



ANSI/TIA-942-2-2010  
APPROVED: FEBRUARY 4, 2010

# TIA STANDARD

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

TIA-942-2

March 2010

**TELECOMMUNICATIONS  
INDUSTRY ASSOCIATION**

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(From Standards Proposal No. 3-0092-AD2-1, formulated under the cognizance of the TIA TR-42 Telecommunications Cabling Systems, TR-42.1 Subcommittee on Commercial Building Telecommunications Cabling 568-B-1).

Published by

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Standards and Technology Department  
2500 Wilson Boulevard  
Arlington, VA 22201 U.S.A.

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

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## FOREWORD

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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	<ul style="list-style-type: none"> <li>• Temperature: 18 – 27 °C (64 – 81 °F) dry bulb               <ul style="list-style-type: none"> <li>◦ high altitude: reduce maximum dry-bulb temperature 1°C for every 300m (1.8°F for every 1000 ft) above 1800 m (5900 ft) altitude</li> </ul> </li> <li>• Maximum Relative Humidity (RH): 60%</li> <li>• Maximum dew point: 15 °C (59 °F)</li> <li>• Minimum dew point (lower moisture limit): 5.5 °C (42 °F)<sup>1</sup></li> <li>• Maximum rate of temperature change: 5 °C (9 °F) per hour</li> </ul>
<b>Notes:</b> <ol style="list-style-type: none"> <li>1. Dewpoint of 5.5 °C - corresponds to approximately 44% RH at 18 °C (64 °F) and 25% RH at 27 °C (81 °F).</li> </ol>	

## 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<sub>1</sub>I<sub>1</sub>C<sub>1</sub>E<sub>1</sub> environment (ANSI/TIA-568-C.0). Note: alternatively, the computer room should be designed to create a MICE M<sub>1</sub>I<sub>1</sub>C<sub>1</sub>E<sub>1</sub> 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  $\pm 1^{\circ}\text{C}$  (1.8°F) 2 °C (3.6 °F)

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

Normal set points:

~~45% RH~~

Control  $\pm 5\%$

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:

Table 9: Tiering reference guide (architectural)

	TIER 1	TIER 2	TIER 3	TIER 4
<b>ARCHITECTURAL</b>				
<b>Site selection</b>				
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 than 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)
<b>Parking</b>				
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
<b>Multi-tenant occupancy within building</b>	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

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Building construction		TIER 1	TIER 2	TIER 3	TIER 4
Type of construction (IBC 2006)		no restriction	no restriction	Type IIA-4H, IIIA-4H, or VA-4H	Type IA or IB-4H
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
<b>Miscellaneous Building components</b>					
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 filled
Understructure (when access floor is provided)		no requirement	no requirement	bolled stringer	bolled stringer with 1.2 m x 1.2 m (4 ft x 4 ft) basket weave pattern
<b>Ceilings within computer room areas (when provided)</b>					
Ceiling Construction		no requirement	no requirement		Suspended with clean room class 100 non-perforated vinyl coated gypsum board tiles
Ceiling Height (above raised access floor if provided)		2.5 m (8.5 ft) minimum	2.7 m (9.0 ft) minimum	If provided, suspended with clean room class 10M-100M perforated tiles 3 m (10 ft) minimum (not less than 460 mm (18 in) above least piece of equipment)	3 m (10 ft) minimum (not less than 500 mm (24 in) above least piece of equipment)

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	TIER 1	TIER 2	TIER 3	TIER 4
<b>Roofing</b>				
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
<b>Doors and windows</b>				
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) 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
<b>Entry Lobby</b>				
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
<b>Administrative offices</b>				
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)
<b>Security office</b>				
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
<b>Operations Center</b>				
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	yes	yes
Proximity to computer room	no requirement	no requirement	1 hour	2 hour
			indirectly accessible (maximum of 1 adjoining room)	directly accessible
<b>Restrooms and break room areas</b>	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
<b>UPS and Battery Rooms</b>				
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)
<b>Required Exit Corridors</b>				
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
<b>Shipping and receiving area</b>				
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)
<b>Generator and fuel storage areas</b>				
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	3 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
<b>Security</b>				
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) (± 1 minimum)	1 per 2,000 sq m (20,000 sq ft) (± 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)
<b>Security Access Control/Monitoring at:</b>				
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 ingress 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, preferably with biometrics	single person interlock, portal or other hardware designed to prevent piggybacking or pass back of access credential, preferably with biometrics
<b>Bullet resistant walls, windows &amp; doors</b>				
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
<b>CCTV Monitoring</b>				
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
<b>CCTV</b>				
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)
<b>Structural</b>				
Seismic zone - any zone acceptable although it may date 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 lb/sq ft)	8.4 kPa (175 lb/sq ft)	12 kPa (250 lb/sq ft)	12 kPa (250 lb/sq ft)
Floor hanging capacity for ancillary loads suspended from below	1.2 kPa (25 lb/sq ft)	1.2 kPa (25 lb/sq ft)	2.4 kPa (50 lb/sq ft)	2.4 kPa (50 lb/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
<b>ELECTRICAL</b>				
<b>General</b>				
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 remaining cord or cords
<b>Utility</b>				
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
<b>Main Utility Switchboard</b>				
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	None	Drawout air circuit breakers or drawout molded case breakers. Mechanical interlocking of breakers. Any switchgear in distribution system can be shutdown for maintenance with by-passes without dropping the critical load.
Generators correctly sized according to installed capacity of UPS	Yes	Yes	Yes	Yes	Yes
Generator Fuel Capacity (at full load)	8 hrs (no generator required if UPS has 5 minutes of backup time)	8 hrs	24 hrs	72 hrs	96 hrs



