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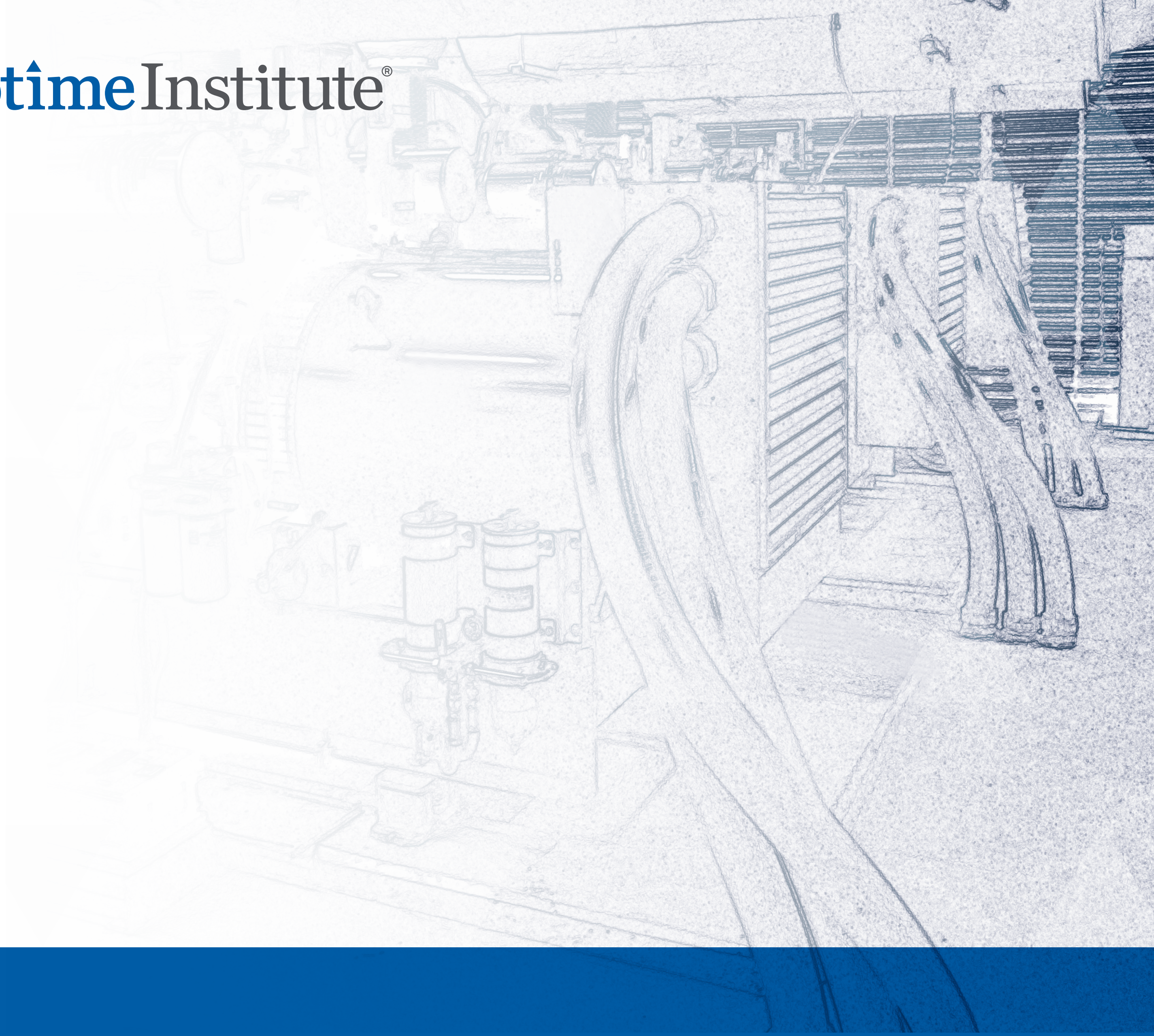

Data Center Site Infrastructure Tier Standard: Topology

Abstract

The Uptime Institute *Tier Standard: Topology* is an objective basis for comparing the functionality, capacity, and expected availability (or performance) of a particular site infrastructure design topology against other sites, or for comparing a group of sites. This Standard describes criteria to differentiate four classifications of site infrastructure topology based on increasing levels of redundant capacity components and distribution paths. This Standard focuses on the definitions of the four Tiers and the performance confirmation tests for determining compliance to the definitions. The Commentary, in a separate section, provides practical examples of site infrastructure system designs and configurations that fulfill the Tier definitions as a means to clarify the Tier classification criteria.

