UPTIME INSTITUTE, LLC

# Data Center Site Infrastructure Tier Standard: Operational Sustainability

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## Abstract:

The Uptime Institute *Tier Standard: Operational Sustainability* is an objective methodology for data center owners to align the facility management program with the specific Tier of installed site infrastructure in order to achieve the organization's business objectives or mission imperatives. *Tier Standard: Operational Sustainability* establishes the behaviors and risks beyond the Tier Classification System (I, II, III, and IV) that impact long-term data center performance. *Tier Standard: Operational Sustainability* unifies site management behaviors with the Tier functionality of the site infrastructure.

## Keywords:

data center, infrastructure, Tier, Classification, Tiers, Tier level, topology, availability, reliability, redundant, Concurrent Maintenance, Concurrently Maintainable, Fault Tolerance, Fault Tolerant, Operational Sustainability, functionality, performance, metrics, Tier Standard, behaviors, risks, business objectives, mission imperatives, maintenance, failure response, critical load, capital investment, elements, Management & Operations, Building Characteristics, Site Location, design, construction, commissioning, transition-to-operations, Basic Capacity, Redundant Capacity, human error, staffing, organization, housekeeping, maintenance management system, service level agreements, life cycle, training, on-the-job training, planning, coordination, management, site policies, financial management, site infrastructure library, building features, design principles, operating conditions, natural disasters, man-made disasters, Gold, Silver, Bronze, Abnormal Incident Reports database, method of procedure, failure analysis, preventative maintenance, predictive maintenance, deferred maintenance, quality control, site configuration procedures, standard operating procedures, emergency operating procedures, purpose built, security, access, setback, redline, set point, flood plain, seismic zone, risk evaluation,

## Introduction

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

*Tier Standard: Topology* (available separately) describes the functionality requirements of the site infrastructure to meet the specific business objective or mission imperative. Long-term availability of data center infrastructure is not guaranteed by Tier alone. *Tier Standard: Operational Sustainability* defines the behaviors and risks *beyond Tier* that impact the ability of a data center to meet its uptime objectives over the long term. The uptime of a data center is the resultant combination of both Tier of the site infrastructure and Operational Sustainability. This standard is a tool to help owners maximize infrastructure investment. Additionally, this standard facilitates comparison of data centers from an operational perspective.

Similar to Tier of installed infrastructure equipment, the rigor and sophistication of Operational Sustainability site management concepts and methodologies are established by the business requirements of the site. A Tier III performance requirement results in a more complex site infrastructure than a Tier I. Similarly, a Tier III data center requires more comprehensive behaviors and more rigor in mitigating risks than a Tier I. Therefore, Operational Sustainability behaviors and risk identification & mitigation are directly tied to the Tier Classification System.

The three elements of Operational Sustainability, in order of decreasing impact to operations, are Management & Operations, Building Characteristics, and Site Location. Each of these three elements has multiple categories and components with associated behaviors and risk. The Institute Abnormal Incident Reports (AIRs) database reveals that approximately 70% of the reported data center outages are directly attributed to "human error." Accordingly, Management & Operations is the most influential element to sustain operations.

Finally, *Tier Standard: Operational Sustainability* defines behaviors that result in more efficient operation of the data center, thereby offering opportunities to increase energy efficiency.

## Copyrights



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# 1. Overview

## 1.1 Scope

This standard establishes the Uptime Institute *Data Center Site Infrastructure Tier Standard: Operational Sustainability*. This standard establishes the behaviors and risks beyond Tier of installed infrastructure that impact the ability of a data center to meet its business objectives or mission imperatives over the long term.

This owner's standard is complementary to the *Tier Standard: Topology*. *Tier Standard: Topology* establishes the performance requirements for configuration of the power and cooling equipment, including the capability for redundancy, planned maintenance work, or failure response without impacting the critical load. *Tier Standard: Topology* does not prescribe or constrain solutions. Rather the intent of *Tier Standard: Topology* is to provide the framework to align site infrastructure capital investment with the business objective(s) or mission imperative(s) that the data center supports.

