sq ft)	2.4 kPa (50 lbf/sq ft)

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	TIER 1	TIER 2	TIER 3	TIER 4
Concrete Slab Thickness at ground	127 mm (5 in)	127 mm (5 in)	127 mm (5 in)	127 mm (5 in)
Concrete topping over flutes for elevated floors affects size of anchor which can be installed	102 mm (4 in)	102 mm (4 in)	102 mm (4 in)	102 mm (4 in)
Building LFRS (Shearwall/Braced Frame/Moment Frame) indicates displacement of structure	Steel/Conc MF	Conc. Shearwall / Steel BF	Conc. Shearwall / Steel BF	Conc. Shearwall / Steel BF
Building Energy Dissipation - Passive Dampers/Base Isolation (energy absorption)	none	none	Passive Dampers	Passive Dampers/Base Isolation
Battery/UPS floor vs. building composition. Concrete floors more difficult to upgrade for intense loads. Steel framing with metal deck and fill much more easily upgraded.	PT concrete	CIP Mild Concrete	Steel Deck & Fill	Steel Deck & Fill
Steel Deck & Fill/ PT concrete/ CIP Mild - PT slabs much more difficult to install anchors	PT concrete	CIP Mild Concrete	Steel Deck & Fill	Steel Deck & Fill

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Table 10: Tiering reference guide (electrical)

	TIER 1	TIER 2	TIER 3	TIER 4
ELECTRICAL				
General				
System allows concurrent maintenance	No	Down to but not including UPS Output Panelboard	Down to but not including Power Distribution Unit	Throughout Distribution System
Single Point of Failure	One or more single points of failure for distribution systems serving electrical equipment or mechanical systems	One or more single points of failure for distribution systems serving electrical equipment or mechanical systems	No more than one single point of failure for distribution systems serving electrical equipment or mechanical systems	No single points of failure for distribution systems serving electrical equipment or mechanical systems
Power System Analysis	Short Circuit Study Coordination Study Arc Flash Analysis	Short Circuit Study Coordination Study Arc Flash Analysis	Short Circuit Study Coordination Study Arc Flash Analysis Load Flow Study	Short Circuit Study Coordination Study Arc Flash Analysis Load Flow Study
Computer & Telecommunications Equipment Power Cords	Single Cord Feed with 100% capacity	Single Cord Feed with 100% capacity	Redundant Cord Feed with 100% capacity on remaining cord or cords	Redundant Cord Feed with 100% capacity on remainging cord or cords
Utility				
~~Number of Delivery Paths~~	~~1~~	~~1~~	~~1 active and 1 passive~~	~~2 active~~
Utility Entrance	Single Feed	Single Feed	N+1 Redundant Feed ~~Dual Feed (600 volts or higher)~~	2N Redundant Feed ~~Dual Feed (600 volts or higher)~~ from different utility substations
Main Utility Switchboard				
Service	Shared	Dedicated	Dedicated	Dedicated
Construction	Panelboard with bolt on circuit breakers	Switchboard with stationary circuit breakers	Switchboard with drawout circuit breakers	Switchgear with drawout circuit breakers
Surge Suppression	Optional	Optional	Yes	Yes
~~System allows concurrent maintenance~~	~~No~~	~~No~~	~~Yes~~	~~Yes~~
~~Computer & Telecommunications Equipment Power Cords~~	~~Single Cord Feed with 100% capacity~~	~~Dual Cord Feed with 100% capacity on each cord~~	~~Dual Cord Feed with 100% capacity on each cord~~	~~Dual Cord Feed with 100% capacity on each cord~~
~~All electrical system equipment labeled with certification from 3rd party test laboratory~~	~~Yes~~	~~Yes~~	~~Yes~~	~~Yes~~
~~Single Points of Failure~~	~~One or more single points of failure for distribution systems serving electrical equipment or mechanical systems~~	~~One or more single points of failure for distribution systems serving electrical equipment or mechanical systems~~	~~No single points of failure for distribution systems serving electrical equipment or mechanical systems~~	~~No single points of failure for distribution systems serving electrical equipment or mechanical systems~~