Keywords

ambient temperatures, autonomous response, availability, classification, Compartmentalization, Concurrent Maintenance, Concurrently Maintainable, Continuous Cooling, critical power distribution, data center, dry bulb, dual power, electrical power backbone, Fault Tolerance, Fault Tolerant, functionality, infrastructure, metrics, Operational Sustainability, performance, redundant, reliability, Tier, Tier level, Tiers, topology, wet bulb

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Introduction

This introduction is not part of Uptime Institute *Data Center Site Infrastructure Tier Standard: Topology*. It provides the reader with context for the application of the Standard.

This *Data Center Site Infrastructure Tier Standard: Topology* is a restatement of the content previously published as Uptime Institute publication *Tier Classifications Define Site Infrastructure Performance*. Selected content of this publication has been reedited into a more traditional standards model format. Future updates or changes to Uptime Institute *Tier Standard: Topology* shall be accomplished through a review and recommendation process consistent with other recognized Standards bodies.

The Tier Classifications were created to consistently describe the site-level infrastructure required to sustain data center operations, not the characteristics of individual systems or subsystems. Data centers are dependent upon the successful and integrated operation of electrical, mechanical, and building systems. Every subsystem and system must be consistently deployed with the same site uptime objective to satisfy the distinctive Tier requirements. The most critical decision-making perspective owners and designers must consider, when making inevitable tradeoffs, is what effect does the decision have on the life-cycle-integrated operation of the information technology (IT) environment in the computer room. Most successful owners align data center site infrastructure investment with the business case for availability or selected mission imperatives. These organizations will know the cost of a disruption, usually in terms of actual dollar costs, impact to market share, and continued mission imperatives. The cost of disruption makes the case for investment in high-availability infrastructure a straightforward business decision.

Simply put, the Tier topology rating for an entire site is constrained by the rating of the weakest subsystem that will impact site operation. For example, a site with a robust Tier IV UPS configuration combined with a Tier II chilled water system yields a Tier II site rating.

This very stringent definition is driven by senior executives who have approved multi-million dollar investments for an objective report of actual site capabilities. Any exceptions and exclusions footnoted in the approval documents will be quickly lost and forgotten. If a site has been advertised within an organization as being Fault Tolerant (Tier IV), it will be inconsistent to have to plan a site shutdown at any time in the future—regardless of any “fine print” exclusions that diligently identified the risk. For this reason, there are no partial or fractional Tier ratings. A site’s Tier rating is not the average of the ratings for the critical site infrastructure subsystems. The site’s Tier rating is the lowest of the individual subsystem ratings.

Similarly, the Tier rating cannot be claimed by using calculated mean time between failures (MTBF) component statistical reliability to generate a predictive availability and then using that number to match the empirical availability results with those of sites representing the different Tier classifications. Statistically valid component values are not available, partly because product life cycles are getting shorter and no independent, industry-wide database exists to collect failure data.

Finally, this Standard focuses on the topology and performance of an individual site. High levels of end-user availability may be attained through the integration of complex IT architectures and network configurations that take advantage of synchronous applications running on multiple sites. However, this Standard is independent of the IT systems operating within the site.

Additional Factors and Exposures

Uptime Institute *Tier Standard: Topology* and *Tier Standard: Operational Sustainability* establish a consistent set of performance criteria that can be satisfied, and adjudicated, worldwide. For the data center design, implementation, and sustained operation to be successful, additional factors and exposures must also be considered by the owner and project team. Many of these will be dictated by the site location as well as local, national, or regional considerations and/or regulations. For example, building codes and Authorities Having Jurisdiction (AHJs); seismic, extreme weather (high winds, tornado); flooding; adjacent property uses; union or other organized labor force; and/or physical security (either as corporate policy or warranted by immediate surroundings).

Due to the many design and management options that may be dictated by the owner, regulated by local government, recommended by industry groups, or followed as a general practice, it is not feasible for *Tier Standard: Topology* and *Tier Standard: Operational Sustainability* to establish criteria for these additional factors and exposures worldwide. And, Uptime Institute does not wish to displace or confuse the guidance of local experts, which are key for timely project delivery, regulatory compliance, and implementation of best practices.

