

## Introduction

This document provides program updates as a foundation for EPA's assembly of a dataset for all servers with 1-4 processor sockets in all form factors (rack-mounted, pedestal, and blade), as listed in the scope for the Draft 1 Version 2.0 ENERGY STAR Computer Servers Specification. For a discussion of data needs and background, please refer to the *Server Energy Use Evaluation – Discussion Document*.

EPA encourages stakeholders to provide data in both Idle State and at full utilization as described further in this document. Tracked changes in the text identify revisions to Draft 1 references and are based on stakeholder comment received over the summer of 2010. For the purposes of this effort, all definitions not included in this document should be assumed to be identical to Draft 1.

## 1 DEFINITIONS

A. Computer Server: A computer that provides services and manages networked resources for client devices (e.g., desktop computers, notebook computers, thin clients, wireless devices, PDAs, IP telephones, other computer servers, or other network devices). A computer server is sold through enterprise channels for use in data centers and office/corporate environments. A computer server is primarily accessed via network connections, versus directly-connected user input devices such as a keyboard or mouse. For purposes of this specification, a computer server must meet **all** of the following criteria:

- 1) is marketed and sold as a computer server;
- 2) is designed for and listed as supporting one or more computer server operating systems (OS) and/or hypervisors, and is targeted to run user-installed enterprise applications;
- 3) is packaged and sold with one or more ac-dc or dc-dc power supplies; and
- 4) is designed such that all processors have access to shared system memory and are independently visible to a single OS or hypervisor.

**Note:** EPA removed the provision for ECC memory from the Computer Server definition, since ECC is now present in the Resilient Server sub-type definition.

Provision 4 remains as a holdover from the Version 1.0 definition. However, EPA is interested in revisiting the rationale for this provision with stakeholders, specifically to determine if it is still necessary in the general server definition or if it would better be placed elsewhere (e.g., sub-type definition, discussion of nodes versus sockets, etc.).

### B. Computer Server Types

1) Managed Server: A computer server that is designed for a high level of availability in a highly managed environment. For purposes of this specification, a managed server must meet **all** of the following criteria:

- i) is designed to be configured with redundant power supplies; and
- ii) contains an installed dedicated management controller (e.g., service processor).

2) Blade System: A system comprised of a blade chassis and one or more removable blade servers

38 and/or other units (e.g., blade storage, blade network equipment). Blade systems provide a  
39 scalable means for combining multiple blade server or storage units in a single enclosure, and are  
40 designed to allow service technicians to easily add or replace (hot-swap) blades in the field.

41 i) Blade Server: A computer server that is designed for use in a blade chassis. A blade server is  
42 a high-density device that functions as an independent computer server and includes at least  
43 one processor and system memory, but is dependent upon shared blade chassis resources  
44 (e.g., power supplies, cooling) for operation. A processor or memory module that is intended  
45 to scale up a standalone server is not considered a Blade Server.

46 (a) Multi-bay Blade Server: A blade server requiring more than one bay for installation in a  
47 blade chassis.

48 ii) Blade Chassis: An enclosure that contains shared resources for the operation of blade  
49 servers, blade storage, and other blade form-factor devices. Shared resources provided by a  
50 chassis may include power supplies, data storage, and hardware for dc power distribution,  
51 thermal management, system management, and network services.

52 iii) Blade Storage: A storage device that is designed for use in a blade chassis. A blade storage  
53 device is dependent upon shared blade chassis resources (e.g., power supplies, cooling) for  
54 operation.

55 3) Fully Fault Tolerant Server: A computer server that is designed with complete hardware  
56 redundancy, in which every computing component is replicated between two nodes running  
57 identical and concurrent workloads (i.e., if one node fails or needs repair, the second node can run  
58 the workload alone to avoid downtime). A fully fault tolerant server uses two systems to  
59 simultaneously and repetitively run a single workload for continuous availability in a mission critical  
60 application.