*Tier Standard: Operational Sustainability* provides the site management behaviors and risks—contingent upon achievement of the site infrastructure. Consistent with the progressive nature of *Tier Standard: Topology*, Operational Sustainability behaviors increase in complexity and comprehensiveness as Tier increases.

The three elements of Operational Sustainability are Management & Operations, Building Characteristics, and Site Location. Each of these three elements has multiple categories and components with associated behaviors or risks. The specific behaviors, prioritized so that owners may address highest risks first, are presented in table format in this standard.

The benefits of Operational Sustainability behaviors are fully realized when incorporated early into the project in the conceptual planning. Then, carried through design, construction, commissioning, and transition-to-operations—and ultimately addressed on a persistent basis during the operational life of the data center.

## 1.2 Purpose

*Tier Standard: Operational Sustainability* provides data center owners, operators, and managers with the prioritized behaviors and risks intrinsic to data center operations. Adherence to the recommended behaviors will assist in attaining the full performance potential of the installed infrastructure. This standard is a tool to help owners maximize infrastructure investment. Additionally, this standard facilitates comparison of data centers from an operational perspective. *Tier Standard: Operational Sustainability* establishes a baseline of site management behaviors by Tier.

## 1.3 *Tier Standard: Topology*

*Tier Standard: Topology* establishes four distinctive definitions of data center site infrastructure using the Tier Classifications (I, II, III, and IV) and the performance confirmation tests for determining compliance to the definitions. The Tier Classification System describes the site-level infrastructure topology required to sustain data center operations, not the characteristics of individual systems or subsystems.

For informational purposes, the following is a brief summary of each Tier from the *Tier Standard: Topology*.

- Tier I – Basic Capacity: Site-wide shutdowns are required for maintenance or repair work. Capacity or distribution failures will impact the site.
- Tier II – Redundant Capacity components: Site-wide shutdowns for maintenance are still required. Capacity failures may impact the site. Distribution failures will impact the site.
- Tier III – Concurrently Maintainable: ***Each and every*** capacity component and distribution path in a site can be removed on a planned basis for maintenance or replacement without impacting operations. The site is still exposed to a equipment failure or operator error.
- Tier IV – Fault Tolerant: An individual equipment failure or distribution path interruption will not impact operations. A Fault Tolerant site is also Concurrently Maintainable.

The Institute reserves the exclusive right to rate and Certify data centers according to *Tier Standard: Topology*. Uptime Institute Professional Services assesses both designs and constructed environments and awards Tier Certifications accordingly.

## 1.4 Relationship between Tiers and Operational Sustainability

Similar to Tier of installed infrastructure, the rigor and sophistication of Operational Sustainability site management concepts and methodologies are driven by the business requirements of the site. All three Operational Sustainability elements impact the performance potential of the Tier topology of the installed infrastructure, yet the Management & Operations Element has the largest impact on long-term availability. Staffing levels, the approach to maintenance, and the number and details of processes and procedures are illustrative categories of the Management & Operations Element that are directly related to each Tier level.

### 1.5 Exclusions from Operational Sustainability

Safety, environmental, security, and personnel management are not addressed in *Tier Standard: Operational Sustainability*. Failure to address any of these will add significant risk to data center operations. Yet, these items are excluded from the standard because they are under the purview of a) management or internal corporate compliance audit groups and/or b) external enforcement and regulatory agencies.

### 1.6 Reference

Institute *Data Center Site Infrastructure Tier Standard: Topology* (www.uptimeinstitute.com/resources)

*Natural Disaster Risk Profiles for Data Centers* (www.uptimeinstitute.com/resources)

## 2. Elements Of Operational Sustainability

### 2.1 Management & Operations

Analysis of the Institute AIR database reveals that approximately 70% of the reported data center outages are directly attributable to human error. "Human Error" includes operator error—but more importantly, speaks to management decisions regarding staffing levels, training, maintenance, and overall rigor of the operation.

**2.1.1** Staffing and Organization: The right number of qualified people on appropriate shifts is critical to meeting long-term performance objectives. The number of employees, qualifications, and shift coverage increases with the Tier. The roles and responsibilities of each position are defined and their criticality acknowledged by management.

