



ENERGY STAR[®] Program Requirements Product Specification for Computer Servers

Eligibility Criteria Draft 3 Version 2.0

1 Following is the Version 2.0 ENERGY STAR Product Specification for Computer Servers. A product shall
2 meet all of the identified criteria if it is to earn the ENERGY STAR.

3 **1 DEFINITIONS**

4 A) Product Types:

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

- 12 a) is marketed and sold as a Computer Server;
- 13 b) is designed for and listed as supporting one or more computer server operating systems
14 (OS) and/or hypervisors;
- 15 c) is targeted to run user-installed applications typically, but not exclusively, enterprise in
16 nature;
- 17 d) provides support for error-correcting code (ECC) and/or buffered memory (including both
18 buffered dual in-line memory modules (DIMMs) and buffered on board (BOB)
19 configurations).

20 **Note:** After further analysis, accounting for changing market conditions, and discussion with stakeholders,
21 EPA has removed the proposed ECC exemption for systems larger than 50 nodes sharing the same
22 chassis.

- 23 e) is packaged and sold with one or more ac-dc or dc-dc power supplies; and
- 24 f) is designed such that all processors have access to shared system memory and are
25 independently visible to a single OS or hypervisor.
- 26 2) Managed Server: A computer server that is designed for a high level of availability in a highly
27 managed environment. For purposes of this specification, a managed server must meet **all** of
28 the following criteria:
 - 29 a) is designed to be configured with redundant power supplies; and
 - 30 b) contains an installed dedicated management controller (e.g., service processor).
- 31 3) Blade System: A system comprised of a blade chassis and one or more removable blade
32 servers and/or other units (e.g., blade storage, blade network equipment). Blade systems
33 provide a scalable means for combining multiple blade server or storage units in a single
34 enclosure, and are designed to allow service technicians to easily add or replace (hot-swap)
35 blades in the field.
 - 36 a) Blade Server: A computer server that is designed for use in a blade chassis. A blade
37 server is a high-density device that functions as an independent computer server and

38 includes at least one processor and system memory, but is dependent upon shared blade
39 chassis resources (e.g., power supplies, cooling) for operation. A processor or memory
40 module that is intended to scale up a standalone server is not considered a Blade Server.

41 (1) *Multi-bay Blade Server*: A blade server requiring more than one bay for installation in
42 a blade chassis.

43 (2) *Single-wide Blade Server*: A blade server requiring the width of a standard blade
44 server bay.

45 (3) *Double-wide Blade Server*: A blade server requiring twice the width of a standard
46 blade server bay.

47 (4) *Half-height Blade Server*: A blade server requiring one half the height of a standard
48 blade server bay.

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

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

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

62 5) Resilient Server: A Computer Server designed with extensive Reliability, Availability,
63 Serviceability (RAS) and scalability features integrated in the micro architecture of the
64 system, CPU and chipset. For purposes of ENERGY STAR qualification under this
65 specification, a Resilient Server shall have the characteristics as described in Appendix B of
66 this specification.

67 **Note:** Given the length of the description for a Resilient Server, EPA has created a new Appendix B for
68 reference. The definition provided in Appendix B is based on stakeholder recommendation and
69 evaluation by EPA prior to inclusion in this draft version. It is EPA's intention to proceed with this definition
70 to accurately characterize socket Resilient Servers. EPA has examined data indicating that two socket
71 Resilient Servers use considerably more power in Idle compared to Non-Resilient Servers; however, the
72 data does not clearly show the driver of this additional power consumption. Instead, analysis shows a
73 significant portion of the additional power consumption is not likely attributed to differences in Processor
74 Socket Power nor documented CPU power states. EPA welcomes additional input from stakeholders on
75 the components responsible for the increase in power consumption in systems using state of the art
76 processors that have energy management features. This input will be used to determine whether
77 separate Resilient Server Idle thresholds, similar to those shown in Table 3, would be appropriate for
78 Version 2.0.

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

83 a) Dual-node Server: A common multi-node server configuration consisting of two server
84 nodes.

85 7) Server Appliance: A computer server that is bundled with a pre-installed operating system
86 and application software that is used to perform a dedicated function or set of tightly coupled

87 functions. Server appliances deliver services through one or more networks (e.g., IP or SAN),
88 and are typically managed through a web or command line interface. Server appliance
89 hardware and software configurations are customized by the vendor to perform a specific
90 task (e.g., name services, firewall services, authentication services, encryption services, and
91 voice-over-IP (VoIP) services), and are not intended to execute user-supplied software.

92 8) High Performance Computing (HPC) System: A computing system which is designed and
93 optimized to execute highly parallel applications. HPC systems feature a large number of
94 clustered homogeneous nodes often featuring specialized high speed inter-processing
95 interconnects as well as large memory capability and bandwidth. HPC systems may be
96 purposely built, or assembled from more commonly available servers. HPC systems must
97 meet ALL the following criteria:

- 98 a) Marketed and sold as a high performance computer;
- 99 b) Designed (or assembled) and optimized to execute highly parallel applications;
- 100 c) Consist of a number of typically homogeneous computing nodes, clustered primarily to
101 increase computational capability;
- 102 d) Includes high speed IPC interconnections between nodes.

103 **Note:** A definition for High Performance Computing System was submitted by stakeholders to differentiate
104 HPC systems from typical server products. EPA has condensed the proposed definition and welcomes
105 stakeholder feedback on this definition.

106 9) Direct Current (Dc) Server: A computer server that is designed solely to operate on a dc
107 power source.

108 10) Large Server: A resilient/scalable server which ships as a pre-integrated/pre-tested system
109 housed in one or more full frames or racks and that includes a high connectivity I/O
110 subsystem with a minimum of 32 dedicated I/O slots.