61 4) Resilient Server: A computer server that is designed with resiliency, RAS, and self-correction  
62 features integrated in the micro-architecture of the CPU and chipset to ensure data resiliency and  
63 accuracy. A resilient server is often used for a limited set of workloads that may include business  
64 processing, decision support, or handling of virtualized workloads. For purposes of this  
65 specification, a resilient server must meet **all** of the following criteria:

66 i) contains hot-swappable components (e.g., I/O, hard drives, and ac-dc power supplies);

67 ii) contains multiple physical banks of memory and I/O busses;

68 iii) provides machine check architecture (i.e., both Fault Isolation and Resiliency);

69 iv) provides memory fault detection and system recovery through DRAM chip sparing, extended  
70 ECC, and mirrored memory;

71 v) provides support for error-correcting code (ECC) and/or buffered memory (including both  
72 buffered DIMMs and buffered on board (BOB) configurations);

73 vi) provides end-to-end bus retry; and

74 vii) supports on-line expansion/retraction of hardware resources without the need for operating  
75 system reboot ("on-demand" features).

76 5) Multi-node Server: A computer server that is designed with two or more independent server nodes  
77 that share a single enclosure and one or more power supplies. In a multi-node server, power is  
78 distributed to all nodes through shared power supplies. Server nodes in a multi-node server are  
79 not designed to be hot-swappable.

80 i) Dual-node Server: A common multi-node server configuration consisting of two server nodes.

81 6) Server Appliance: A computer server that is bundled with a pre-installed operating system and  
82 application software that is used to perform a dedicated function or set of tightly coupled functions.  
83 Server appliances deliver services through one or more networks (e.g., IP or SAN), and are  
84 typically managed through a web or command line interface. Server appliance hardware and  
85 software configurations are customized by the vendor to perform a specific task (e.g., name

86 services, firewall services, authentication services, encryption services, and voice-over-IP (VoIP)  
87 services), and are not intended to execute user-supplied software.

88 7) High Performance Computing (HPC) System: A system designed with multiple, centrally-managed  
89 nodes connected with high-speed interconnect technology. An HPC system is intended to  
90 maximize performance in parallel and computationally-intensive workloads. HPC system power  
91 management features are typically removed or disabled. An HPC system includes a larger  
92 number of memory controllers compared to a general-purpose computer server in order to  
93 maximize data bandwidth available to the processors. For the purposes of this specification, an  
94 HPC server must be clearly identified as an HPC server in marketing literature and product  
95 specification sheets, and must be sold as an HPC server or system.

96 8) Direct Current (Dc) Server: A computer server that is designed solely to operate on a dc power  
97 source.

#### 98 C. Computer Server Form Factors

99 1) Rack-mounted Server: A computer server that is designed for deployment in a standard 19-inch  
100 data center rack as defined by EIA-310, IEC 60297, or DIN 41494. For the purposes of this  
101 specification, a blade server is considered under a separate category and excluded from the rack-  
102 mounted category.

103 2) Pedestal Server: A self-contained computer server that is designed with PSUs, cooling, I/O  
104 devices, and other resources necessary for stand-alone operation. The frame of a pedestal server  
105 is similar to that of a tower client computer.

#### 106 D. Computer Server Components

107 1) Power Supply Unit (PSU): A device that converts ac or dc input power to one or more dc power  
108 outputs for the purpose of powering a computer server. A computer server PSU must be self-  
109 contained and physically separable from the motherboard and must connect to the system via a  
110 removable or hard-wired electrical connection.

111 i) Ac-Dc Power Supply: A PSU that converts line-voltage ac input power into one or more dc  
112 power outputs for the purpose of powering a computer server.

113 ii) Dc-Dc Power Supply: A PSU that converts line-voltage dc input power to one or more dc  
114 outputs for the purpose of powering a computer server. For purposes of this specification, a  
115 dc-dc converter (also known as a voltage regulator) that is internal to a computer server and is  
116 used to convert a low voltage dc (e.g., 12 V dc) into other dc power outputs for use by  
117 computer server components is not considered a dc-dc power supply.

118 iii) Single-output Power Supply: A PSU that is designed to deliver the majority of its rated output  
119 power to one primary dc output for the purpose of powering a computer server. Single-output  
120 PSUs may offer one or more standby outputs that remain active whenever connected to an  
121 input power source. For purposes of this specification, the total rated power output from any  
122 additional PSU outputs that are not primary and standby outputs shall be no greater than 20  
123 watts. PSUs that offer multiple outputs at the same voltage as the primary output are  
124 considered single-output PSUs unless those outputs (1) are generated from separate  
125 converters or have separate output rectification stages, or (2) have independent current limits.