~~Critical Load System Transfer~~	~~Automatic Transfer Switch (ATS) with maintenance bypass feature for serving the switch with interruption in power; automatic changeover from utility to generator when a power outage occurs.~~	~~Automatic Transfer Switch (ATS) with maintenance bypass feature for serving the switch with interruption in power; automatic changeover from utility to generator when a power outage occurs.~~	~~Automatic Transfer Switch (ATS) with maintenance bypass feature for serving the switch with interruption in power; automatic changeover from utility to generator when a power outage occurs.~~	~~Automatic Transfer Switch (ATS) with maintenance bypass feature for serving the switch with interruption in power; automatic changeover from utility to generator when a power outage occurs.~~
~~Site Switchgear~~	~~None~~	~~None~~	~~Fixed air circuit breakers or fixed molded case breakers. Mechanical interlocking of breakers. Any switchgear in distribution system can be shutdown for maintenance with bypasses without dropping the critical load~~	~~Drawout air circuit breakers or drawout molded case breakers. Mechanical interlocking of breakers. Any switchgear in distribution system can be shutdown for maintenance with bypasses without dropping the critical load~~
~~Generators correctly sized according to installed capacity of UPS~~	~~Yes~~	~~Yes~~	~~Yes~~	~~Yes~~
~~Generator Fuel Capacity (at full load)~~	~~8 hrs (no generator required if UPS has 8 minutes of backup time)~~	~~24 hrs~~	~~72 hrs~~	~~96 hrs~~

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	TIER 1	TIER 2	TIER 3	TIER 4
Uninterruptible Power Supply System ~~***UPS***~~				
~~UPS~~ Redundancy	N	N~~+1~~	N+1	2N
~~UPS~~ Topology	Single ~~Module~~ or Parallel ~~Non-Redundant~~ Modules	~~Parallel Redundant Modules or Distributed Redundant~~ Single or Parallel Modules with static bypass	Parallel Redundant Modules or Distributed Redundant Modules or Block Redundant System	Parallel Redundant Modules or Distributed Redundant Modules or Block Redundant System
Automatic Bypass	None	Yes with non dedicated feeder to automatic bypass	Yes, with dedicated feeder to automatic bypass	Yes, with dedicated feeder to automatic bypass
~~UPS~~ Maintenance Bypass Arrangement	~~By-pass power taken from same utility feeds and UPS modules~~ None	~~By-pass power taken from same utility feeds and UPS modules~~ Non dedicated maintenance bypass feeder to UPS output switchboard	~~By-pass power taken from same utility feeds and UPS modules~~ Dedicated maintenance bypass feeder serving UPS output switchboard	~~By-pass power taken from a reserve UPS system that is powered from a different bus as is used for the UPS system~~ Dedicated maintenance bypass feeder serving UPS output switchboard
~~UPS Power Distribution - voltage level~~	~~Voltage Level 120/208V up to loads of 1440 kVA and 480V for loads greater than 1440 kVA~~	~~Voltage Level 120/208V up to loads of 1440 kVA and 480V for loads greater than 1440 kVA~~	~~Voltage Level 120/208V up to loads of 1440 kVA and 480V for loads greater than 1440 kVA~~	~~Voltage Level 120/208V up to loads of 1440 kVA and 480V for loads greater than 1440 kVA~~
~~UPS~~ Output Power Distribution ~~panel boards~~	Panelboard incorporating standard thermal magnetic trip breakers	Panelboard incorporating standard thermal magnetic trip breakers	Panelboard incorporating ~~standard thermal magnetic trip breakers~~ circuit breakers that are coordinated under overload and ground fault current condition	Panelboard incorporating ~~standard thermal magnetic trip breakers~~ circuit breakers that are coordinated under all overcurrent conditions
Battery String	Common String for multiple modules	Dedicated String for each module	Dedicated String for each module	Dedicated String for each module
Battery type	5 Year valve regulated lead acid	10 Year valve regulated lead acid or flooded type	15 Year valve regulated lead acid or flooded type	20 Year lead acid flooded type
Battery Minimum Back Up Time	5 minutes	7 minutes	10 minutes	15 minutes
Battery Monitoring System	Optional	Optional	String level by UPS System	Centralized automated system to check each cell for, voltage, and impedance or resistance
Flywheel	Allowed	Allowed	Allowed	Allowed
~~PDUs feed all computer and telecommunications equipment~~	~~No~~	~~No~~	~~Yes~~	~~Yes~~
~~K-Factor transformers installed in PDUs~~	~~Yes, but not required if harmonic canceling transformers are used~~	~~Yes, but not required if harmonic canceling transformers are used~~	~~Yes, but not required if harmonic canceling transformers are used~~	~~Yes, but not required if harmonic canceling transformers are used~~
~~Load Bus Synchronization (LBS)~~	~~No~~	~~No~~	~~Yes~~	~~Yes~~