111 **Note:** A definition for Large Server was submitted by a stakeholder to differentiate mainframe-type
112 servers from typical server products. EPA welcomes stakeholder feedback on this definition.

113 B) Product Category: A second-order classification or sub-type within a product type that is based on
114 product features and installed components. Product categories are used in this specification to
115 determine qualification and test requirements.

116 C) Computer Server Form Factors:

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

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

124 D) Computer Server Components:

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

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

131 b) Dc-Dc Power Supply: A PSU that converts line-voltage dc input power to one or more dc

- 132 outputs for the purpose of powering a computer server. For purposes of this specification,
133 a dc-dc converter (also known as a voltage regulator) that is internal to a computer server
134 and is used to convert a low voltage dc (e.g., 12 V dc) into other dc power outputs for use
135 by computer server components is not considered a dc-dc power supply.
- 136 c) Single-output Power Supply: A PSU that is designed to deliver the majority of its rated
137 output power to one primary dc output for the purpose of powering a computer server.
138 Single-output PSUs may offer one or more standby outputs that remain active whenever
139 connected to an input power source. For purposes of this specification, the total rated
140 power output from any additional PSU outputs that are not primary and standby outputs
141 shall be no greater than 20 watts. PSUs that offer multiple outputs at the same voltage as
142 the primary output are considered single-output PSUs unless those outputs (1) are
143 generated from separate converters or have separate output rectification stages, or (2)
144 have independent current limits.
- 145 d) Multi-output Power Supply: A PSU that is designed to deliver the majority of its rated
146 output power to more than one primary dc output for the purpose of powering a computer
147 server. Multi-output PSUs may offer one or more standby outputs that remain active
148 whenever connected to an input power source. For purposes of this specification, the
149 total rated power output from any additional PSU outputs that are not primary and
150 standby outputs is greater than or equal to 20 watts.
- 151 2) I/O Device: A device which provides data input and output capability between a computer
152 server and other devices. An I/O device may be integral to the computer server motherboard
153 or may be connected to the motherboard via through expansion slots (e.g., PCI, PCIe).
154 Examples of I/O devices include discrete Ethernet devices, InfiniBand devices, RAID/SAS
155 controllers, and Fibre Channel devices.
- 156 a) I/O Port: Physical circuitry within an I/O device where an independent I/O session can be
157 established. A port is not the same as a connector receptacle; it is possible that a single
158 connector receptacle can service multiple ports of the same interface.
- 159 3) Motherboard: The main circuit board of the server. For purposes of this specification, the
160 motherboard includes connectors for attaching additional boards and typically includes the
161 following components: processor, memory, BIOS, and expansion slots.
- 162 4) Processor: The logic circuitry that responds to and processes the basic instructions that drive
163 a server. For purposes of this specification, the processor is the central processing unit
164 (CPU) of the computer server. A typical CPU is a physical package to be installed on the
165 server motherboard via a socket or direct solder attachment. The CPU package may include
166 one or more processor cores.
- 167 5) Memory: For purposes of this specification, memory is a part of a server external to the
168 processor in which information is stored for immediate use by the processor.
- 169 6) Hard Drive (HDD): The primary computer storage device which reads and writes to one or
170 more rotating magnetic disk platters.
- 171 7) Solid State Drive (SSD): A disk drive that uses memory chips instead of rotating magnetic
172 platters for data storage.
- 173 E) Other Datacenter Equipment:
- 174 1) Network Equipment: A device whose primary function is to pass data among various network
175 interfaces, providing data connectivity among connected devices (e.g., routers and switches).
176 Data connectivity is achieved via the routing of data packets encapsulated according to
177 Internet Protocol, Fibre Channel, InfiniBand or similar protocol.
- 178 2) Storage Product: A fully-functional storage system that supplies data storage services to
179 clients and devices attached directly or through a network. Components and subsystems that
180 are an integral part of the storage product architecture (e.g., too provide internal
181 communications between controllers and disks) are considered to be part of the storage

182 product. In contrast, components that are normally associated with a storage environment at
183 the data center level (e.g., devices required for operation of an external SAN) are not
184 considered to be part of the storage product. A storage product may be composed of
185 integrated storage controllers, storage devices, embedded network elements, software, and
186 other devices. While storage products may contain one or more embedded processor, these
187 processors do not execute user-supplied software applications but may execute data-specific
188 applications (e.g., data replication, backup utilities, data compression, install agents).

189 **Note:** The Storage Equipment definition has been revised to harmonize with the Storage Product
190 definition found in the proposed Version 1.0 Data Center Storage specification.

191 3) Uninterruptible Power Supply (UPS): Combination of convertors, switches, and energy
192 storage devices (such as batteries) constituting a power system for maintaining continuity of
193 load power in case of input power failure.

194 F) Operational Modes and Power States:

195 1) Idle State: The operational state in which the OS and other software have completed loading,
196 the computer server is capable of completing workload transactions, but no active workload
197 transactions are requested or pending by the system (i.e., the computer server is operational,
198 but not performing any useful work). For systems where ACPI standards are applicable, Idle
199 State correlates only to ACPI System Level S0.

200 2) Active State: The operational state in which the computer server is carrying out work in
201 response to prior or concurrent external requests (e.g., instruction over the network). Active
202 state includes **both** (1) active processing and (2) data seeking/retrieval from memory, cache,
203 or internal/external storage while awaiting further input over the network.

204 G) Other Key Terms:

205 1) Controller System: A computer or computer server that manages a benchmark evaluation
206 process. The controller system performs the following functions:

- 207 a) start and stop each segment (phase) of the performance benchmark;
- 208 b) control the workload demands of the performance benchmark;
- 209 c) start and stop data collection from the power analyzer so that power and performance
210 data from each phase can be correlated;
- 211 d) store log files containing benchmark power and performance information;
- 212 e) convert raw data into a suitable format for benchmark reporting, submission and
213 validation; and
- 214 f) collect and store environmental data, if automated for the benchmark.