126 iv) Multi-output Power Supply: A PSU that is designed to deliver the majority of its rated output  
127 power to more than one primary dc output for the purpose of powering a computer server.  
128 Multi-output PSUs may offer one or more standby outputs that remain active whenever  
129 connected to an input power source. For purposes of this specification, the total rated power  
130 output from any additional PSU outputs that are not primary and standby outputs is greater  
131 than or equal to 20 watts.

132 2) I/O Device: A device which provides data input and output capability between a computer server  
133 and other devices. An I/O device may be integral to the computer server motherboard or may be  
134 connected to the motherboard via though expansion slots (e.g., PCI, PCIe). Examples of I/O  
135 devices include discrete Ethernet devices, InfiniBand devices, RAID/SAS controllers, and Fibre

- 136 Channel devices.
- 137 i) I/O Port: Physical circuitry within an I/O device where an independent I/O session can be  
138 established. A port is not the same as a connector receptacle; it is possible that a single  
139 connector receptacle can service multiple ports of the same interface.
- 140 3) Motherboard: The main circuit board of the server. For purposes of this specification, the  
141 motherboard includes connectors for attaching additional boards and typically includes the  
142 following components: processor, memory, BIOS, and expansion slots.
- 143 4) Processor: The logic circuitry that responds to and processes the basic instructions that drive a  
144 server. For purposes of this specification, the processor is the central processing unit (CPU) of the  
145 computer server. A typical CPU is a physical package to be installed on the server motherboard  
146 via a socket or direct solder attachment. The CPU package may include one or more processor  
147 cores.
- 148 5) Memory: For purposes of this specification, memory is a part of a server external to the processor  
149 in which information is stored for immediate use by the processor.
- 150 6) Hard Drive (HDD): The primary computer storage device which reads and writes to one or more  
151 rotating magnetic disk platters.
- 152 7) Solid State Drive (SSD): A disk drive that uses memory chips instead of rotating magnetic platters  
153 for data storage.
- 154 E. Other Data Center Equipment
- 155 1) Network Equipment: A device whose primary function is to pass data among various network  
156 interfaces, providing data connectivity among connected devices (e.g., routers and switches).  
157 Data connectivity is achieved via the routing of data packets encapsulated according to Internet  
158 Protocol, Fibre Channel, InfiniBand or similar protocol.
- 159 2) Storage Equipment: A system composed of integrated storage controllers, storage devices (e.g.,  
160 hard drives or solid state storage) and software that provides data storage services to one or more  
161 computer servers. While storage equipment may contain one or more embedded processors,  
162 these processors do not execute user-supplied software applications but may execute data-  
163 specific applications (e.g., data replication, backup utilities, data compression, install agents).
- 164 3) Uninterruptible Power Supply (UPS): A device intended to maintain continuity of power to  
165 electrical loads in the event of a disruption to expected utility power supply. The ride-through time  
166 of a UPS varies from seconds to tens of minutes. UPS designs offer a range of features, from  
167 acting as a temporary power source to the load during a power disruption, to conditioning the  
168 power reaching the load under normal operation. UPSs contain energy storage mechanisms to  
169 supply power to the attached load in the event of full disruption from the utility.
- 170 F. Computer Server Power States
- 171 1) Idle State: The operational state in which the OS and other software have completed loading, the  
172 computer server is capable of completing workload transactions, but no active workload  
173 transactions are requested or pending by the system (i.e., the computer server is operational, but  
174 not performing any useful work). For systems where ACPI standards are applicable, Idle State  
175 correlates only to ACPI System Level S0.
- 176 2) Active State: The operational state in which the computer server is carrying out work in response  
177 to prior or concurrent external requests (e.g., instruction over the network). Active state includes  
178 **both** (1) active processing and (2) data seeking/retrieval from memory, cache, or internal/external  
179 storage while awaiting further input over the network.
- 180 G. Other Key Terms:
- 181 1) Controller System: A computer or computer server that manages a benchmark evaluation  
182 process. The controller system performs the following functions:
- 183 i) start and stop each segment (phase) of the performance benchmark;