~~Redundant components (UPS)~~	~~Static UPS Design.~~	~~Static or Rotary UPS Design. Rotating M-G Set Converters.~~	~~Static or Rotary UPS design. Static Converters.~~	~~Static, Rotary, or Hybrid UPS Design~~
~~UPS on separate distribution panel from computer & telecommunications equipment~~	~~No~~	~~Yes~~	~~Yes~~	~~Yes~~
Power Distribution Unit				
Transformer	Optional	K-Rated or Harmonic Cancelling	K-Rated or Harmonic Cancelling Front Accessible for maintenance	K-Rated or Harmonic Cancelling, Low Inrush Front Accessible for maintenance
Automatic Static Transfer Switch				
Overcurrent Device	NA	Fuse	Circuit Breaker	Circuit Breaker
Maintenance Bypass Procedure	NA	Manual Non Guided	Manual Guided	Manual Guided
Ouput	NA	Single Circuit Breaker	Dual Circuit Breaker	Dual Circuit Breaker
Grounding				
Lightning protection system	Based on risk analysis as per NFPA 780 and insurance requirements.	Based on risk analysis as per NFPA 780 and insurance requirements.	Yes	Yes
Service entrance grounds and generator grounds fully conform to NEC or local codes	Yes	Yes	Yes	Yes
Lighting fixtures ~~(277v)~~ neutral isolated from service entrance derived from lighting transformer for ground fault isolation	~~Yes~~ No	~~Yes~~ No	Yes	Yes
Data center grounding infrastructure in computer room	~~Not required~~ Optional	~~Not required~~ Optional	Yes	Yes

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	TIER 1	TIER 2	TIER 3	TIER 4
Computer Room Emergency Power Off (EPO) System				Yes
Installation	Do not install if not required by authorities having jurisdic-tion	Do not install if not required by authorities having jurisdiction	Do not install if not required by authorities having jurisdiction	Do not install if not required by authorities having jurisdiction
Test Mode	Optional	Optional	Yes	Yes
Alarm	Optional	Optional	Yes	Yes
Abort Switch	Optional	Optional	Yes	Yes
~~Activated by Emergency Power Off (EPO) at exits with computer and telecommunications system shutdown only~~	~~Yes~~	~~Yes~~	~~Yes~~	~~Yes~~
~~Automatic fire suppressant release after computer and telecommunications system shutdown~~	~~Yes~~	~~Yes~~	~~Yes~~	~~Yes~~
~~Second zone fire alarm system activation with manual Emergency Power Off (EPO) shutdown~~	~~No~~	~~No~~	~~No~~	~~Yes~~
~~Master control disconnects batteries and releases suppressant from a 24/7 attended station~~	~~No~~	~~No~~	~~No~~	~~Yes~~
~~***Battery Room Emergency Power Off (EPO) System***~~				
~~Activated by Emergency Power Off (EPO) buttons at exits with manual suppressant release~~	~~Yes~~	~~Yes~~	~~Yes~~	~~Yes~~
~~Fire suppressant release for single zone system after Emergency Power Off (EPO) shutdown~~	~~Yes~~	~~Yes~~	~~Yes~~	~~Yes~~
~~Second zone fire alarm system activation. Disconnects batteries on first zone with suppressant release on the second zone~~	~~No~~	~~No~~	~~Yes~~	~~Yes~~
~~Master control disconnects batteries and releases suppressant from a 24/7 attended station~~	~~No~~	~~No~~	~~Yes~~	~~Yes~~
~~***Emergency Power Off (EPO) Systems***~~				

~~Shutdown of UPS power receptacles in computer room area.~~	~~Yes~~	~~Yes~~	~~Yes~~	~~Yes~~
~~Shutdown of AC power for CRACs and chillers~~	~~Yes~~	~~Yes~~	~~Yes~~	~~Yes~~
~~Compliance with local code (e.g. separate systems for UPS and HVAC)~~	~~Yes~~	~~Yes~~	~~Yes~~	~~Yes~~