215 2) Network Client (Testing): A computer or computer server that generates workload traffic for
216 transmission to a UUT connected via a network switch.

217 3) RAS Features: An acronym for reliability, availability, and serviceability features. RAS is
218 sometimes expanded to RASM, which adds "Manageability" criteria. The three primary
219 components of RAS as related to a computer server are defined as follows:

- 220 a) *Reliability Features*: Features that support a server's ability to perform its intended
221 function without interruption due to component failures (e.g., component selection,
222 temperature and/or voltage de-rating, error detection and correction).
- 223 b) *Availability Features*: Features that support a server's ability to maximize operation at
224 normal capacity for a given duration of downtime (e.g., redundancy [both at micro- and
225 macro-level]).
- 226 c) *Serviceability Features*: Features that support a server's ability to be serviced without
227 interrupting operation of the server (e.g., hot plugging).

228 4) Server Processor Utilization: The ratio of processor computing activity to full-load processor
229 computing activity at a specified voltage and frequency, measured instantaneously or with a
230 short term average of use over a set of active and/or idle cycles.

231 5) Hypervisor: A type of hardware virtualization technique that enables multiple guest operating
232 systems to run on a single host system at the same time.

233 H) Product Family: A high-level description referring to a group of computers sharing one
234 chassis/motherboard combination that often contains hundreds of possible hardware and software
235 configurations.

236 1) Common Product Family Attributes: A set of features common to all models/configurations
237 within a product family that constitute a common basic design. All models/configurations
238 within a product family must share the following:

239 a) Be from the same model line or machine type;

240 b) Share the same form factor (i.e., rack-mounted, blade, pedestal);

241 c) Either share processors from a single defined processor series or share processors that
242 plug into a common socket type.

243 **Note:** EPA received stakeholder feedback inquiring whether models without all sockets fully populated
244 can be included in the same family as systems with all processors installed. Both fully populated and
245 partially populated configurations are considered to be in the same family, but all measurements shall be
246 made with fully populated sockets. As an example: In the case of two socket servers two processor
247 configurations shall be used for qualification purposes, but the system can be sold with one processor
248 under the same family.

249 d) share PSUs that perform with efficiencies greater than or equal to the efficiencies at all
250 required load points specified in Section 3.2 (i.e., 10%, 20%, 50%, and 100% of
251 maximum rated load for single-output; 20%, 50%, and 100% of maximum rated load for
252 multi-output).

253 2) Product Family Tested Product Configurations:

254 a) Purchase Consideration Variations:

255 (1) Low-end Performance Configuration: The combination of Processor Socket Power,
256 PSUs, Memory, Storage (HDD/SDD), and I/O devices that represents the lower-price
257 or lower-performance computing platform within the Product Family.

258 (2) High-end Performance Configuration: The combination of Processor Socket Power,
259 PSUs, Memory, Storage (HDD/SDD), and I/O devices that represents either the
260 higher-price or higher-performance computing platform within the Product Family.

261 b) Typical Configuration:

262 (1) Typical Configuration: A product configuration that lies between the Minimum and
263 Maximum Power configurations and is representative of a deployed product with high
264 volume sales.

265 c) Power Utilization Variations:

266 (1) Minimum Power Configuration: The minimum configuration that is able to boot and
267 execute supported OSs. The Minimum Configuration contains the lowest Processor
268 Socket Power, least number of installed PSUs, Memory, Storage (HDD/SDD), and
269 I/O devices, that is both offered for sale and capable of meeting ENERGY STAR
270 requirements.

271 (2) Maximum Power Configuration: The vendor-selected combination of components that
272 maximize power usage within the Product Family once assembled and operated. The
273 Maximum Configuration contains the highest Processor Socket Power, greatest

274 number of installed PSUs, Memory, Storage (HDD/SDD), and I/O devices that is both
275 offered for sale and capable of meeting ENERGY STAR requirements.

276 **Note:** In response to the Product Family Tested Configurations section (above) in Draft 2, stakeholders
277 commented that they anticipated the possibility of products falling outside the power profile defined by the
278 five tested product configurations. Stakeholders recommended that these outside configurations be
279 considered ENERGY STAR qualified provided that the manufacturer was responsible for verifying that the
280 configuration fully met the ENERGY STAR requirements.

281 EPA wishes to clarify that in this scenario, the manufacturer may not have correctly selected the five
282 tested product configurations to sufficiently describe the Product Family. The four boundary points are
283 meant to delineate an enclosed border and to illustrate the maximum and minimum power consumption of
284 products in the family. If configuration A is beyond the point defined by the High-End, Max Power
285 configuration, then configuration A should be the High-End Max Power configuration.

286 If this configuration, for whatever reason, is not appropriate to list as the High-End Max Power
287 configuration, then manufacturers are welcome to test it as an independent product, outside of the
288 product family. This product would be listed separately on the ENERGY STAR qualified product list. The
289 same consideration applies to small groups of product configurations that fall outside the main boundaries
290 of the four corners—in this case, this group would define a new product family.

291 The program will maintain the ability to individually test and qualify single configurations of Computer
292 Servers or to qualify additional families as needed if one or more configurations can meet ENERGY
293 STAR requirements but fall outside the four corner boundaries of an initial family.

294 2 SCOPE

295 2.1 Included Products

296 2.1.1 A product must meet the definition of a Computer Server provided in *Section 1* of this document
297 to be eligible for ENERGY STAR qualification under this specification. Eligibility under Version 2.0
298 is limited to Blade-, Multi-node, Rack-mounted, or Pedestal form factor computer servers with no
299 more than four processor sockets. Products explicitly excluded from Version 2.0 are identified in
300 *Section 2.2*.