**2.1.2** Maintenance: A comprehensive approach to maintaining the data center is an absolute requirement to meet the business objective or mission imperative of the data center. An effective maintenance program encompasses increasingly rigorous preventative maintenance (PM), housekeeping policies, maintenance management system ([MMS] to track work), service level agreements (SLAs), and life-cycle planning. As the performance objective increases, the requirements for documentation, complexity, and detail for each of these items increases.

**2.1.3** Training: A training program, which ensures that all personnel understand policies, procedures, and unique requirements of work in the data center, is essential to avoid unplanned outages and respond to anticipated events. The level of training can range from on-the-job training (OJT) to formal classroom/certification programs depending on the Tier objective. Because most data centers rely on some level of vendor support, a training program for vendors is equally critical.

**2.1.4** Planning, Coordination, and Management: Effective management of the data center requires planning, coordination, and the use of numerous management tools. Components of an effective planning, coordination, and management program include site policies; financial management policies; site infrastructure library; and space, power, and cooling capacity management tools.

### 2.2 Building Characteristics

Building Characteristics include building features, infrastructure, operating conditions, and pre-operation activities, which can potentially affect attainment of availability objectives.

**2.2.1** Building Features: Building features can positively or negatively impact the availability objectives. Building features that support performance objectives include topology enhancements beyond the Tier objective (i.e., deploying a Fault Tolerant uninterruptible power supply [UPS] system in a Tier III facility), purpose-built data centers, adequate space for support and specialty spaces, and controlled access areas.

**2.2.2** Infrastructure: The infrastructure is available for incremental capacity increases and the electrical and mechanical support systems are available to extend the life of or protect the infrastructure. There must be adequate space available for effective and proper maintenance. In order to avoid wasted capital expenditures, the space, power, and cooling exhaust points shall be aligned and monitored.

**2.2.3** Operating Conditions: Consistent and documented load limits on capacity components and set points represent opportunities to reduce risk and provide for efficient operations. Additionally, a plan to alternate the use of redundant infrastructure components ensures that all equipment is in good working order and extends the life of each component.

**2.2.4** Pre-Operational: Pre-operational activities are critical to bringing a new data center or a major data center expansion on line with confidence that it will operate as designed. Comprehensive commissioning is the only way to ensure that the site infrastructure functions according to the design. For new data centers or large additions, a comprehensive transition-to-operations plan must be written and executed to ensure a smooth segue into operations.

### 2.3 Site Location

The highest level of functionality in a data center can be easily defeated by a local or regional disaster whether relating to natural occurrences or man-made factors. The site selection process for a new data center should evaluate the risks of these types of disasters. For new or existing data centers, these risks must be well documented, signed off by management, and with the proper level of mitigation in place. Thus, both management expectations and the likely impact of the event on availability are accounted for. Depending on the performance objective, mitigation actions may be required.

**2.3.1** Natural Disasters: A risk assessment for natural disasters must be conducted and appropriate mitigation actions must be in place to reduce impact. The potential for natural disaster risks should be a major consideration in any site selection for a new data center because of the extreme cost typically associated with mitigation measures.

**2.3.2** Man-Made Disasters: Man-made disasters are classified into either adjacent property exposures or transportation corridor risks. Because the potential for these types of disasters can change over time, they need to be regularly reviewed and mitigation actions updated when and where appropriate.

## 3. Operational Sustainability Rating

### 3.1 Rating System

The Institute rating system for Operational Sustainability evaluates the effectiveness of management response to three elements in the context of the data center's Tier Certification. The Operational Sustainability rating, when determined by the Institute, becomes a suffix to the Tier Certification. Institute Tier Certification of the installed infrastructure is a prerequisite to the Operational Sustainability rating. For example, a Tier III Concurrently Maintainable site with a Gold rating of Operational Sustainability will be indicated by a composite rating of Tier III–Gold. *Tier Standard: Operational Sustainability* does not seek to dilute or conflict with unique and proprietary site management methodologies. Rather, Gold, Silver, Bronze will rate the evidence of success of the behaviors provided in the tables herein.