For a successful project, Uptime Institute recommends that the project team create a comprehensive catalogue of project requirements, which incorporates *Tier Standard: Topology*, *Tier Standard: Operational Sustainability*, and carefully considered mitigation measures of these additional factors and exposures. This approach will ensure the project meets the compliance objectives of Uptime Institute's international standards, as well as local constraints and owner's business case.

Contents

1. Overview

1.1 Scope

This Standard establishes four distinctive definitions of data center site infrastructure Tier classifications (Tier I, Tier II, Tier III, Tier IV), and the performance confirmation tests for determining compliance to the definitions. The Tier classifications describe the site-level infrastructure topology required to sustain data center operations, not the characteristics of individual systems or subsystems. This Standard is predicated on the fact that data centers are dependent upon the successful and integrated operation of several separate site infrastructure subsystems, the number of which is dependent upon the individual technologies (e.g., power generation, refrigeration, uninterruptible power sources) selected to sustain the operation.

Every subsystem and system integrated into the data center site infrastructure must be consistently deployed with the same site uptime objective to satisfy the distinctive Tier requirements.

Compliance with the requirements of each Tier is measured by outcome-based confirmation tests and operational impacts. This method of measurement differs from a prescriptive design approach or a checklist of required equipment.

Commentary on this Standard is in a separate section that provides examples for the design and configuration of facility systems for each Tier topology level. The commentary section also offers guidance in the application and implementation of the Tier definitions. In addition, the commentary section includes discussion and examples to aid in understanding Tier concepts as well as information on common design topology shortfalls.

1.2 Purpose

The purpose of this Standard is to equip design professionals, data center operators, and non-technical managers with an objective and effective means for identifying the anticipated performance of different data center site infrastructure design topologies.

1.3 References

American Society of Heating, Refrigerating, and Air-Conditioning Engineers, *ASHRAE Handbook – Fundamentals* (Latest Version).

ASHRAE Thermal Guidelines for Data Processing Environments, Third Edition

1.4 Related Publications

Accredited Tier Designer Technical Paper Series

Further information can be found at **www.uptimeinstitute.com**.

2. Site Infrastructure Tier Standards

2.1 Tier I: Basic Site Infrastructure

2.1.1 The fundamental requirement:

a) A Tier I basic data center has non-redundant capacity components and a single, non-redundant distribution path serving the critical environment. Tier I infrastructure includes: a dedicated space for IT Systems; a UPS to filter power spikes, sags, and momentary outages; dedicated cooling equipment; and on-site power production (e.g., engine generator, fuel cell) to protect IT functions from extended power outages.

b) Twelve hours of on-site fuel storage for on-site power production (e.g., engine generator, fuel cell).

2.1.2 The performance confirmation tests:

a) There is sufficient capacity to meet the needs of the site.

b) Planned work will require most or all of the site infrastructure systems to be shut down affecting critical environment, systems, and end users.

2.1.3 The operational impacts:

a) The site is susceptible to disruption from both planned and unplanned activities. Operation (human) errors of site infrastructure components will cause a data center disruption.
b) An unplanned outage or failure of any capacity system, capacity component, or distribution element will impact the critical environment.
c) The site infrastructure must be completely shut down on an annual basis to safely perform necessary preventive maintenance and repair work. Urgent situations may require more frequent shutdowns. Failure to regularly perform maintenance significantly increases the risk of unplanned disruption as well as the severity of the consequential failure.

2.2 Tier II: Redundant Site Infrastructure Capacity Components

2.2.1 The fundamental requirement:

a) A Tier II data center has redundant capacity components and a single, non-redundant distribution path serving the critical environment. The redundant components are extra on-site power production (e.g., engine generator, fuel cell), UPS modules and energy storage, chillers, heat rejection equipment, pumps, cooling units, and fuel tanks.
b) Twelve hours of on-site fuel storage for 'N' capacity.

2.2.2 The performance confirmation tests:

a) Redundant capacity components can be removed from service on a planned basis without causing any of the critical environment to be shut down.
b) Removing distribution paths from service for maintenance or other activity requires shutdown of critical environment.
c) There is sufficient permanently installed capacity to meet the needs of the site when redundant components are removed from service for any reason.