301 **Note:** In response to stakeholder feedback, EPA has revised the above language to clearly indicate the
302 inclusion of Multi-node Servers in the program scope.

303 2.2 Excluded Products

304 2.2.1 Products that are covered under other ENERGY STAR product specifications are not eligible for
305 qualification under this specification. The list of specifications currently in effect can be found at
306 www.energystar.gov/products.

307 2.2.2 The following products are not eligible for qualification under this specification:

- 308 i. Fully Fault Tolerant Servers;
- 309 ii. Server Appliances;
- 310 iii. High Performance Computing Systems;

311 **Note:** In response to stakeholder feedback and EPA's own internal evaluation, HPC systems have been
312 excluded from the scope of Version 2.0. These highly specialized and customized configurations differ
313 greatly from the more standardized rack/pedestal or blade server configurations that this specification
314 covers. The development of a test method, suitable metrics, and appropriate qualification criteria for
315 these systems would require an extended, independent effort in the future.

316 iv. Large Servers

317 **Note:** EPA proposes to exclude Large Servers from the scope of this specification. These systems, as
318 defined above, are effectively small mainframes that are configured, operated, and sold in ways that differ
319 from more common rack/pedestal or blade servers. EPA believes these products are not appropriate for
320 inclusion in the scope of this specification and welcomes stakeholder feedback on this issue.

321 v. Storage Products including Blade Storage; and

322 vi. Network Equipment.

323 3 QUALIFICATION CRITERIA

324 3.1 Significant Digits and Rounding

325 3.1.1 All calculations shall be carried out with directly measured (unrounded) values.

326 3.1.2 Unless otherwise specified, compliance with specification limits shall be evaluated using directly
327 measured or calculated values without any benefit from rounding.

328 3.1.3 Directly measured or calculated values that are submitted for reporting on the ENERGY STAR
329 website shall be rounded to the nearest significant digit as expressed in the corresponding
330 specification limit.

331 3.2 Power Supply Requirements

332 3.2.1 Power supply test data and test reports from testing entities recognized by EPA to perform power
333 supply testing shall be accepted for the purpose of qualifying the ENERGY STAR product.

334 3.2.2 Power Supply Efficiency Criteria: Power Supplies used in products eligible under this specification
335 must meet the following requirements when tested using the *Generalized Internal Power Supply*
336 *Efficiency Test Protocol, Rev. 6.6* (available at www.efficientpowersupplies.org). Power Supply
337 data generated using Rev. 6.4.2 (as required in Version 1.1), 6.4.3, or 6.5 are acceptable
338 provided the test was conducted prior to the effective date of Version 2.0.

339 **Note:** EPA has clarified that legacy PSU data generated using the revision of the test protocol
340 incorporated in Version 1.1 will be accepted if the data was generated prior to Version 2.0 taking effect.
341 Such an approach allows Partners to avoid unnecessary retesting, and EPA believes that the changes
342 implemented in the test protocol do not impact the consistency of the data requested in this specification.

343 i. Pedestal and Rack-mounted Servers: To qualify for ENERGY STAR, a pedestal or rack-
344 mounted computer server must be configured with **only** PSUs that meet or exceed the
345 applicable efficiency requirements specified in Table 1 **prior to shipment**.

346 ii. Blade and Multi-node Servers: To qualify for ENERGY STAR, a Blade or Multi-node server
347 shipped with a chassis must be configured such that **all** PSUs supplying power to the chassis
348 meet or exceed the applicable efficiency requirements specified in Table 1 **prior to**
349 **shipment**.

350 **Note:** A stakeholder recommended that the previous language referring to PSUs “in the chassis” be
351 reworded to refer to PSUs supplying power to the chassis. This change has been incorporated in both the
352 efficiency and power factor language.

353

Table 1: Efficiency Requirements for PSUs

Power Supply Type	Rated Output Power	10% Load	20% Load	50% Load	100% Load
Multi-output (Ac-Dc & Dc-Dc)	All Output Levels	N/A	85%	88%	85%
Single-output (Ac-Dc & Dc-Dc)	All Output Levels	80%	88%	92%	88%

354 3.2.3 Power Supply Power Factor Criteria: Power Supplies used in Computers eligible under this
 355 specification must meet the following requirements when tested using the *Generalized Internal*
 356 *Power Supply Efficiency Test Protocol, Rev. 6.6* (available at www.efficientpowersupplies.org).
 357 Power Supply data generated using Rev. 6.4.2 (as required in Version 1.1), 6.4.3, or 6.5 are
 358 acceptable provided the test was conducted prior to the effective date of Version 2.0.

- 359 i. Pedestal and Rack-mounted Servers: To qualify for ENERGY STAR, a pedestal or rack-
 360 mounted computer server must be configured with **only** PSUs that meet or exceed the
 361 applicable power factor requirements specified in Table 2 **prior to shipment**, under all
 362 loading conditions for which output power is greater than or equal to 75 watts. Partners are
 363 required to measure and report PSU power factor under loading conditions of less than 75
 364 watts, though no minimum power factor requirements apply.
- 365 ii. Blade or Multi-node Servers: To qualify for ENERGY STAR, a Blade or Multi-node Server
 366 shipped with a chassis must be configured such that **all** PSUs supplying power to the chassis
 367 meet or exceed the applicable power factor requirements specified in Table 2 **prior to**
 368 **shipment**, under all loading conditions for which output power is greater than or equal to 75
 369 watts. Partners are required to measure and report PSU power factor under loading
 370 conditions of less than 75 watts, though no minimum power factor requirements apply.