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	TIER 1	TIER 2	TIER 3	TIER 4
~~***System***~~ ***Central Power Monitoring***				
Monitored Points	None	Utility UPS Generator	Utility Main Transformer UPS Generator Feeder Circuit Breakers Automatic Static Transfer Switch PDU Automatic Transfer Switches	Utility Main Transformer UPS Generator Feeder Circuit Breakers Automatic Static Transfer Switch PDU Automatic Transfer Switches Surge Protection Device Critical Load Branch Circuits
Notification Method	NA	Control Room Console	Control Room Console Pager Email Text message	Control Room Console Pager Email Text message
~~Locally Displayed at UPS~~	~~Yes~~	~~Yes~~	~~Yes~~	~~Yes~~
~~Central power and environmental monitoring and control system (PEMCS) with remote engineering console and manual overrides for all automatic controls and set points~~	~~No~~	~~No~~	~~Yes~~	~~Yes~~
~~Interface with BMS~~	~~No~~	~~No~~	~~Yes~~	~~Yes~~
~~Remote Control~~	~~No~~	~~No~~	~~No~~	~~Yes~~
~~Automatic Text Messaging to Service Engineer's Pager~~	~~No~~	~~No~~	~~No~~	~~Yes~~
~~***Battery Configuration***~~				
~~Common Battery String for All Modules~~	~~Yes~~	~~No~~	~~No~~	~~No~~
~~One Battery String per Module~~	~~No~~	~~Yes~~	~~Yes~~	~~Yes~~
~~Minimum Full Load Standby Time~~	~~5 minutes~~	~~10 Minutes~~	~~15 minutes~~	~~15 minutes~~
~~Battery type~~	~~Valve regulated lead acid (VRLA) or flooded type~~	~~Valve regulated lead acid (VRLA) or flooded type~~	~~Valve regulated lead acid (VRLA) or flooded type~~	~~Valve regulated lead acid (VRLA) or flooded type~~
~~***Flooded Type Batteries***~~				
~~Mounting~~	~~Racks or cabinets~~	~~Racks or cabinets~~	~~Open racks~~	~~Open racks~~
~~Wrapped Plates~~	~~No~~	~~Yes~~	~~Yes~~	~~Yes~~
~~Acid Spill Containment Installed~~	~~Yes~~	~~Yes~~	~~Yes~~	~~Yes~~
~~Battery Full Load Testing/Inspection Schedule~~	~~Every two years~~	~~Every two years~~	~~Every two years~~	~~Every two years or annually~~
Battery Room				
Separate from UPS/Switchgear Equipment Rooms	No	Yes	Yes	Yes

Individual Battery Strings Isolated from Each Other	No	Yes	Yes	Yes
Shatterproof Viewing Glass in Battery Room Door	No	No	No	Yes
~~Battery Disconnects Located Outside Battery Room~~	~~Yes~~	~~Yes~~	~~Yes~~	~~Yes~~
~~Battery Monitoring System~~	~~UPS self monitoring~~	~~UPS self monitoring~~	~~UPS self monitoring~~	~~Centralized automated system to check each cell for temperature, voltage, and impedance~~

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	TIER 1	TIER 2	TIER 3	TIER 4
~~***Rotating UPS System Enclosures (With Diesel Generators)***~~				
~~Units Separately Enclosed by Fire Rated Walls~~	~~No~~	~~No~~	~~Yes~~	~~Yes~~
~~Fuel Tanks on Exterior~~	~~No~~	~~No~~	~~Yes~~	~~Yes~~
~~Fuel Tanks in Same Room as Units~~	~~Yes~~	~~Yes~~	~~No~~	~~No~~
Standby Generating System				
Generator Sizing	Sized for ~~computer & telecommunications system electrical & mechanical~~ UPS System only	Sized for ~~computer & telecommunications system electrical~~ UPS & mechanical system ~~only~~	Sized for total building load N+1 redundancy ~~computer & telecommunications system electrical & mechanical only + 1 spare~~	Sized for total building load ~~+ 1 Spare~~ with 2N redundancy
Generators on Single Bus	Yes	Yes	Yes	No
~~Single Generator per System with (1) Spare Generator~~	~~No~~	~~Yes~~	~~Yes~~	~~Yes~~
~~Individual 83G ft. Ground Fault Protection Detection for Each Generator~~	~~No~~	~~Yes~~	~~Yes~~	~~Yes~~
Loadbank ~~for Testing~~				
Installation	None	Provision for Portable	Provision for Portable	Permanent
Equipment Tested	NA	Generator	Generator UPS	Generator UPS
Auto Shutdown	NA	None	Automatic upon failure of utility	Automatic upon failure of utility
~~Testing UPS modules only~~	~~Yes~~	~~Yes~~	~~Yes~~	~~No~~
~~Testing of Generators only~~	~~Yes~~	~~Yes~~	~~Yes~~	~~No~~
~~Testing of Both UPS modules and generators~~	~~No~~	~~No~~	~~No~~	~~Yes~~
~~UPS Switchgear~~	~~No~~	~~No~~	~~No~~	~~Yes~~
~~Permanently Installed~~	~~No - Rental~~	~~No - Rental~~	~~No - Rental~~	~~Yes~~
Testing				
Factory Acceptance Testing	Optional	Optional	Yes	Yes
Site circuit breaker testing	Optional	Optional	Contact Resistance test of all circuit breakers in critical and essential paths, 225 Amps and higher	Primary Injection and Contact Resistance test of all circuit breakers in critical and essential paths, 225 Amps and higher