<u>Uninterruptible Power Supply System UPS</u>		TIER 1	TIER 2	TIER 3	TIER 4
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



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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
<b>Power Distribution Unit</b>				
Transformer	Optional	K-Rated or Harmonic Cancel- ling	K-Rated or Harmonic Cancel- ling Front Accessible for mainten- ance	K-Rated or Harmonic Cancel- ling, Low Inrush Front Accessible for mainten- ance
<b>Automatic Static Transfer Switch</b>				
Overcurrent Device	NA	Fuse	Circuit Breaker	Circuit Breaker
Maintenance Bypass Procedure	NA	Manual Non Guided	Manual Guided	Manual Guided
Output	NA	Single Circuit Breaker	Dual Circuit Breaker	Dual Circuit Breaker
<b>Grounding</b>				
Lightning protection system	Based on risk analysis as per NFPA 780 and insurance re- quirements.	Based on risk analysis as per NFPA 780 and insurance re- quirements.	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 trans- former for ground fault isolation	Yes-No	Yes-No	Yes	Yes
Data center grounding infrastructure in com- puter room	Not required Optional	Not required Optional	Yes	Yes

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	TIER 1	TIER 2	TIER 3	TIER 4
<b>Computer Room Emergency Power Off (EPO) System Installation</b>	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	Do not install if not required by authorities having jurisdiction
<u>Test Mode</u>	Optional	Optional	Yes	Yes
<u>Alarm</u>	Optional	Optional	Yes	Yes
<u>Abort Switch</u>	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
<b>Battery Room Emergency Power Off (EPO) System</b>				
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
<b>Emergency Power Off (EPO) Systems</b>				

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

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	TIER 1	TIER 2	TIER 3	TIER 4
<b>System Central Power Monitoring</b>				
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 Control Room Console
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	No	Yes
Remote Control	No	No	No	Yes
Automatic Text Messaging to Service Engineer's Pager	No	No	No	Yes
<b>Battery Configuration</b>				
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
<b>Flooded Type Batteries</b>				
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
<b>Battery Room</b>				
Separate from UPS/Switchgear Equipment Rooms	No	Yes	Yes	Yes

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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
<b>Rotating UPS System Enclosures (With Diesel Generators)</b>				
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
<b>Standby Generating System</b>				
Generator Sizing	Sized for computer & telecommunications system electrical & mechanical 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
<b>Loadbank for Testing</b>				
Installation	None	Provision for Portable Generator	Provision for Portable Generator UPS	Permanent Generator UPS
Equipment Tested	NA	Generator	Automatic upon failure of utility	Automatic upon failure of utility
Auto Shutdown	NA	None		
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
<b>Testing</b>				
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



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Commissioning	Optional	Component level System level	Component level System level Integrated System	Component level System level Integrated System
<b>Equipment Maintenance</b>				
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 mainten- ance program	Comprehensive preventative maintenance program
Facility Training Programs	None	None	Comprehensive training pro- gram	Comprehensive training pro- gram including manual opera- tion procedures if it is neces- sary to bypass control system

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Table 11: Tiering reference guide (mechanical)

		TIER 1		TIER 2	TIER 3	TIER 4
MECHANICAL						
<b>General</b>						
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
<b>Water-Cooled System</b>						
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 <u>No</u> 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
<b>Heat Rejection</b>						
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

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	TIER 1	TIER 2	TIER 3	TIER 4
<b>Chilled Water System</b>				
Indoor Terminal Air Conditioning Units	No redundant air conditioning units	One redundant AC Unit per critical area	Qty. of AC Units sufficient to maintain <u>provide minimal temporary capacity to critical area</u> 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 <u>provided</u> 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
<b>Heat Rejection</b>				
Chilled Water Piping System	Single path chilled water system	Single path chilled water system	Dual path ladder loop chilled water system <u>with isolation valves</u>	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 <u>maintain provide minimal temporary capacity to critical area</u> 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 <u>chilled water pumps chillers</u> sufficient to provide minimal temporary capacity to <u>maintain critical area</u> 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 <u>maintain provide minimal temporary capacity to critical area</u> 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 <u>maintain provide minimal temporary capacity to critical area</u> 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 <u>maintain provide minimal temporary capacity to critical area</u> 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 <u>Headered parallel piped</u> condenser water system	Dual path condenser water system

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		TIER 1	TIER 2	TIER 3	TIER 4
<b>Air-Cooled System</b>					
Indoor Terminal Units/Outdoor Condensers	Air Conditioning	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 <u>No</u> requirement	Humidification provided	Humidification provided	Humidification provided
<b>HVAC Control System</b>					
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 <u>BMS</u> Control	Redundant, UPS electrical power to AC equipment <u>BMS</u> Control	Redundant, UPS electrical power to AC equipment <u>BMS</u> Control
<b>Plumbing (for water-cooled heat rejection)</b>					
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
<b>Fuel Oil System</b>					
Bulk Storage Tanks		Single storage tank	Multiple <u>Single</u> storage tanks	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
<b>Fire Suppression</b>					
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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## THE TELECOMMUNICATIONS INDUSTRY ASSOCIATION

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