2.2.3 The operational impacts:

a) The site is susceptible to disruption from both planned activities and unplanned events. Operation (human) errors of site infrastructure components may cause a data center disruption.
b) An unplanned capacity component failure may impact the critical environment. An unplanned outage or failure of any capacity system or distribution element will impact the critical environment.
c) The site infrastructure must be completely shut down on an annual basis to safely perform preventive maintenance and repair work. Urgent situations may require more frequent shutdowns. Failure to regularly perform maintenance significantly increases the risk of unplanned disruption as well as the severity of the consequential failure.

2.3 Tier III: Concurrently Maintainable Site Infrastructure

2.3.1 The fundamental requirements:

a) A Concurrently Maintainable data center has redundant capacity components and multiple independent distribution paths serving the critical environment. For the electrical power backbone and mechanical distribution path, only one distribution path is required to serve the critical environment at any time.

   The electrical power backbone is defined as the electrical power distribution path from the output of the on-site power production system (e.g., engine generator, fuel cell) to the input of the IT UPS and the power distribution path that serves the critical mechanical equipment. The mechanical distribution path is the distribution path for moving heat from the critical space to the outdoor environment. For example, chilled water piping, condenser water piping, refrigerant piping, etc.
b) All IT equipment is dual powered and installed properly to be compatible with the topology of the site's architecture. Transfer devices, such as point-of-use switches, must be incorporated for critical environment that does not meet this requirement.
c) Twelve hours of on-site fuel storage for 'N' capacity.

2.3.2 The performance confirmation tests:

a) Each and every capacity component and element in the distribution paths can be removed from service on a planned basis without impacting any of the critical environment.
b) There is sufficient permanently installed capacity to meet the needs of the site when redundant components and distribution paths are removed from service for any reason.

2.3.3 The operational impacts:

a) The site is susceptible to disruption from unplanned activities. Operation errors of site infrastructure components may cause a computer disruption.
b) An unplanned outage or failure of any capacity system may impact the critical environment.
c) An unplanned outage or failure of a capacity component or distribution element may impact the critical environment.
d) Planned site infrastructure maintenance can be performed by using the redundant capacity components and distribution paths to safely work on the remaining equipment.
e) During maintenance activities, the risk of disruption may be elevated. (This maintenance condition does not defeat the Tier rating achieved in normal operations.)

2.4 Tier IV: Fault Tolerant Site Infrastructure

2.4.1 The fundamental requirements:

a) A Fault Tolerant data center has multiple, independent, physically isolated systems that provide redundant capacity components and multiple, independent, diverse, active distribution paths simultaneously serving the critical environment. The redundant capacity components and diverse distribution paths shall be configured such that 'N' capacity is providing power and cooling to the critical environment after any infrastructure failure.
b) All IT equipment is dual powered with a Fault Tolerant power design internal to the unit and installed properly to be compatible with the topology of the site's architecture. Transfer devices, such as point-of-use switches, must be incorporated for critical environment that does not meet this specification.
c) Complementary systems and distribution paths must be physically isolated from one another (Compartmentalized) to prevent any single event from simultaneously impacting both systems or distribution paths.
d) Continuous Cooling is required. Continuous Cooling provides a stable environment for all critical spaces within the ASHRAE maximum temperature change for IT equipment as defined in *Thermal Guidelines for Data Processing Environments, Third Edition*. Additionally, the Continuous Cooling duration should be such that it provides cooling until the mechanical system is providing rated cooling at the extreme ambient conditions.
e) Twelve hours of on-site fuel storage for 'N' capacity.

2.4.2 The performance confirmation tests:

a) A single failure of any capacity system, capacity component, or distribution element will not impact the critical environment.
b) The infrastructure controls system demonstrates autonomous response to a failure while sustaining the critical environment.
c) ***Each and every*** capacity component and element in the distribution paths can be removed from service on a planned basis without impacting any of the critical environment.
d) There is sufficient capacity to meet the needs of the site when redundant components or distribution paths are removed from service for any reason.
e) Any potential fault must be capable of being detected, isolated, and contained while maintaining N capacity to the critical load.