Commissioning	Optional	Component level System level	Component level System level Integrated System	Component level System level Integrated System
Equipment Maintenance				
Maintenance Staff	Onsite Day Shift only. On-call at other times	Onsite Day Shift only. On-call at other times	Onsite 24 hrs M-F, on-call on weekends	Onsite 24/7
Preventative Maintenance	None	None	Limited preventative maintenance program	Comprehensive preventative maintenance program
Facility Training Programs	None	None	Comprehensive training program	Comprehensive training program including manual operation procedures if it is necessary to bypass control system

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Table 11: Tiering reference guide (mechanical)

	TIER 1	TIER 2	TIER 3	TIER 4
MECHANICAL				
General				
Routing of water or drain piping not associated with the data center equipment in data center spaces	Permitted but not recommended	Permitted but not recommended	Not permitted	Not permitted
Positive pressure in computer room and associated spaces relative to outdoors and non-data center spaces	No requirement	Yes	Yes	Yes
Floor drains in computer room for condensate drain water, humidifier flush water, and sprinkler discharge water	Yes	Yes	Yes	Yes
Mechanical systems on standby generator	No requirement	Yes	Yes	Yes
Water-Cooled System				
Indoor Terminal Air Conditioning Units	No redundant air conditioning units	One redundant AC Unit per critical area	Qty. of AC Units sufficient to maintain critical area during loss of one source of electrical power	Qty. of AC Units sufficient to maintain critical area during loss of one source of electrical power
Humidity Control for Computer Room	~~Humidification provided~~ No requirement	Humidification provided	Humidification provided	Humidification provided
Electrical Service to Mechanical Equipment	Single path of electrical power to AC equipment	Single path of electrical power to AC equipment	Multiple paths of electrical power to AC equipment. Connected in checkerboard fashion for cooling redundancy	Multiple paths of electrical power to AC equipment. Connected in checkerboard fashion for cooling redundancy
Heat Rejection				
Dry-coolers (where applicable)	No redundant dry coolers	One redundant dry cooler per system	Qty. of dry coolers sufficient to ~~maintain~~ provide minimal temporary capacity to critical area during loss of one source of electrical power	Qty. of dry coolers sufficient to maintain critical area during loss of one source of electrical power
Closed-Circuit Fluid Coolers (where applicable)	No redundant fluid coolers	One redundant fluid cooler per system	Qty. of fluid coolers sufficient to ~~maintain~~ provide minimal temporary capacity to critical area during loss of one source of electrical power	Qty. of fluid coolers sufficient to maintain critical area during loss of one source of electrical power
Circulating Pumps	No redundant condenser water pumps	One redundant condenser water pump per system	Qty. of condenser water pumps sufficient to ~~maintain~~ provide minimal temporary capacity to critical area during loss of one source of electrical power	Qty. of condenser water pumps sufficient to maintain critical area during loss of one source of electrical power
Piping System	Single path condenser water system	Single path condenser water system	~~Dual path~~ Headered parallel piped condenser water system	Dual path condenser water system