- 184 ii) control the workload demands of the performance benchmark;
- 185 iii) start and stop data collection from the power analyzer so that power and performance data
- 186 from each phase can be correlated;
- 187 iv) store log files containing benchmark power and performance information;
- 188 v) convert raw data into a suitable format for benchmark reporting, submission and validation;
- 189 and
- 190 vi) collect and store environmental data, if automated for the benchmark.
- 191 2) Network Client (Testing): A computer or computer server that generates workload traffic for
- 192 transmission to a UUT connected via a network switch.
- 193 3) RAS Features: An acronym for reliability, availability, and serviceability features. RAS is
- 194 sometimes expanded to RASM, which adds “Manageability” criteria. The three primary
- 195 components of RAS as related to a computer server are defined as follows:
- 196 i) *Reliability Features*: Features that support a server’s ability to perform its intended function
- 197 without interruption due to component failures (e.g., component selection, temperature and/or
- 198 voltage de-rating, error detection and correction).
- 199 ii) *Availability Features*: Features that support a server’s ability to maximize operation at normal
- 200 capacity for a given duration of downtime (e.g., redundancy [both at micro- and macro-level]).
- 201 iii) *Serviceability Features*: Features that support a server’s ability to be serviced without
- 202 interrupting operation of the server (e.g., hot plugging).
- 203 4) Server Processor Utilization: The ratio of instantaneous processor computing activity to full-load
- 204 processor computing activity at a specified voltage and frequency.

H. System Configuration

- 205 3) Product Family:

207 **Note:** The following definitions are described further in the accompanying Server Energy Use Evaluation –  
 208 Discussion Document.

- 209 4) Product Family Tested Product Configurations: A set of features common to all
- 210 models/configurations within a product family that constitute a common basic design. All
- 211 models/configurations within a product family must share the following:
- 212 i) be from the same model line;
- 213 ii) share the same form factor (i.e., rack-mounted, blade, pedestal);
- 214 iii) share PSUs with both the same rated maximum output and greater than or equal to the rated
- 215 efficiency of the tested configurations at all required load points specified in Section 3.2 (i.e.,
- 216 10%, 20%, 50%, and 100% for single-output; 20%, 50%, and 100% for multi-output). For the
- 217 purposes of testing, configurations shall use PSUs in non-redundant configuration.
- 218 1) Product Family Tested Product Configurations: The required representative tests that cover an
- 219 ENERGY STAR Product Family.
- 220 i) Low-end Performance Configuration: The combination of PSUs, Memory, Storage
- 221 (HDD/SDD), and I/O devices that represents the lowest-price computing platform within the
- 222 Product Family.
- 223 ii) High-end Performance Configuration: The combination of PSUs, Memory, Storage
- 224 (HDD/SDD), and I/O devices that represents either the highest-price or highest-performance
- 225 computing platform within the Product Family.

- 226 iii) Typical Configuration: A product configuration that lies between the Minimum and Maximum  
227 Power configurations and is representative of a product with high volume sales.
- 228 iv) Minimum Power Configuration: The minimum configuration that is able to boot and execute  
229 supported OSs. The Minimum Configuration contains the least number of installed PSUs,  
230 Memory, Storage (HDD/SDD), and I/O devices, that is both offered for sale and capable of  
231 meeting ENERGY STAR requirements.
- 232 v) Maximum Power Configuration: The vendor-selected combination of components that  
233 maximize power usage within the Product Family once assembled and operated. The  
234 Maximum Configuration contains the greatest number of installed PSUs, Memory, Storage  
235 (HDD/SDD), and I/O devices that is both offered for sale and capable of meeting ENERGY  
236 STAR requirements.

## 237 2 QUALIFYING PRODUCTS

238 **Note:** The following section contains the program scope for Version 2 of the Server specification.

### 239 2.1 INCLUDED PRODUCTS

240 A product must meet the definition of a Computer Server provided in *Section 0* of this document to be  
241 eligible for ENERGY STAR qualification under this specification. Eligibility under Version 2.0 is limited to  
242 blade-, rack-mounted, or pedestal form factor computer servers with no more than four processor sockets.  
243 Products explicitly excluded from Version 2.0 are identified in *Section 2.2*.

### 244 2.2 EXCLUDED PRODUCTS

245 Products that are covered under other existing ENERGY STAR product specifications are not eligible for  
246 qualification under the ENERGY STAR Computer Server specification. The list of specifications currently  
247 in effect can be found at [www.energystar.gov/products](http://www.energystar.gov/products).