371

Table 2: Power Factor Requirements for PSUs

Power Supply Type	Rated Output Power	10% Load	20% Load	50% Load	100% Load
Dc-Dc (All)	All Output Ratings	N/A	N/A	N/A	N/A
Ac-Dc Multi-output	All Output Ratings	N/A	0.80	0.90	0.95
Ac-Dc Single-output	Output Rating ≤ 500 W	N/A	0.80	0.90	0.95
	Output Rating > 500 W and Output Rating ≤ 1,000 W	0.65	0.80	0.90	0.95
	Output Rating > 1,000 watts	0.80	0.90	0.90	0.95

372

373 **3.3 Power Management Requirements**

374 3.3.1 Server Processor Power Management: To qualify for ENERGY STAR, a server must offer
 375 processor power management that is enabled by default in the BIOS and/or through a
 376 management controller, service processor, and / or the operating system shipped with the server.
 377 **All** processors must be able to reduce power consumption in times of low utilization by

- 378 i. reducing voltage and/or frequency through Dynamic Voltage and Frequency Scaling (DVFS),
379 or
380 ii. enabling processor or core reduced power states when a core or socket is not in use.
381

Note: To accommodate systems that enable power management features via in-band capabilities, operating system has been added to the power management list in 3.3.1.

384 3.3.2 Supervisor Power Management: To qualify for ENERGY STAR, a product which offers a pre-
385 installed supervisor system (e.g., operating system, hypervisor) must offer supervisor system
386 power management that is enabled by default.

387 3.3.3 Power Management Disclosure: To qualify for ENERGY STAR, all power management
388 techniques that are enabled by default must be itemized on the Power and Performance Data
389 Sheet.

390 **3.4 Blade System Criteria**

391 3.4.1 Blade Chassis Thermal Management: To qualify for ENERGY STAR, a blade chassis that is (1)
392 shipped with an ENERGY STAR qualified blade server, or (2) marketed for use with an ENERGY
393 STAR qualified blade server, must provide real-time chassis temperature monitoring and fan
394 speed management capability that is enabled by default.

395 3.4.2 Blade Server Shipping Documentation: To qualify for ENERGY STAR, a blade server that is
396 shipped to a customer independent of a blade chassis must be accompanied with documentation
397 to inform the customer that the blade server is ENERGY STAR qualified only if it is installed in a
398 blade chassis meeting requirements in *Section 3.4.1* of this document. A list of qualifying blade
399 chassis and ordering information must also be provided as part of product collateral provided with
400 the blade in either a printed format or an alternative format approved by EPA. These
401 requirements may be met via either printed materials, electronic documentation provided with the
402 Blade Server, or information publically available on the Partner's website where information about
403 the Blade Server is found.

Note: EPA understands that some manufacturers may no longer provide physical documentation in an effort to reduce waste. The shipping documentation requirement above has been clarified to allow information to be communicated via Partner websites.

407 **3.5 Active State Efficiency Criteria**

408 3.5.1 Active Mode Efficiency Disclosure: To qualify for ENERGY STAR, a computer server or computer
409 server family must be submitted for qualification with the following information disclosed in full
410 and in the context of the complete active mode efficiency rating test report:

- 411 i. final rating tool results; and
412 ii. intermediate rating tool results over the entire test run at **all** of the following load levels:
413 **[TBD]**.

414 Public disclosure and formatting requirements are discussed in *Section 3.7* of this specification.

415 3.5.2 Incomplete Disclosure: Partners shall not selectively report individual workload module results, or
416 otherwise presenting efficiency rating tool results in any form other than a complete test report, in
417 customer documentation or marketing materials.

Note: Section 3.5 remains to be determined and will be updated as the SERT development process comes to a close. EPA will re-engage with stakeholders regarding Section 3.5 before finalizing any changes to this section.

421 **3.6 Idle Mode and Full Load Efficiency Criteria – One-Socket (1S) and Two-Socket (2S)**
 422 **Servers (non-Blade)**

423 3.6.1 Idle Mode Efficiency: Measured Idle State power (P_{IDLE}) shall be less than or equal to the
 424 Maximum Idle State Power Requirement (P_{IDLE_MAX}), as calculated per Equation 1.

425 **Equation 1: Calculation of Maximum Idle State Power**

426
$$P_{IDLE_MAX} = P_{BASE} + \sum_{i=1}^n P_{ADDL_i}$$

427 *Where:*

- 428 ▪ P_{IDLE_MAX} is the Maximum Idle State Power Requirement,
- 429 ▪ P_{BASE} is the base idle power allowance, as determined per
 430 Table 3,
- 431 ▪ P_{ADDL_i} is the Idle State power allowance for additional
 432 components, as determined per Table 4.

- 434 i. These Idle power limits are applicable to single and dual socket systems only.
- 435
- 436 ii. All quantities (with the exception of installed processors) in Table 3 and Table 4 refer to the
 437 number of components installed in the system, not the maximum number of components the
 438 system can support (e.g., installed memory, not supported memory; etc.)
- 439 iii. The Additional Power Supply allowance may be applied for each redundant power supply
 440 used in the configuration.
- 441 iv. For the purposes of determining Idle power allowances, all memory capacities shall be
 442 rounded to the nearest GB.
- 443 v. The Additional I/O Device allowance may be applied for all I/O Devices over the Base
 444 Configuration (i.e., Ethernet devices additional to two ports of 1 Gigabit per second (Gbit/s),
 445 onboard Ethernet, plus any non-Ethernet I/O devices), including on-board I/O devices and
 446 add-in I/O devices installed through expansion slots.
- 447 vi. The Additional I/O Device allowance shall be calculated based upon the rated link speed of a
 448 single connection, rounded to the nearest Gbit. I/O devices with less than 1 Gbit speed do
 449 not qualify for the Additional I/O Device allowance.
- 450 vii. The Additional I/O Device allowance shall only be applied for I/O devices that are
 451 active/enabled upon shipment, and are capable of functioning when connected to an active
 452 switch.