	TIER 1	TIER 2	TIER 3	TIER 4
Chilled Water System				
Indoor Terminal Air Conditioning Units	No redundant air conditioning units	One redundant AC Unit per critical area	Qty. of AC Units sufficient to ~~maintain~~ provide minimal temporary capacity to critical area during loss of one source of electrical power	Qty. of AC Units sufficient to maintain critical area during loss of one source of electrical power
Humidity Control for Computer Room	~~Humidification provided~~ No requirement	Humidification provided	Humidification provided	Humidification provided
Electrical Service to Mechanical Equipment	Single path of electrical power to AC equipment	Single path of electrical power to AC equipment	Multiple paths of electrical power to AC equipment	Multiple paths of electrical power to AC equipment
Heat Rejection				
Chilled Water Piping System	Single path chilled water system	Single path chilled water system	Dual path ladder loop chilled water system with isolation valves	Dual path chilled water system
Chilled Water Pumps	No redundant chilled water pumps	One redundant chilled water pump per system	Qty. of chilled water pumps sufficient to ~~maintain~~ provide minimal temporary capacity to critical area during loss of one source of electrical power	Qty. of chilled water pumps sufficient to maintain critical area during loss of one source of electrical power
Air-Cooled Chillers	No redundant chiller	One redundant chiller per system	Qty. of ~~chilled water pumps~~ chillers sufficient to provide minimal temporary capacity to ~~maintain~~ critical area during loss of one source of electrical power	Qty. of chillers sufficient to maintain critical area during loss of one source of electrical power
Water-cooled Chillers	No redundant chiller	One redundant chiller per system	Qty. of chillers sufficient to ~~maintain~~ provide minimal temporary capacity to critical area during loss of one source of electrical power	Qty. of chillers sufficient to maintain critical area during loss of one source of electrical power
Cooling Towers	No redundant cooling tower	One redundant cooling tower per system	Qty. of cooling towers sufficient to ~~maintain~~ provide minimal temporary capacity to critical area during loss of one source of electrical power	Qty. of cooling towers sufficient to maintain critical area during loss of one source of electrical power
Condenser Water Pumps	No redundant condenser water pumps	One redundant condenser water pump per system	Qty. of condenser water pumps sufficient to ~~maintain~~ provide minimal temporary capacity to critical area during loss of one source of electrical power	Qty. of condenser water pumps sufficient to maintain critical area during loss of one source of electrical power
Condenser Water Piping System	Single path condenser water system	Single path condenser water system	~~Dual path~~ Headered parallel piped condenser water system	Dual path condenser water system

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	TIER 1	TIER 2	TIER 3	TIER 4
Air-Cooled System				
Indoor Terminal Air Conditioning Units/Outdoor Condensers	No redundant air conditioning units	One redundant AC Unit per critical area	Qty. of AC Units sufficient to ~~maintain~~ provide minimal temporary capacity to critical area during loss of one source of electrical power	Qty. of AC Units sufficient to maintain critical area during loss of one source of electrical power
Electrical Service to Mechanical Equipment	Single path of electrical power to AC equipment	Single path of electrical power to AC equipment	Multiple paths of electrical power to AC equipment	Multiple paths of electrical power to AC equipment
Humidity Control for Computer Room	~~Humidification provided~~ No requirement	Humidification provided	Humidification provided	Humidification provided
HVAC Control System				
HVAC Control System	Control system failure will interrupt cooling to critical areas	Control system failure will not interrupt cooling to critical areas	Control system failure will not interrupt cooling to critical areas	Control system failure will not interrupt cooling to critical areas
Power Source to HVAC Control System	Single path of electrical power to HVAC control system	Redundant, UPS electrical power to ~~AC equipment~~ BMS Control	Redundant, UPS electrical power to ~~AC equipment~~ BMS Control	Redundant, UPS electrical power to ~~AC equipment~~ BMS Control
Plumbing (for water-cooled heat rejection)				
~~Dual sources of~~ Make-up Water	Single water supply, with no on-site back-up storage	Dual sources of water, or one source + on-site storage	Dual sources of water, or one source + on-site storage	Dual sources of water, or one source + on-site storage
Points of Connection to Condenser Water System	Single point of connection	Single point of connection	Two points of connection	Two points of connection
Fuel Oil System				
Bulk Storage Tanks	Single storage tank	~~Multiple~~ Single storage tank~~s~~	Multiple storage tanks	Multiple storage tanks
Storage Tank Pumps and Piping	Single pump and/or supply pipe	Multiple pumps, multiple supply pipes	Multiple pumps, multiple supply pipes	Multiple pumps, multiple supply pipes
Fire Suppression				
Fire detection system	no	yes	yes	yes
Fire sprinkler system	When required	Pre-action (when required)	Pre-action (when required)	Pre-action (when required)
Gaseous suppression system	no	no	clean agents listed in NFPA 2001	clean agents listed in NFPA 2001
Early Warning Smoke Detection System	no	yes	yes	yes
Water Leak Detection System	no	yes	yes	yes

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