248 The following products are specifically excluded from qualification under this specification:

- 249 • Fully Fault Tolerant Servers;
  - 250 • Server Appliances;
  - 251 • Storage Equipment including Blade Storage; and
  - 252 • Network Equipment.
- 253

254 **Note:** Stakeholders should refer to the Draft 1 specification for definitions of Fully Fault Tolerant Servers,  
255 Server Appliances, and Storage Equipment.

256

257  
258

## Appendix A: ENERGY STAR Computer Server Test Method

### 259 **1 OVERVIEW**

260 The following test method shall be used for determining compliance with requirements in the ENERGY  
261 STAR Product Specification for Computer Servers, and when acquiring test data for reporting of Full Load  
262 power on the ENERGY STAR Power and Performance Data Sheet.

### 263 **2 APPLICABILITY**

264 The following test method is applicable to all products eligible for qualification under the ENERGY STAR  
265 Product Specification for Computer Servers.

266 Products must be tested with hardware and software features and capabilities in the default, or “as-  
267 shipped” configuration, unless otherwise specified in this document. This procedure is intended to be  
268 followed in the specified sequence for UUT configuration in Appendix A *Section 5* and testing in *Section 6*.

### 269 **3 DEFINITIONS**

270 Unless otherwise specified, all terms used in this document are consistent with the definitions contained in  
271 the ENERGY STAR Product Specification for Computer Servers.

### 272 **4 TEST SETUP**

273 A) Input Power: Input power shall be as specified in Table 1.

274

**Table 1: Input Power Requirements for Computer Servers**

Product Type	Supply Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
Servers with Ac-Dc Single-Output PSUs	230 Vac	+/- 1.0 % (for products which are rated for ≤ 1.5 kW maximum Power) or	2.0 % (for products which are rated for ≤ 1.5 kW maximum Power) or	50 Hz or 60 Hz	+/- 1.0 %
Servers with Ac-Dc Multi-Output PSUs1	230 Vac and/or 115 Vac	+/- 4.0 % (for products which are rated for > 1.5 kW maximum Power)	5.0 % (for products which are rated for > 1.5 kW maximum Power)	@ 230 Vac: 50 Hz or 60 Hz @ 115 Vac: 60 Hz	+/- 1.0 %
Optional Testing Conditions For Ac-Dc Japanese Market	100 Vac	+/- 4.0 % (for products which are rated for > 1.5 kW maximum Power)	5.0 % (for products which are rated for > 1.5 kW maximum Power)	50 Hz or 60 Hz	+/- 1.0 %
Dc Servers	+/- 53 Vdc	+/- 1.0 V		N/A	N/A

276 B) Ambient Temperature: Ambient temperature shall be from 18 °C to 27 °C.

277 C) Relative Humidity:

278 1) Low-End Moisture: 5.5 °C Dew Point

279 2) High-End Moisture: 60% Relative Humidity, 15 °C Dew Point.

280 D) Power Meter: Power meters shall possess the following attributes:

281 1) Crest Factor: An available current crest factor of 3 or more at its rated range value. For analyzers  
 282 that do not specify the current crest factor, the analyzer must be capable of measuring an  
 283 amperage spike of at least 3 times the maximum amperage measured during any 1-second  
 284 sample.

285 2) Minimum Frequency Response: 3.0 kHz

286 3) Minimum Resolution:

287 a) 0.01 W for measurement values less than 10 W;

288 b) 0.1 W for measurement values from 10 W to 100 W; and

289 c) 1.0 W for measurement values greater than 100 W.

290 E) Measurement Accuracy:

291 1) Power measurements with a value greater than or equal to 0.5 W shall be made with an  
 292 uncertainty of less than or equal to 2% at the 95% confidence level.

293 2) Power measurements with a value less than 0.5 W shall be made with an uncertainty of less than  
 294 or equal to 0.01 W at the 95% confidence level.



## 295 5 TEST CONDUCT

### 296 5.1 PSU TEST CONFIGURATION

297 **Note:** Removed from this document as it does not apply to system testing.