### 3.2 Ratings

The Institute reserves the exclusive right to rate and Certify data centers according to *Tier Standard: Operational Sustainability*.

**3.2.1** Gold rating

- A site with a rating of Gold demonstrates exceptional Management & Operations and Building Characteristics behaviors, and low Site Location risks. The full uptime capability of the installed infrastructure is potentially realized or exceeded.
- There is consistent application over time and uniformity across the spectrum of operations. Observed conditions represent acutely minimized risks to continuous availability objectives.
- Institute Gold-level Operational Sustainability Certification interval is 5 years before a re-Certification is required.

**3.2.2** Silver rating

- A site with a rating of Silver demonstrates evolved Management & Operations and Building Characteristics behaviors, and low Site Location risks. There are opportunities for improvement in order to achieve the full uptime potential of the installed infrastructure.
- Institute Silver-level Operational Sustainability Certification interval is 3 years before a re-Certification is required.

**3.2.3** Bronze rating

- A site with a rating of Bronze is demonstrates minimal Management & Operations and Building Characteristics behaviors and manageable Site Location risks. There is significant room for improvement in order to achieve the full uptime potential of the installed infrastructure. Observed conditions represent risk to availability objectives.
- Institute Bronze-level Operational Sustainability Certification interval is 1 year before a re-Certification is required.

### 3.3 Prioritization of the Management & Operation and Building Characteristic Behaviors

The prioritization of the Management & Operation and Building Characteristic behaviors are based on analysis of the AIRs database. Within each element, the categories and components are listed in the tables in order of decreasing importance.

### 3.4 Managing the Site Location Risks

Any Tier IV data center constructed after 1 January 2013 will receive one rating level reduction (Gold to Silver or Silver to Bronze) for placement in a 100-year flood zone or an active volcanic area.

### 3.5 Bonus Behaviors

Within the Management & Operations and Building Characteristics tables, there are select behaviors qualified as Bonus. These include 3rd-party certifications and behaviors beyond the stated Tier objective. These behaviors are not required, but they do add to the efficiency of the data center operations.

## 4. Summary

The behaviors established in *Tier Standard: Operational Sustainability* combined with the infrastructure requirements in the *Tier Standard: Topology* are essential for a site to achieve its uptime potential. The installed infrastructure alone cannot ensure the long-term viability of the site unless Operational Sustainability behaviors are addressed. Site management teams that incorporate the principles of both standards will have notably better results in realizing or exceeding the full uptime potential of the installed infrastructure.

| Staffing and Organization Category | | Applicable for Tier | | | | Bonus |
|---|---|---|---|---|---|---|
| **Component** | **Behavior** | **I** | **II** | **III** | **IV** | |
| Staffing Presence | 1. Staff full-time equivalent (FTE) or vendor assigned full or part time to oversee critical facility operations | ✓ | | | | |
| | 2. Staff FTE or vendor support on site for a single shift 5 days per week | | ✓ | | | |
| | 3. Escalation and call-out procedures are in place for assigned staff and specified vendor support for designated critical systems and equipment | | ✓ | ✓ | ✓ | |
| | 4. 24 x 7 staff presence: minimum of 1 qualified FTE | | | ✓ | | |
| | 5. 24 x 7 staff presence: 2 qualified FTEs of facility support per shift | | | | ✓ | |
| | 6. Engineering trade (e.g., electrical, mechanical, controls, building management system [BMS], etc.) coverage split by shift based on operations and maintenance requirements | | | | | ✓ |
| Qualifications | 1. Appropriate staff trade licenses required by governmental regulation | ✓ | ✓ | ✓ | ✓ | |
| | 2. Documented training on site specific data center equipment and processes | | ✓ | ✓ | ✓ | |
| | 3. Completed formal site training for all personnel on a) site configuration/operating/emergency procedures for specific technical area and b) all site-level policies, processes, and procedures | | | ✓ | ✓ | |
| | 4. Duties assigned to designated individuals for maintenance, safety, training, and computer room engineering | | | | | ✓ |
| | 5. Shift personnel qualified for specific shift operations individually and as a shift team | | | | | ✓ |
| Organization | 1. Organization chart showing reporting chain and all interfaces between the Facility, Engineering, Information Technology (IT), and Security groups | ✓ | ✓ | ✓ | ✓ | |
| | 2. Critical facility job descriptions—available and in use | | ✓ | ✓ | ✓ | |
| | 3. Total FTE count numerically matches shift presence requirements | | | ✓ | ✓ | |
| | 4. Roles and responsibilities matrix covering all activities at the data center—available and in use | | | ✓ | ✓ | |
| | 5. Designated key positions and succession plan in place for each | | | | ✓ | |
| | 6. Integrated approach to operational management, including all facets of the data center operation (Facilities, IT, and Security), reporting up through the same organizational structure | | | | | ✓ |