2.4.3 The operational impacts:

a) The site is not susceptible to disruption from a single unplanned event.
b) The site is not susceptible to disruption from any planned work activities.
c) The site infrastructure maintenance can be performed by using the redundant capacity components and distribution paths to safely work on the remaining equipment.
d) During maintenance activity where redundant capacity components or a distribution path shut down, the critical environment is exposed to an increased risk of disruption in the event a failure occurs on the remaining path. This maintenance configuration does not defeat the Tier rating achieved in normal operations.
e) Operation of the fire alarm, fire suppression, or the emergency power off (EPO) feature may cause a data center disruption.

2.5 Engine-Generator Systems

On-site power production systems (e.g., engine generator, fuel cell) are considered the primary power source for the data center. The local power utility is an economic alternative. Disruptions to the utility power are not considered a failure, but rather an expected operational condition for which the site must be prepared. Accordingly, on-site power production systems must automatically start and assume load upon loss of utility. In addition, all critical equipment not backed up by UPS power must autonomously restart after the power is restored. Although engine generators are only one solution for onsite power production, the nuances of the ratings dictate additional commentary to describe the specific requirements that must be met when using an engine-generator system for on-site power production.

2.5.1 Site on Engine-Generator Power

A Tier III or IV engine-generator system, along with its power paths and other supporting elements, shall meet the Concurrently Maintainable and/or Fault Tolerant performance confirmation tests while they are carrying the site on engine-generator power.

2.5.2 Manufactures' Runtime Limitation

Engine generators for Tier III and IV sites shall not have a limitation on consecutive hours of operation when loaded to 'N' demand. Engine generators that have a limit on consecutive hours of operation at 'N' demand are appropriate for Tier I or II.

2.5.3 Regulatory Runtime Limitation

Engine-generator systems often have an annual regulatory limit on operating hours driven by emissions. These environmental limits do not impact the consecutive hours of operation constraint established in this section.

2.6 Ambient Temperature Design Points

The effective capacity for data center facilities infrastructure equipment shall be determined at the peak demand condition based on the climatological region and steady state operating set points for the data center. All manufactures' equipment capacities shall be adjusted to reflect the extreme observed temperatures and altitude at which the equipment will operate to support the data center.

2.6.1 Extreme Annual Design Conditions

The capacity of all equipment that rejects heat to the atmosphere shall be determined at the Extreme Annual Design Conditions that best represents the data center location in the most recent edition of the *ASHRAE Handbook – Fundamentals*. (Each ASHRAE Handbook is revised and published every 4 years.) The design maximum values shall be the n=20 years value for both the Dry Bulb (DB) and Wet Bulb (WB) temperatures. Additionally, all systems must be able to fully operate at the extreme minimum temperatures. This must consider the n=20 years extreme minimum DB temperature. The n=20 years extreme minimum WB temperature must be considered if any operational or site condition will negatively impact capacity or the ability of the equipment to operate.

2.6.2 Computer Room Set Points

The capacity for computer room cooling equipment shall be determined at the return air temperature, and relative humidity established by the owner for steady state data center operations.

2.6.3 Additional Impacts

Extreme ambient conditions must be considered for anything that can impact capacities, loads, or equipment operation.

2.7 Communications

The equipment supporting the communication demarcation points must also be provided with cooling and power systems according to the Tier objective if they are critical the support of the data center functionality. Accordingly, for Tier IV data centers that critical equipment must meet Compartmentalization requirements.

2.8 Makeup Water

For all Tier sites using evaporative cooling, on-site, backup makeup water storage is required for 12 hours according to the Tier objective. Accordingly, for Tier III and Tier IV data centers, the makeup water system must also be Concurrently Maintainable and Fault Tolerant as required to the point of delivery for a minimum duration of 12 hours.

2.9 Tier Requirements Summary

A summary of the preceding requirements defining the four distinct Tier classification levels is in Table 1. In the table, Crtitical Power Distribution is defined as the power from the UPS output to the IT assets.

