



Uptime Institute's Tier Classifications Standard Technical Users Guide

The purpose of this Technical Users Guide is to provide a useable but concise summary of the Uptime Institute Tier Classification criteria for the practitioner. The unabridged Tier white paper provides a more in-depth discussion of the history, development, requirements, and application of Tier concepts and can be found at computersiteengineering.com/whitepapers.

Although owners' business objectives (e.g. "Green Data Center" initiatives) and technology improvements have led to subtle changes in Tier-level details, the fundamental requirements have not changed. The four Tier topologies address increasing maintenance opportunities and decreasing impacts of human interaction, which can be shown to affect overall facility infrastructure availability supporting the IT environment.

The sections that follow highlight the criteria distinct to each Tier. Each Tier Level builds on the level before it, so that Tier II requires that all Tier I criteria are met, plus those added at Tier II. Similarly, Tier III criteria require all Tier II criteria are met, plus those added at Tier III, and so on for Tier IV.

GENERAL TIER STANDARD CONCEPTS

In addition to the additive nature of the Tier levels cited above, these important concepts apply to one or more Tiers:

- To qualify as an enterprise data center, UPS and engine generator systems are required in addition to other necessary equipment.
- Capacity components and distribution paths must be shut down on an annual basis to safely perform recurring maintenance activities and repair work. Although some may believe annual availability for Tier I and Tier II sites may be "improved" in the short term by deferring maintenance, failure to regularly perform maintenance significantly increases the risk of unplanned disruption as well as the severity of the consequential failure.
- During maintenance activities when redundant components and/or distribution paths are shut down, the risk of a disruption may be elevated. For example, if one distribution path is de-energized, a failure in the second distribution path may result in an outage.
- Engine generators are the primary source of power for reliability and availability. Engine generators shall not have a runtime limitation when load to "N" demand for Tier III and Tier IV sites. Engine generators that have a runtime limit at "N" demand are acceptable for Tier I or II.
- Tier III and Tier IV require the engine generator system with its power paths and other supporting elements to meet the Concurrently Maintainable or Fault Tolerant performance criteria when the site is on engine generator power.
- In order to establish Concurrent Maintainability of the critical power distribution system between the UPS and the computer equipment, Tier III and Tier IV sites require all computer hardware have dual power inputs.
- The operation of the Emergency Power Off (EPO) system or the Fire Protection system, alone or in concert, may cause a data center disruption regardless of data center Tier Level.
- Fault Tolerance (Tier IV) is based only on a single capacity component or distribution element failure. Multiple, simultaneous failures are outside the scope of Tier IV criteria. However, the entire range of impact from a single failure must be considered. For example, failure of a switchboard must account for all the equipment powered through that switchboard.

TIER REQUIREMENTS SUMMARY

	Tier I	Tier II	Tier III	Tier IV
Capacity Components	<i>N</i>	<i>N+1</i>	<i>N+1</i>	<i>N after any failure</i>
Distribution Paths	<i>1</i>	<i>1</i>	<i>1 active and 1 alternate</i>	<i>2 simultaneously active</i>
Concurrently Maintainable	<i>No</i>	<i>No</i>	<i>Yes</i>	<i>Yes</i>
Fault Tolerance (single event)	<i>No</i>	<i>No</i>	<i>No</i>	<i>Yes</i>
Compartmentalization	<i>No</i>	<i>No</i>	<i>No</i>	<i>Yes</i>



TIER PERFORMANCE STANDARDS

Tier I: Basic Site Infrastructure

Fundamental Requirement

- A Tier I data center has non-redundant capacity components and a single non-redundant distribution path serving the computer equipment.

Definitive Result

- Scheduled facility maintenance activities will require most or all of the site infrastructure systems to be shut down, affecting computer equipment, systems, and end users.
- An unplanned outage or failure of any capacity system, capacity component, or distribution element will impact the computer equipment.

Operational Impact

- The site is susceptible to disruption from both planned and unplanned activities. Operation errors or spontaneous failures of site infrastructure components will cause a data center disruption.

Tier II: Redundant Capacity Components Site Infrastructure

Fundamental Requirement

- A Tier II data center has redundant capacity components and a single, non-redundant distribution path serving the computer equipment.

Definitive Result

- Redundant capacity components can be removed from service on a planned basis without causing any of the computer equipment to be shut down. An unplanned capacity component failure may impact the computer equipment.
- Removing distribution paths from service for maintenance or other activity will require the computer equipment to be shut down.
- An unplanned outage or failure of any capacity system or distribution element will impact the computer equipment.

Operational Impact

- The site is susceptible to disruption from both planned activities and unplanned events. Operation errors or spontaneous failures of site infrastructure components may cause a data center disruption.

Tier III: Concurrently Maintainable Site Infrastructure

Fundamental Requirements

- A Tier III data center has redundant capacity components and multiple independent distribution paths serving the computer equipment. Generally, only one distribution path serves the computer equipment at any time.