**Table 1.1 Management & Operations—Staffing and Organization Category**

| Maintenance Category | | Applicable for Tier | | | | Bonus |
|---|---|---|---|---|---|---|
| Component | Behavior | I | II | III | IV | |
| Preventative Maintenance Program | 1. Effective preventative maintenance (PM) program including list of maintenance actions, due dates, and record of completion | ✓ | ✓ | ✓ | ✓ | |
| | 2. PM program encompasses original equipment manufacturer (OEM) maintenance recommendations | | ✓ | ✓ | ✓ | |
| | 3. Detailed procedures for switching between redundant equipment—available and in use | | | ✓ | ✓ | |
| | 4. Fully scripted preventative maintenance activities (PMs) (e.g., through a method of procedure [MOP] process) | | | ✓ | ✓ | |
| | 5. Quality control process in place that validates a) the proper completion of and b) the quality of the PM | | | ✓ | ✓ | |
| | 6. All PMs linked to and managed through the change management program | | | | | ✓ |
| Housekeeping Policies | 1. Computer room floor and underfloor free of dirt and debris | ✓ | ✓ | ✓ | ✓ | |
| | 2. Data center free of combustibles, cleaning equipment, shipping boxes, or personal conveniences items (e.g., coffee pots, microwaves) | | ✓ | ✓ | ✓ | |
| | 3. Housekeeping protocols in practice to ensure a contaminant free data center environment | | | ✓ | ✓ | |
| Maintenance Management System | 1. Effective maintenance management system ([MMS] paper or computerized) to track status of all maintenance activities—available and in use | ✓ | ✓ | ✓ | ✓ | |
| | 2. Maintains list of installed equipment (make, model, year of manufacture, year of installation, operating specifications, warranty information, etc.) | | ✓ | ✓ | ✓ | |
| | 3. Tracks PM tools and parts | | | ✓ | ✓ | |
| | 4. Maintains performance/trend data: equipment, history of maintenance activities, calibration requirements, and list of critical spares and reorder points | | | ✓ | ✓ | |
| Vendor Support | 1. List of qualified vendors by system available for normal and emergency work | ✓ | ✓ | ✓ | ✓ | |
| | 2. Service level agreements (SLA) outlining scope of work, PM schedule, and response times for all critical vendors | | ✓ | ✓ | ✓ | |
| | 3. Vendor call-in processes and points-of-contact for pre-approved and qualified technician(s) | | | ✓ | ✓ | |
| Life-Cycle Planning | 1. Effective process for planning, scheduling, and funding the life-cycle replacement of major infrastructure components | | | ✓ | ✓ | |
| Failure Analysis Program | 1. Maintains list of all outages including dates, times, infrastructure equipment/systems involved and specific computing outages, root-cause analysis, and lessons learned | | ✓ | ✓ | ✓ | |
| | 2. Effective process to determine root cause, identify lessons learned, and implement corrective actions | | | ✓ | ✓ | |
| | 3. Trend analysis process | | | | ✓ | |
| Deferred Maintenance Program | 1. PM and scheduled tasks accomplishment rate greater than (>) 90% | ✓ | ✓ | | | |
| | 2. PM accomplishment rate of 100% | | | ✓ | ✓ | |
| Predictive Maintenance Program | 1. Effective predictive maintenance program | | | | | ✓ |