	Tier I	Tier II	Tier III	Tier IV
Minimum Capacity Components to Support the IT Load	N	N+1	N+1	N After any Failure
Distribution Paths - Electrical Power Backbone	1	1	1 Active and 1 Alternate	2 Simultaneously Active
Critical Power Distribution	1	1	2 Simultaneously Active	2 Simultaneously Active
Concurrently Maintainable	No	No	Yes	Yes
Fault Tolerance	No	No	No	Yes
Compartmentalization	No	No	No	Yes
Continuous Cooling	No	No	No	Yes

Table 1: Tier Requirements Summary

2.10 Utility Services

Services originating from outside the data center property boundary and not in full control of the data center organization are deemed and treated as a utility system. These include but are not limited to electrical power supplies, municipal water supplies, natural gas supplies, district cooling, etc. These services are not considered reliable supplies for the data center and are not considered to meet the Tier requirements for the site.

Services to meet the Tier requirements must be fully contained on the data center property and in full control of the data center organization. Additionally, where utility systems are utilized as an economic alternative, the data center critical systems must be able to autonomously detect a loss of the service and respond with on-site systems to provide the service. This also requires that on-site systems can autonomously restart once on-site service is restored. For example after a loss of utility power, the engine-generator system must be able to detect the loss of incoming utility power, start the engine-generator system, transfer load to the on-site engine-generator system, and restart any other systems that experienced a temporary interruption of electrical power without an operator intervention.

3. Commentary for Application of the *Tier Standard: Topology*

This Commentary is not part of the Data Center Site Infrastructure *Tier Standard: Topology*. It provides the reader with context for the application of the Standard.

3.1 Outcome-Based Tier Standard

The definitions used in Uptime Institute's Tier Standard are necessarily and intentionally very broad to allow innovation and client manufacture and equipment preferences in achieving the desired level of site infrastructure performance or uptime. The individual Tiers represent categories of site infrastructure topology that address increasingly sophisticated operating concepts, leading to increased site infrastructure availability.

The operational performance outcomes that define the four Tiers of site infrastructure are very straightforward. Many designs that pass a checklist approach will fail an operational performance requirements approach. This means that, in addition to the rigorous application of engineering principles, there is still considerable judgment and flexibility in the design for uptime and how subsystems are integrated to allow for multiple operating modes.

3.2 Impact of Ambient Design Conditions

The sustainable effective capacity of most cooling and power generating equipment is impacted by the actual ambient conditions in which it operates. These components typically require more energy to operate and provide less usable capacity as altitude and ambient air temperatures rise.

A common practice for conventional facilities is to select design values applicable to most but not all anticipated hours of operation of that facility. This results in an economical choice of equipment that meets requirements most of the time. This is not appropriate for data centers that are expected to operate on a 24 x Forever basis.

Using a DB temperature for design that is exceeded 2% of the time results in selection of a component that is undersized 175 hours of the year. Although this may seem to imply that the owner runs an operational risk for a little over one week each year, these hours actually occur incrementally spread over several days. The 2% design value could result in actual conditions exceeding the design parameters of the equipment several hours every afternoon for a 1- to 2-month period. A 0.4% value, considered conservative by many design professionals, still results in equipment performing below requirements approximately 35 hours each year.

Another example concerning ambient conditions arises when selecting heat rejection systems for split-system direct expansion (DX) cooling systems. Many manufactures provide product selection tables based on 95°F/35°C ambient outside conditions. These components will only produce the nominal capacity listed when operating in up to 95°F/35°C outside air. These component capacities must be adjusted downward to provide the required capacity when temperatures exceed 95°F/35°C.

One commonly overlooked impact of ambient conditions is the minimum expected temperature. Air-cooled chilled water machines typically have a minimum temperature at which the unit may not be able to start or operate. Many common air-cooled chilled water machines are rated to operate down to 0°C and must have additional measures taken to operate below that point.

3.3 Restrictions Against Engine-Generator Runtime Limitation (Tier III and Tier IV)

The intent of the restriction against engine-generator runtime limitation is to ensure the engine-generator plant is capable of supporting the site load on a continuous basis. Tier topology requires that the load capacity of engine generators with one of the three main ISO® 8528-1 ratings (Continuous, Prime, Standby) must be considered differently, based on the specific rating.

a) **Continuous**-rated engine generators can be run for an unlimited number of hours at the rated kilowatts.

b) **Prime**-rated engine generators can be run for a limited number of hours at the rated kilowatts. This capacity does not meet the intent of Section 2.5. As stated in ISO 8528-1, the capacity of a prime-rated engine generator must be reduced to 70% (derated) to operate on an unlimited basis. Some manufactures state a different reduced capacity (may be more or less than 70%) at which the engine generator can operate on an unlimited basis either in the product specification, or by separate letter. The manufactures' certification of capacity at an unlimited duration will be used to determine compliance with Tier requirements.

c) **Standby** engine generators are, by definition, held to an annual run-hour limitation. This limitation does not meet the intent of Section 2.5. Some manufactures state a different, reduced capacity at which the engine generator can operate on an unlimited basis either in the product specification, or by separate letter. The manufactures' certification of capacity at an unlimited duration will be used to determine compliance with Tier requirements.