Definitive Result

- '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 computer equipment.
- An unplanned outage or failure of any capacity system or distribution path will impact the computer equipment.
- An unplanned outage or failure of a capacity component or distribution element may impact the computer equipment.

Operational Impact

- The site is susceptible to disruption from unplanned activities. Operation errors or spontaneous failures of site infrastructure components may cause a computer disruption.
- Planned site infrastructure maintenance can be performed by using the redundant capacity components and distribution paths to safely work on the remaining equipment.

Tier IV: Fault Tolerant Site Infrastructure

Fundamental Requirements

- A Tier IV center has multiple, independent, physically-isolated systems with redundant capacity components and multiple, independent, diverse, active distribution paths simultaneously serving the computer equipment.
- Complementary systems and distribution paths must be physically isolated from one another (compartmentalized) to prevent any single event from simultaneously impacting both systems or paths.
- Continuous computer equipment cooling for a duration matching the UPS system battery duration.

Definitive Result

- A single failure of any capacity system, capacity component, or distribution element will not impact the computer equipment.
- The system autonomously responds to a capacity or distribution failure to prevent further impact to the site. 'Each and Every' capacity component and element in the distribution paths can be removed from service on a planned basis or due to a failure or outage without impacting any of the computer equipment.

Operational Impact

- The site is not susceptible to disruption from a single, unplanned event.
- The site is not susceptible to disruption from any planned work activities.



EVALUATION OF COMPLIANCE

The Tier Performance Standards summarized above are sufficient to describe Tier-compliant data center facilities' topology for each Tier level. Checklists and detailed systems analysis guides are not required and likely to be rapidly outdated to the point that they are no longer effective evaluation tools.

Wherein the original Tier concepts are still applicable and appropriate to differentiate facilities infrastructure topologies based on increasing maintenance opportunities and decreasing impacts of human interaction, data center equipment innovations and improvements have made their predecessors obsolete.

The key to successful Tier-based design is attention to detail and consistent application of the Tier concepts to 'Each and Every' component in 'Each and Every' subsystem that affects power and cooling in the computer equipment environment. Uptime Institute Tier Certifications are completed from this perspective of the computer room. Because computer room power and cooling depends on equipment in spaces outside the computer room, Tier criteria extends to all of the 'outside' components required to deliver computer room power and cooling as well.

Glycol-cooled Direct Expansion Computer Room Air Conditioners (CRAC) provide an excellent example of concepts that extend outside the computer room. A CRAC in the computer room requires a means to reject heat outside the computer room. Not only are CRACs in the computer required to be of adequate capacity and number to provide redundant components for Tier II and above, but a Glycol system that provides pumps and outdoor heat-rejection subsystems must be redundant. Tier III adds complexity in that the Glycol system must provide redundant fluid distribution paths, and Concurrently Maintainable electrical power to each component, as well. Tier IV requires that any part of the cooling system, inside and outside, and its power, must sustain a failure without affecting the required level of cooling in the computer room.

The data center Tier system is applicable regardless of the size, complexity, sophistication, or elegance of any data center solution. The four distinct Tiers describe clearly differentiated concepts that when applied consistently can guide the design or evaluate the efficacy of any data center. Consistent application requires evaluation of each element of the data center environment that can affect data center power and cooling, from the interaction of operations personnel, through the monitoring and control systems that manage the data center infrastructure, to life-safety systems such as the EPO and Fire Protection systems. The 'Each and Every' aspect of the Tier III and Tier IV Classifications requires a rigorous understanding of the interaction on an almost limitless variety of data center infrastructure subsystem configurations, rather than a checklist addressing the number of pipes, pumps, and parts the make up the systems.

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About ComputerSite Engineering

- Principal-level consultants experienced in data center operations Affiliated with the Uptime Institute
- Exclusively licensed by the Uptime Institute to rate and Certify against official Tier Classification System
- Objective, third-party expertise independent of any Engineer-of-Record or manufacturer
- Specialize solely in data center consulting for industry-leading organizations with critical uptime needs

ComputerSite Engineering provides the technical staff for many Uptime Institute activities, such as co-authoring white papers. **ComputerSite Engineering** and the Institute believe that creating top quality and timely white papers and other data center operational resources is an important part of improving our industry and continuing an ongoing dialogue about best practices in data center operation.

ComputerSite Engineering is a data center engineering and management consulting firm working in close collaboration with the Uptime Institute to address technical aspects of contemporary data center issues. We are the only firm licensed by the Institute to officially rate and Certify against their Tier Classification System.

Our Principal-level consultants bring first-hand expertise from data center planning, design, building, operations, and management to their evaluations of existing and proposed facilities. Independent of any Engineer-of-Record or manufacturer affiliation, **ComputerSite Engineering's** consulting teams function as an outsourced CIO to our clients in order to develop and execute solutions that are responsive to their unique business needs.

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