453 **Table 3: Base Idle State Power Allowances for 1S and 2S Servers**

Category	Maximum Possible Number of Installed Processors (# P)	Managed Server	Base Idle State Power Allowance, P_{BASE} (watts)
A	1	No	47.0
B	1	Yes	57.0
C	2	No	92.0
D	2	Yes	142.0

454 **Note:** EPA proposes to reduce all base Idle State Power Allowances proposed in Draft 2 by 8 Watts and
 455 apply the adder for hard drives to any installed drives, not just those in excess of the first one. This
 456 change has been made to more accurately represent systems designed to operate only on remote
 457 storage and with no internal storage capacity.

458 **Table 4: Additional Idle Power Allowances for Extra Components**

System Characteristic	Applies To:	Additional Idle Power Allowance
Additional Power Supplies	Power supplies installed explicitly for power redundancy ⁽ⁱⁱⁱ⁾	20 watts per Power Supply
Any Hard Drives (including solid state drives)	Per installed hard drive	8.0 watts per Hard Drive
Additional Memory	Installed memory greater than 4 GB ^(iv)	0.75 watts per GB ^(iv)
Additional I/O Devices ^{(v), (vi), (vii)}	Installed Devices greater than two ports of 1 Gbit, onboard Ethernet	< 1Gbit: No Allowance = 1 Gbit: 2.0 watts / Active Port > 1 Gbit and < 10 Gbit: 4.0 watts / Active Port ≥ 10 Gbit: 8.0 watts / Active Port

459
 460 **Note:** In Draft 2, EPA asked for stakeholder feedback on the possibility of revising the redundant power
 461 supply adder. EPA understands that the performance of these products has not progressed since V1.0
 462 and 20W remains a challenging target for redundant power supplies. As such, EPA proposes retaining
 463 the 20 watt adder for each redundant power supply that was present in Version 1. EPA welcomes
 464 stakeholder feedback on this approach.

465 3.6.2 Full Load Data Disclosure: Measured Full Load power (P_{FULL_LOAD}) shall be measured and
 466 reported, both in qualification materials and as required in Section 4.

467 **3.7 Idle Mode and Full Load Efficiency Criteria – Three-Socket (3S) and Four-Socket**
 468 **(4S) Servers (non-Blade)**

469 3.7.1 Idle Mode Data Disclosure: Measured Idle State power (P_{IDLE}) shall be measured and reported,
 470 both in qualification materials and as required in Section 4.

471 3.7.2 Full Load Data Disclosure: Measured Full Load power (P_{FULL_LOAD}) shall be measured and
 472 reported, both in qualification materials and as required in Section 4.

473 **3.8 Idle Mode and Full Load Efficiency Criteria – Blade Servers**

474 3.8.1 Idle Mode Data Disclosure: Measured Idle State power (P_{IDLE}) shall be measured and reported,
 475 both in qualification materials and as required in Section 4.

476 3.8.2 Full Load Data Disclosure: Measured Full Load power (P_{FULL_LOAD}) shall be measured and
 477 reported, both in qualification materials and as required in Section 4.

478 3.8.3 The testing of Blade Servers for compliance with 3.8.1 and 3.8.2 shall be carried out under all of
 479 the following conditions:

- 480 i. Power values shall be measured and reported using a half-populated Blade Chassis.
- 481 ii. Power for a fully-populated blade chassis may be optionally measured and reported, provided
 482 that half-populated chassis data is also provided.

- 483 iii. All Blade Servers installed in the Blade Chassis shall share the same configuration
 484 (homogeneous).
 485 iv. Per-blade power values shall be calculated using Equation 2.

486 **Equation 2: Calculation of Single Blade Power**

487
$$P_{BLADE} = \frac{P_{TOT_BLADE_SYS}}{N_{INST_BLADE_SRV}}$$

488 *Where:*

- 489 ▪ P_{BLADE} is the per-Blade Server Power (either Idle or Full-
 490 load),
- 491 ▪ $P_{TOT_BLADE_SYS}$ is total measured power of the Blade System,
- 492 ▪ $N_{INST_BLADE_SRV}$ is the number of installed Blade Servers in
 493 the tested Blade Chassis.

495 **Note:** EPA proposes that manufacturers be required to report Idle and Full Load data based on a half-
 496 populated Blade Chassis only. It is EPA’s belief that this provides a consistent standard for all Partners,
 497 will produce more comparable data for future review, and will also reduce testing burden. An optional
 498 provision for submittal of full chassis data is included.

499 EPA has also proposed testing conditions for Blade Server testing in 3.8.3.

500 **3.9 Other Testing Criteria**

501 3.9.1 **Auxiliary Processing Accelerators (APA):** For all Computer Servers sold with computing
 502 expansion add in cards installed in general-purpose add-in expansion slots (e.g., GPGPUs
 503 installed in a PCI slot), the following criteria and provisions apply:

- 504 i. For single configurations: All Idle Mode testing shall be conducted both with and without the
 505 APAs installed. Idle Power measurements taken both with the APAs installed and removed
 506 shall be submitted to EPA as part of ENERGY STAR qualification materials.
- 507 ii. For Product Families: Idle Mode testing shall be conducted both with and without the APAs
 508 installed in the Maximum Power Configuration found in 1.H)2). Testing with and without the
 509 APAs installed may optionally be conducted and disclosed at the other test points.
- 510 iii. Idle Power measurements taken both with the APAs installed and removed shall be
 511 submitted to EPA as part of ENERGY STAR qualification materials.
- 512 iv. Idle Power data with the APAs removed shall be used as P_{BASE} for the purposes of
 513 qualification of the single configuration or Product Family test point.
- 514 v. The total idle power consumption of all installed APAs in qualified configurations shall not
 515 exceed 46 watts.