3.4 Communications Routing

Uptime Institute recommends that the conveyance for fiber or communications connections from off site to data center communication demarcation should be in accordance with Concurrently Maintainable requirements for Tier III and Fault Tolerant, Compartmentalized requirements for Tier IV.

3.5 Tier Functionality Progression

Owners who select Tier I and Tier II solutions to support current IT technology are typically seeking a solution to short-term requirements. Both Tier I and Tier II are usually tactical solutions, i.e., driven by first-cost and time-to-market more than life-cycle cost and uptime (or availability) requirements. Rigorous uptime requirements and long-term viability usually lead to the strategic solutions found more often in Tier III and Tier IV site infrastructure. Tier III and Tier IV site infrastructure solutions have an effective life beyond the current IT requirement. Strategic site infrastructure solutions enable the owner to make strategic business decisions concerning growth and technology, unconstrained by current site infrastructure topology.

3.5.1 Tier I

Tier I solutions acknowledge the owner's desire for dedicated site infrastructure to support IT systems. Tier I infrastructure provides an improved environment over that of an ordinary office setting and includes: a dedicated space for IT systems; a UPS to filter power spikes, sags, and momentary outages; dedicated cooling equipment not shut down at the end of normal office hours; and on-site power production (e.g., engine generator, fuel cell) to protect IT functions from extended power outages.

3.5.2 Tier II

Tier II solutions include redundant critical power and cooling capacity components to provide an increased margin of safety against IT process disruptions due to site infrastructure equipment failures. The redundant components are typically extra UPS modules, chillers, heat rejection equipment, pumps, cooling units, and on-site power production (e.g., engine generator, fuel cell). A malfunction or normal maintenance will result in loss of a capacity component.

3.5.3 Tier III

Tier III site infrastructure adds the concept of Concurrent Maintenance beyond what is available in Tier I and Tier II solutions. Concurrent Maintenance means that ***each and every*** capacity or distribution component necessary to support the IT processing environment can be maintained on a planned basis without impact to the IT environment. The effect on the site infrastructure topology is that a redundant delivery path for power and cooling is added to the redundant critical components of Tier II. Maintenance allows the equipment and distribution paths to be returned to like-new condition on a frequent and regular basis.

Thus, the system will reliably and predictably perform as originally intended. Moreover, the ability to concurrently allow site infrastructure maintenance and IT operation requires that ***each and every*** system or component that supports IT operations must be able to be taken offline for scheduled maintenance without impact to the IT environment. This concept extends to important subsystems such as control systems for the mechanical plant, start systems for on-site power production (e.g., engine generator, fuel cell), EPO controls, power sources for cooling equipment and pumps, isolation valves, and others.

3.5.4 Tier IV

Tier IV site infrastructure builds on Tier III, adding the concept of Fault Tolerance to the site infrastructure topology. Similar to the application of Concurrent Maintenance concepts, Fault Tolerance extends to ***each and every*** system or component that supports IT operations. Tier IV considers that any one of these systems or components may fail or experience an unscheduled outage at any time. The Tier IV definition of Fault Tolerance is based on a single component or path failure.

However, the site must be designed and operated to tolerate the cumulative impact of every site infrastructure component, system, and distribution path disrupted by the failure. For example, the failure of a single switchboard will affect every subpanel and equipment component deriving power from the switchboard. A Tier IV facility will tolerate these cumulative impacts without affecting the operation of the computer room.

3.6 Fractional or Incremental Tier Classification

The four Tier Standard Classifications address topology, or configuration, of site infrastructure, rather than a prescriptive list of components to achieve a desired operational outcome. For example, the same number of chillers and UPS modules can be arranged on single power and cooling distribution paths resulting in a Tier II solution (Redundant Components), or on two distribution paths that may result in a Tier III solution (Concurrently Maintainable).