**Table 1.2 Management & Operations—Maintenance Category**

| Training Category | | Applicable for Tier | | | | Bonus |
|---|---|---|---|---|---|---|
| **Component** | **Behavior** | **I** | **II** | **III** | **IV** | |
| Data Center Staff Training | 1. On-the-job training (OJT) for each new employee on a) the system(s) they will be responsible for operating and maintaining, and b) the rules of working in the data center | ✓ | ✓ | ✓ | ✓ | |
| | 2. Formal classroom, operational demonstrations, and/or shift drills covering the following:<br>• All policies, processes, and procedures for the operation and maintenance of data center systems<br>• Rules for working in the data center<br>• Site Configuration Procedures (SCPs)—how the infrastructure is configured for normal operation<br>• Standard Operating Procedures (SOPs)—how the infrastructure configuration is changed during normal operations<br>• Emergency Operating Procedures (EOPs)—how the site is controlled and operated during abnormal circumstances or emergency situations<br>• MOPs<br>• MMS Procedures | | | ✓ | ✓ | |
| | 3. Training program including training schedule, lesson plans, required reference materials, and records of attendance | | | ✓ | ✓ | |
| | 4. Formal qualification and re-qualification program for designated personnel performing data center operations | | | | | ✓ |
| Vendor Training (Part-time Support) | 1. Training required on data center access, work rules, and housekeeping | ✓ | ✓ | ✓ | ✓ | |
| | 2. Briefing on data center processes and procedures with respect to the work to be performed | | ✓ | ✓ | ✓ | |
| | 3. Formal training covering the following:<br>• All policies, processes, and procedures for the operation and maintenance of the data center systems<br>• Rules for working in the computer room and support areas (e.g., escort requirements)<br>• MOPs | | | ✓ | ✓ | |

**Table 1.3 Management & Operations—Training Category**

| Planning, Coordination, and Management Category | | Applicable for Tier | | | | Bonus |
|---|---|---|---|---|---|---|
| Component | Behavior | I | II | III | IV | |
| Site Policies | 1. Formal documented policies and procedures for the following:<br>• Site staff performs all site infrastructure operations (e.g., configuration changes and operations under normal, emergency, or abnormal conditions)<br>• Site Configuration: site infrastructure configuration for normal operations<br>• Standard Operations: changes to normal operating configuration (e.g., shifting chillers)<br>• Emergency Operations: control of the site during abnormal circumstances or event<br>• Change Management: a) review and approval of changes to the site baseline and b) evaluation of risk as related to planned changes | | | ✓ | ✓ | |
| Financial Management | 1. Operating expense and capital funding levels consistently sufficient and available to support the Tier objective | ✓ | ✓ | ✓ | ✓ | |
| | 2. Operating and capital budgets managed separately from non-critical facilities and are not pooled with other buildings or groups of buildings | | | ✓ | ✓ | |
| Reference Library | 1. The following reference and record documents available for use (off site or on site):<br>• As-built drawings<br>• Operation and maintenance documentation<br>• Studies (e.g., soils, structural, electrical, mechanical, breaker, circuit, etc.)<br>• Commissioning reports<br>• Warranty documentation and pre-purchased maintenance agreements<br>• Written automation sequences of operation | ✓ | ✓ | ✓ | ✓ | |
| | 2. The previously listed reference and record documents available on site at all times | | | ✓ | ✓ | |
| | 3. Reference documents located in centralized location (library) available to site operational personnel | | | ✓ | ✓ | |
| | 4. Process ensuring master copies are maintained current with additional copies available to site operational personnel, vendors, designers, etc. | | | | | ✓ |
| Space, Power, and Cooling Capacity Management | 1. Process for managing the installation and removal of IT equipment from the computer room | ✓ | ✓ | ✓ | ✓ | |
| | 2. Computer room master plan—developed and regularly reviewed/updated | | ✓ | ✓ | ✓ | |
| | 3. Process for forecasting future space, power, and cooling growth requirements on a periodic basis (e.g., 1/6/12/24/36 month) | | | ✓ | ✓ | |
| | 4. Tracking mechanism for current space, power, and cooling capacity and utilization reviewed periodically | | | ✓ | ✓ | |
| 3rd-Party Certifications | 1. International Organization for Standardization® (ISO®) certification | | | | | ✓ |
| | 2. IT Infrastructure Library® (ITIL®) certification | | | | | ✓ |
| | 3. Other relevant site or process certifications | | | | | ✓ |
| Computer Room Management | 1. Effective process for a) computer room airflow management and b) electrical power monitoring, management, and analysis | | | | | ✓ |