### 298 5.2 ACTIVE MODE EFFICIENCY TEST CONFIGURATION

299 The Partner must test and report power and efficiency test results for all computer servers. Testing shall  
300 be conducted as follows:

- 301 A) As-shipped Condition: Products shall be tested in their “as-shipped” configuration, which includes both  
302 hardware configuration and system settings, unless otherwise specified in this test method. Where  
303 relevant, all options and software shall be set to their default condition.
- 304 B) Measurement Location: All power measurements shall be taken at a point between the ac or dc power  
305 source and the unit under test (UUT). No UPS units may be connected between the power meter and  
306 the UUT. The power meter shall remain in place until all Idle and full load power data is fully recorded.
- 307 C) Power Supplies: All PSUs must be connected and operational.
- 308 1) UUTs with Multiple PSUs: All power supplies must be connected to the ac or dc power source and  
309 operational during the test. If necessary, a Power Distribution Unit (PDU) may be used to connect  
310 multiple power supplies to a single source. If a PDU is used, any overhead electrical use from the  
311 PDU shall be included in the measurement of Idle power for the UUT.
- 312 D) Power Management and Operating System: The as-shipped operating system or a representative  
313 operating system must be installed. Products that are shipped without operating systems must be  
314 tested with a representative OS installed. For all tests, manufacturers must ensure that only the power  
315 management techniques and/or power saving features which are enabled on shipment are those  
316 enabled on systems under test. Any power management features which require the presence of an  
317 operating system (i.e. those that are not explicitly controlled by the BIOS or management controller)  
318 must be tested using only those power management features enabled by the operating system by  
319 default.
- 320 E) Storage (HDD, SSD): Products that do not include pre-installed hard drives (HDD or SSD) must have  
321 an identical hardware and software configuration as a product that was tested and qualified with at  
322 least one installed hard drive.
- 323 F) Blade and Dual/Multi-Node Servers: A Blade or Dual/Multi-Node Server must have identical  
324 configurations for each node or blade including all hardware components and software/power  
325 management settings. These systems must also be measured in a way to ensure that all power from  
326 all tested nodes/blades is being captured by the power meter the entire test.
- 327 G) Blade Chassis: [TBD]
- 328 H) BIOS and UUT System Settings: [TBD]
- 329 I) I/O and Network Connection: The UUT must have at least one port connected to an Ethernet network  
330 switch capable of the UUT’s highest and lowest network speeds. The network connection must be live  
331 during all tests, and although the link must be ready and able to transmit packets, no specific traffic is  
332 required over the connection during testing. The UUT shall be set up with minimal I/O add-in cards; for  
333 testing, ensure the server offers at least one Ethernet port (using a single add-in card only if no  
334 onboard Ethernet support is offered).

335 1) Ethernet Connections: Products shipped with support for Energy Efficient Ethernet (compliant with  
336 IEEE 802.3az) shall be connected only to Energy Efficient Ethernet compliant network equipment  
337 during testing and appropriate measures shall be taken to enable EEE features on both ends of  
338 the network link during all tests.

### 339 5.3 UUT PREPARATION

340 The Partner must test and report power and efficiency test results for a computer server under the  
341 following conditions:

- 342 1) Record the UUT manufacturer, model name, and configuration details, including: operating  
343 system name and version, processor type and speed, installed power supplies, physical memory,  
344 hard drive configuration, installed I/O devices, power management features enabled, etc. Record  
345 nameplate power ratings.
- 346 a) When testing a blade server, also record the blade chassis model.
- 347 2) Install the UUT in a test rack or location. The UUT shall not be physically moved until testing is  
348 complete. If the UUT is a blade system, populate the chassis as follows:
- 349 a) All blade servers installed in the chassis must be identical.
- 350 b) When testing a single blade, install it in the chassis location that is recommended in the  
351 manufacturer's documentation for optimal thermal performance. If manufacturer documented  
352 recommendations either do not exist or are not available, install the blade in a top corner  
353 position in the chassis.
- 354 c) When testing a partially-populated blade system, populate 1/2 of available chassis bays,  
355 rounding up to the nearest whole power domain if necessary. Populate bays using the  
356 following guidelines:
- 357 i. According to the blade chassis manufacturer recommendations, with all blades in the  
358 same power domain.
- 359 ii. If manufacturer documented recommendations either do not exist or are not available:  
360 Fill the top row of the chassis first, then proceeding downward. For partially-  
361 populated rows, fill from the center outward. For example, when installing six blades  
362 in a chassis with 3 rows and 4 bays per row, four blades must be installed into the top  
363 row, and two blades must be installed into the center two positions of the middle row.
- 364 d) Fill all empty bays with blanking panels or an equivalent airflow restriction for the duration of  
365 testing.