516 **Note:** Recognizing that “add-in compute” capability may be delivered by solutions other than GPUs, EPA
 517 proposes the use of the more general term Auxiliary Processing Accelerators (APAs). Further, EPA also
 518 proposes a maximum Idle Power of 46 Watts for APAs shipped with a qualified product. This requirement
 519 supports EPA’s goal of better understanding the power implications of APAs as an emerging product
 520 trend while maintaining the rigor of the efficiency criteria. This level is informed by EPA’s research into
 521 power consumption of fully-featured GPUs in the Workstation/Computer space.

522 **4 STANDARD INFORMATION REPORTING REQUIREMENTS**

523 **4.1 Power and Performance Datasheet (PPDS)**

- 524 4.1.1 Data for a standardized Power and Performance Data Sheet (PPDS) shall be submitted to
525 EPA for each ENERGY STAR qualified Computer Server or Computer Server Product Family.
- 526 i. Partners are encouraged to provide one set of data for each ENERGY STAR qualified
527 product configuration, though EPA will also accept a data set for each qualified product
528 family.
- 529 ii. A product family PPDS must include data for all defined test points in 1.H)2), as applicable.
- 530 iii. Whenever possible, Partners must also provide a hyperlink to a more detailed power
531 calculator on their Web site that purchasers can use to understand power and performance
532 data for specific configurations within the product family.
- 533 4.1.2 Templates for the Power and Performance Data Sheet can be found on the ENERGY STAR
534 Web site at www.energystar.gov/products.

535 Note: EPA has published a proposed PPDS template for the Version 2.0 ENERGY STAR Computer
536 Servers specification on the ENERGY STAR Computer Servers product development page found at
537 www.energystar.gov/revisedspecs (click on Computer Servers). EPA seeks feedback on the proposed
538 data to be collected for Version 2.0.

539 The PPDS contains the following information:

- 540 i. model name and number, identifying SKU and/or configuration ID;
- 541 ii. system characteristics (form factor, available sockets/slots, power specifications, etc.);
- 542 iii. system type (unmanaged, managed, scalable, etc.);
- 543 iv. system configuration(s) (including Low-end Performance Configuration, High-end
544 Performance Configuration, Minimum Power Configuration, Maximum Power Configuration,
545 and Typical Configuration for Product Family qualification);
- 546 v. Data from required Active State Efficiency Criteria testing;
- 547 vi. power data for Idle and Full Load, estimated kWh/year, link to power calculator (where
548 available);
- 549

550 **Note:** Based on the near term completion of SERT and the widespread investment in and support of this
551 tool, EPA proposes to consider only power and performance data from the SERT benchmark..

- 552 vii. available and enabled power saving features (e.g., power management);
- 553
- 554 viii. power consumption and performance data, along with guaranteed accuracy levels for all
555 power and temperature measurements, disclosure of the time period used for data averaging,
556 and a hyperlink to a detailed power calculator, as available;
- 557 ix. a list of selected data from the ASHRAE Thermal Report;
- 558 x. for product family qualifications, a list of qualified configurations with qualified SKUs or
559 configuration IDs; and
- 560 xi. for a blade server, a list of compatible blade chassis that meet ENERGY STAR qualification
561 criteria.

- 562 4.1.3 EPA may periodically revise this PPDS, as necessary, and will notify and invite stakeholder
563 engagement in such a revision process.

564 **5 STANDARD PERFORMANCE DATA MEASUREMENT AND OUTPUT**
565 **REQUIREMENTS**

566 **5.1 Measurement and Output**

567 5.1.1 A computer server must provide data on input power consumption (W), inlet air temperature
568 (°C), and utilization of all logical CPUs. Data must be made available in a published or user-
569 accessible format that is readable by third-party, non-proprietary management software over a
570 standard network. For blade servers and systems, data may be aggregated at the chassis
571 level.

572 5.1.2 Servers classified as Class B equipment as set out in EN 55022:2006 are exempt from the
573 requirements to provide data on input power consumption and inlet air temperature in 5.1.1.
574 Class B refers to household and home office equipment (intended for use in the domestic
575 environment). All servers in the program must meet the requirement and conditions to report
576 utilization of all logical CPUs.

577 **5.2 Reporting Implementation**

578 5.2.1 Products may use either embedded components or add-in devices that are packaged with the
579 computer server to make data available to end users (e.g., a service processor, embedded
580 power or thermal meter (or other out-of-band technology), or pre-installed OS);

581 5.2.2 Products that include a pre-installed OS must include all necessary drivers and software for
582 end users to access standardized data as specified in this document. Products that do not
583 include a pre-installed OS must be packaged with printed documentation of how to access
584 registers that contain relevant sensor information. This requirement may be met via either
585 printed materials, electronic documentation provided with the Computer Server, or information
586 publically available on the Partner's website where information about the Computer Server is
587 found.

588 **Note:** The shipping documentation requirement has been clarified to allow information to be
589 communicated via Partner websites.

590 5.2.3 When an open and universally available data collection and reporting standard becomes
591 available, manufacturers should incorporate the universal standard into their systems;

592 5.2.4 Evaluation of the accuracy (5.3) and sampling (5.4) requirements shall be completed through
593 review of data from component product datasheets. If this data is absent, Partner declaration
594 shall be used to evaluate accuracy and sampling.

595 **Note:** 5.2.4 is added to clarify CB responsibilities in evaluating requirements in Section 5.