**Table 1.4 Management & Operations—Planning, Coordination, and Management Category**

| Building Features Category | | Applicable for Tier | | | | Bonus |
|---|---|---|---|---|---|---|
| Component | Behavior | I | II | III | IV | |
| Purpose Built | 1. Purpose-built data center | | | ✓ | ✓ | |
| | 2. Single-purpose facility to support IT equipment operations | | | | | ✓ |
| | 3. Stand-alone building physically separated from other corporate facilities on the site | | | | | ✓ |
| | 4. Data center built to standards exceeding local building codes to ensure continued operations following a natural event | | | | | ✓ |
| Support and Specialty Spaces | 1. Adequate space separate from computer room for IT hardware receiving, storage, staging, build, and test space | | ✓ | ✓ | ✓ | |
| | 2. Adequate space separate from computer room for the following functions:<br>• BMS/Building Automation System (BAS) control center<br>• Command Center/Disaster Recovery<br>• Parts, supply, and tool storage<br>• Engineering and Facility shop activities<br>• Meeting and training purposes | | | ✓ | ✓ | |
| Security and Access | 1. Controlled access to all computer rooms and support spaces | | ✓ | ✓ | ✓ | |
| | 2. Controlled building access | | | ✓ | ✓ | |
| | 3. Periodic review of access | | | ✓ | ✓ | |
| | 4. Controlled site access | | | | | ✓ |
| Setbacks | 1. Adequate space around the data center to minimize impacts from adjacent facilities | | | | | ✓ |
| Topology Enhancements | 1. Electrical topology enhancements above the Certified Tier level | | | | | ✓ |
| | 2. Mechanical/cooling topology enhancements above the Certified Tier level | | | | | ✓ |
| | 3. Other topology enhancements above the Certified Tier level | | | | | ✓ |
| 3rd-Party Certifications | 1. ENERGY STAR® Rating | | | | | ✓ |
| | 2. Leadership in Energy and Environmental Design (LEED®) certification | | | | | ✓ |
| | 3. Other relevant certifications | | | | | ✓ |

**Table 2.1 Building Characteristics—Building Features Category**

| Infrastructure Category | | Applicable for Tier | | | | Bonus |
|---|---|---|---|---|---|---|
| Component | Behavior | I | II | III | IV | |
| Flexibility for Incremental Capacity Increases | 1. Designed and constructed so that computer room space can be reconfigured with reasonable effort, and incremental increases in space, power, and cooling can be accomplished with minimal risk to the existing critical load | | | ✓ | ✓ | |
| | 2. Connection points for future/temporary extensions or capacity units | | | ✓ | ✓ | |
| Infrastructure to Support Operations | 1. Mechanical support systems available (e.g., chemical treatment, fuel scrubbing, etc.) to extend the life of or protect the infrastructure | | | ✓ | ✓ | |
| | 2. Mechanical systems installed to facilitate ease of operations | | | ✓ | ✓ | |
| | 3. Consistent labeling of infrastructure equipment and standardized sizes | | | ✓ | ✓ | |
| | 4. Electrical systems installed to facilitate ease of operations | | | ✓ | ✓ | |
| Ease of Maintenance | 1. Adequate space for the safe conduct of all normal maintenance activities on infrastructure equipment | | ✓ | ✓ | ✓ | |
| | 2. Adequate space (sufficient swing radii, lifting points, and in/out pathways) for the safe conduct of rapid removal and replacement on infrastructure equipment | | | ✓ | ✓ | |
| | 3. Equipment access provided to facilitate delivery and installation of motors or other large components | | | ✓ | ✓ | |
| Space, Power, and Cooling Exhaust Points | 1. Data center design coordinated space, power, and cooling capacity exhaust points | | | | | ✓ |