366 **Note:** The section above covers testing of a half-filled blade chassis, EPA welcomes stakeholders to  
367 additionally test and submit data for a fully-populated chassis, as long as half-chassis data is also acquired  
368 and forwarded to EPA.

369 3) Connect the UUT to a live Ethernet (IEEE 802.3) network switch. The live connection must be  
370 maintained for the duration of testing, except for brief lapses necessary for transitioning between  
371 link speeds. If a controller system is required to provide workload harness control, data  
372 acquisition, or other UUT testing support, the controller system shall be connected to the same  
373 network switch as the UUT and satisfy all other UUT network requirements.

374 4) Connect the power analyzers to an ac or dc voltage source set to the appropriate voltage and  
375 frequency for the test.

- 376 5) Plug the UUT into the measurement power outlet on the power analyzer, as follows:
- 377 a) no UPS units shall be connected between the power analyzer and the UUT;
- 378 b) the power analyzer shall remain connected until all testing is complete;
- 379 c) when testing a single blade server, the UUT shall be metered independently of the blade  
380 chassis;
- 381 d) when testing a Blade System, power shall be measured at the input of the blade chassis (i.e.,  
382 at the power supplies that convert data center distribution power to chassis distribution  
383 power).
- 384 6) If a controller system is being used, connect the data output interface of the power analyzer(s) to  
385 the appropriate input of the controller system..
- 386 7) Install the workload software on the UUT. Record the installed workload and configuration,  
387 including any custom parameters or settings.
- 388 8) Record the input voltage and frequency.
- 389 9) Verify that the UUT is configured in its as-shipped configuration.
- 390 10) Verify that only those system and hard drive power management features that are enabled upon  
391 shipment to a customer are enabled for testing.

## 392 **6 TEST PROCEDURE**

### 393 **6.1 POWER AND EFFICIENCY TESTING**

- 394 1. Power up the UUT, either by switching it on or connecting it to mains power.
- 395 2. If necessary, power up the controller system.
- 396 3. Begin recording elapsed time.
- 397 4. Between 5 and 15 minutes after the initial boot or log in, set the analyzer to begin accumulating  
398 power values at an interval of greater than or equal to 1 reading per second.
- 399 a. When testing using a controller system, the controller system may automate data  
400 accumulation and benchmark workload operation provided the measurement interval  
401 requirements are met.
- 402 5. Engage workload operation.
- 403 a. If the workload does not automate measurement of Idle power, between 5 and 15 minutes  
404 after the workload has completed operation, accumulate Idle power values for 5 additional  
405 minutes. The UUT must maintain an Idle state throughout this period and must not enter  
406 lower power states with limited availability (e.g., server sleep or hibernate states).
- 407 6. Record the following data at the end of workload operation:
- 408 a. Average Idle power (arithmetic mean) during either the automated Idle state period or 5  
409 minute test period;
- 410 b. Full power (the maximum power value measured during workload operation).
- 411 7. When testing a Blade System, proceed as follows to derive single blade power:

- 412 a. Remove a single blade from the chassis;
- 413 b. Repeat steps 3-6.

## 414 **7 REPORTING**

### 415 **7.1 BLADE CHASSIS** 416

- 417 1. Report the following details:
  - 418 a. Fan speed control features;
  - 419 b. Available chassis cooling options;
  - 420 c. Chassis reporting capability (e.g., input power, inlet air temperature or other thermal  
421 information, utilization, etc.)

### 422 **7.2 LOW POWER MODES**

- 423 1. Conduct the following steps for each low power mode available on the system:
  - 424 a. Begin recording elapsed time.
  - 425 b. Direct the UUT to enter the low power mode to be investigated.
  - 426 c. After the UUT has reached the low power mode, set the analyzer to begin accumulating  
427 power values at an interval of greater than or equal to 1 reading per second.
  - 428 d. Accumulate power values for the low power mode for 5 minutes and record the average  
429 (arithmetic mean) value observed during that 5 minute period. The UUT must maintain the  
430 low power mode Idle state throughout this period and must not enter lower power states.
- 431 2. Record the following data at the end of each low power mode evaluation:
  - 432 a. Average power in the low power mode (arithmetic mean);the following details for each low  
433 power mode available on the system:
  - 434 b. Rated or measured latency of the UUT in returning to a ready state from the low power  
435 mode.