Consistent, across-the-board application of Tier topology concepts for electrical, mechanical, automation, and other subsystems is required for any site to satisfy the Tier standards defining any classification level. Selecting the appropriate topology solution based on the IT availability requirements to sustain well-defined business processes, and the substantial financial consequences for downtime, provides the best foundation for investment in data center facilities. It is preferable for the owner's focus during the data center design and delivery process to be on the consistent application of the Tier Performance Standard rather than on the details that make up the data center site infrastructure.

However, site infrastructure has been occasionally described by others in the industry in terms of fractional Tiers (e.g., Tier 2.5), or incremental Tiers (Tier III +, Enhanced Tier III, or Tier IV-lite). Fractional or incremental descriptions for site infrastructure are not appropriate and are misleading. Including a criteria or an attribute of a higher Tier Classification in the design does not increase the overall Tier Classification. However, deviation from the Tier objective in any subsystem will prevent a site from being Certified at that Tier.

a) A site that has an extra (redundant) UPS module but needs all the installed cooling units running to keep the computer room temperature within limits does not meet the redundancy requirements for Tier II.

b) A switchboard that cannot be shut down without affecting more than the redundant number of secondary chilled water pumps (reducing the available capacity to less than N) is not Concurrently Maintainable and will not be Certified as Tier III.

c) Including a UPS system patterned after a Tier IV system within a site having a Tier II power distribution backbone yields a Tier II Certification.

3.7 Non-Compliance Trends

The most significant deviations from the Tier Standard found in most sites can be summarized as inconsistent solutions. Frequently, a site will have a robust, Fault Tolerant electrical system patterned after a Tier IV solution, but will utilize a Tier II mechanical system that cannot be maintained without interrupting computer room operations. This results in an overall Tier II site rating.

Most often, the mechanical system fails Concurrent Maintenance criteria because of inadequate coordination between the number and location of isolation valves in the chilled water distribution path. Another common oversight is branch circuiting of mechanical components, which results in having to shut down the entire mechanical system to perform electrical maintenance. If more than the redundant number of chillers, towers, or pumps is de-energized for electrical maintenance, computer-room cooling is impacted.

Electrical systems often fail to achieve Tier III or Tier IV criteria due to design choices made in the UPS and the critical power distribution path. UPS configurations that utilize common input and output switchgear are almost always unmaintainable without critical environment outages and will fail the Tier III requirements even after spending many hundreds of thousands of dollars. Topologies that include static transfer switches in the critical power path for single-corded IT devices will likely fail both the Fault Tolerance criteria and the Concurrent Maintenance criteria.

Consistent application of standards is necessary to have an integrated solution for a specific data center. It is clear that the IT organization invests heavily in the features offered by newer critical environment technology. Often, as the electrical and mechanical infrastructures are defined and the facility operations are established, there is a growing degree of inconsistency in the solutions incorporated in a site. An investment in one segment must be met with a similar investment in each of the other segments if any of the elements in the combined solution are to have the desired effect on IT availability. A well-executed data center master plan or strategy should consistently resolve the entire spectrum of IT and facility requirements.

Modifications

This Standard incorporates the 2010 voting results of the Owners Advisory Committee.
The on-site power production fuel storage requirements is effective 1 May 2010.

The changes incorporated are a result of the 2012 discussion and voting by the Owners Advisory Committee. All updates specific to this version are effective 1 August 2012.

The changes incorporated are a result of clarifications based on industry feedback. All updates specific to this version are effective 1 January 2018.

The changes incorporated align with *ASHRAE Handbook – Fundamentals* revisions to provide consistent reference detail. All updates specific to this version are effective 1 October 2018.

About the Uptime Institute

Uptime Institute is an unbiased advisory organization focused on improving the performance, efficiency, and availability of business critical infrastructure through innovation, collaboration, and independent certifications. Uptime Institute serves all stakeholders responsible for IT service availability through industry leading standards, education, peer-to-peer networking, consulting, and award programs delivered to enterprise organizations and third-party operators, manufacturers, and providers. Uptime Institute is recognized globally for the creation and administration of the Tier Standards & Certifications for Data Center Design, Construction, and Operational Sustainability along with its Management & Operations reviews, FORCSS® methodology, and Efficient IT Stamp of Approval.

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