**Table 2.2 Building Characteristics—Infrastructure Category**

| Operating Conditions Category | | Applicable for Tier | | | | Bonus |
|---|---|---|---|---|---|---|
| Component | Behavior | I | II | III | IV | |
| Redline Ratings | 1. Redline rating process to limit the maximum load on all capacity delivery equipment and systems | | ✓ | ✓ | ✓ | |
| Operating Set Points | 1. Consistent operating set points (e.g., temperature, pressure, volumetric flow, etc.) established based on ***both*** risk to continuous availability ***and*** cost of operation | | ✓ | ✓ | ✓ | |
| Rotating Redundant Equipment | 1. Effective process for alternating the use of redundant infrastructure equipment as part of the site maintenance program | | ✓ | ✓ | ✓ | |

**Table 2.3 Building Characteristics—Operating Conditions Category**

| Pre-Operational Category | | Applicable for Tier | | | | Bonus |
|---|---|---|---|---|---|---|
| Component | Behavior | I | II | III | IV | |
| Commissioning | 1. Factory witness testing (FWT) of critical infrastructure equipment | | ✓ | ✓ | ✓ | |
| | 2. Receipt, installation, and pre-functional testing of critical infrastructure components | | ✓ | ✓ | ✓ | |
| | 3. Functional testing, critical infrastructure stand-alone testing, and pre-system startup configuration | | ✓ | ✓ | ✓ | |
| | 4. System start, OEM test, and individual system test (IST) commissioning | | ✓ | ✓ | ✓ | |
| | 5. Integrated systems operational test (ISOT) | | | ✓ | ✓ | |
| Transition-to-Operations Plan (New Facility or Major Capacity Expansion Only) | 1. Owner used a transition-to-operations protocol with requirements defined for development and implementation of the following key components of data center operations:<br>• Staffing plan<br>• Training program<br>• Maintenance program<br>• Reference library<br>• Outfitting plan (tools, critical spare parts, equipment, 1st-year consumables, etc.)<br>• Site procedures<br>• Financial management program | | | | | ✓ |

**Table 2.4 Building Characteristics—Pre-Operational Category**

| Natural Disaster Risk Category | Scale of Risk [1] | |
|---|---|---|
| **Component** | **Higher** | **Lower** |
| Flooding (river, lake, reservoir, canal, pond, etc.) and Tsunami [2] | < 100-Year Flood Plain [3] | > 100-Year Flood Plain |
| Hurricanes, Tornadoes, and Typhoons [4] | High | Medium |
| Seismic Activity [5] | Seismic Zone (SZ) – 3 or 4 | SZ – 2A or 2B |
| Active Volcanoes | High [3] | Medium |

**Table 3.1 Site Location—Natural Disaster Risk Category**

| Man-Made Disaster Risk Category | Scale of Risk [1] | |
|---|---|---|
| **Component** | **Higher** | **Lower** |
| Airport /Military Airfield | < 3 miles from any active runway; inside a 1 x 5-mile runway extension | > 3 miles from any active runway ; outside a 1 x 5-mile runway extension |
| Adjacent Properties Exposures | Chemical plant, fireworks factory, etc. | Office building, undeveloped land, etc. |
| Transportation Corridors | < 1 mile | > 1 mile and < 5 miles |

**Table 3.2 Site Location—Man-Made Disaster Risk Category**

[1] The level of mitigation in place will reduce potential impact to operations.

[2] Risk evaluation from the Regional or Local FEMA Flood Plain Map or international equivalent.

[3] A Tier IV Certified Data Center will receive one level rating reduction (Gold to Silver or Silver to Bronze) if constructed in this area after 1 January 2013.

[4] Risk evaluation from the *Natural Disaster Risk Locations* map of the U.S. (www.uptimeinstitute.com/resources) or international equivalent.

[5] Risk evaluation from the Inspection & Valuation International, Inc. (IVI) U*nited States Seismic Zones Map* (available at http://ivi-intl.com/pdfs/IVI_seismic_map_zones.pdf) or international equivalent.

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