596 **5.3 Measurement Accuracy**

597 5.3.1 *Input power:* Measurements must be reported with accuracy of at least $\pm 5\%$ of the actual
598 value, with a maximum level of accuracy of $\pm 10W$ for each installed PSU (i.e., power reporting
599 accuracy for each power supply is never required to be better than ± 10 watts) through the
600 operating range from Idle to full power;

601 5.3.2 *Processor utilization:* Utilization must be estimated for each logical CPU that is visible to the
602 OS and must be reported to the operator or user of the computer server through the operating
603 environment (OS or hypervisor);

604 5.3.3 *Inlet air temperature:* Measurements must be reported with an accuracy of at least $\pm 2^\circ C$.

605 **5.4 Sampling Requirements**

606 5.4.1 *Input power and processor utilization:* Input power and processor utilization measurements
607 must be collected at a rate of ≥ 1 measurement per contiguous 10 second period. A rolling
608 average, encompassing a period of no more than 30 seconds, must be reported at a
609 frequency of greater than or equal to once per ten seconds.

610 5.4.2 *Inlet air temperature:* Inlet air temperature measurements must be collected at a rate of ≥ 1
611 measurement every 10 seconds.

612 5.4.3 *Timestamping:* Systems that implement timestamping of environmental data shall collect data
613 at a rate of ≥ 1 measurement every 30 seconds

614 **Note:** EPA proposes that systems which incorporate timestamping of environmental data (power and
615 temperature) shall be subject to modified data reporting frequency requirements in Section 5.4.3. The
616 frequency of reporting measurements in Sections 5.4.1 and 5.4.2 will remain unchanged. Timestamped
617 data can be assembled in time-order at a later date, providing increased flexibility for users of systems
618 that offer this capability. EPA wishes to encourage this capability and has relaxed the reporting frequency
619 requirements to encourage its use.

620 **6 TESTING**

621 **6.1 Test Methods**

622 6.1.1 When testing Computer Server products, the test methods identified in Table 5 shall be used to
623 determine ENERGY STAR qualification.

624 **Table 5: Test Methods for ENERGY STAR Qualification**

Product Type or Component	Test Method
All	ENERGY STAR Test Method for Computer Servers, Rev. May 2012

625 6.1.2 When testing Computer Server products, SUTs must have all Processor Sockets populated
626 during testing.

627 **Note:** As stated in the note box in the Common Product Family Attributes definition above, all
628 measurements and data collection shall be made with fully populated sockets. This requirement ensures
629 that systems are tested in configuration that the end-user is most likely to purchase. EPA welcomes
630 feedback on this proposed change.

631 **6.2 Number of Units Required for Testing**

632 6.2.1 Representative Models shall be selected for testing per the following requirements:

- 633 i. For qualification of an individual product configuration, the unique configuration that is
634 intended to be marketed and labeled as ENERGY STAR is considered the Representative
635 Model.
- 636 ii. For qualification of a product family of all product types, one product configuration for each
637 of the five points identified in definitions 1.H)2) within the family are considered
638 Representative Models. All such representative models shall have the same Common
639 Product Family Attributes as defined in 1.H)1).

640 **6.3 Qualifying Families of Products**

- 641 6.3.1 Partners are encouraged to test and submit data on individual product configurations for
642 qualification to ENERGY STAR. However, a Partner may qualify multiple product
643 configurations under one Product Family designation if each configuration within the family
644 meets one of the following requirements:
- 645 i. Individual products are built on the same platform, are eligible under and meet the same
646 specific requirements in this specification, and are identical in every respect to the tested,
647 representative product configuration except for housing and color; or
 - 648 ii. Individual products meet the requirements of a product family, as defined in Section H),
649 above. In this case, partners must test and submit data as required in Section 6.2.1ii.
- 650 6.3.2 Partners are required to submit a Power and Performance Data Sheet for each product family
651 that is submitted for qualification.
- 652 6.3.3 **All** product configurations within a product family that is submitted for qualification must meet
653 ENERGY STAR requirements, including products for which data was not reported.

654 7 EFFECTIVE DATE

- 655 7.1.1 Effective Date: The Version 2.0 ENERGY STAR Computer Server specification shall take effect
656 on August 1, 2013. To qualify for ENERGY STAR, a product model shall meet the ENERGY
657 STAR specification in effect on its date of manufacture. The date of manufacture is specific to
658 each unit and is the date on which a unit is considered to be completely assembled.

659 **Note:** EPA intends to publish the final ENERGY STAR Servers v2.0 specification by November
660 9, 2012.

- 661 7.1.2 Future Specification Revisions: EPA reserves the right to change this specification should
662 technological and/or market changes affect its usefulness to consumers, industry, or the
663 environment. In keeping with current policy, revisions to the specification are arrived at through
664 stakeholder discussions. In the event of a specification revision, please note that the ENERGY
665 STAR qualification is not automatically granted for the life of a product model.

666

667 8 CONSIDERATIONS FOR FUTURE REVISIONS

668

669 8.1 TBD

670

671
672
673

APPENDIX A: Sample Calculations

674
675

Note: This appendix will ultimately include sample calculations for reference in calculating performance levels for products covered in this specification.

676
677
678

679
680
681

APPENDIX B: IDENTIFYING RESILIENT SERVER CLASS

682 **Note:** This appendix describes the feature set for identification of Resilient Servers.

- 683 a) *Processor RAS and Scalability* - All of the following shall be supported:
- 684 (1) *Processor RAS*: The processor must have capabilities to detect, correct, and contain
685 data errors, as described by all of the following:
- 686 (a) Error detection on L1 caches, directories and address translation buffers using
687 parity protection;
- 688 (b) Single bit error correction using ECC on caches that can contain modified data.
689 Corrected data is delivered to the recipient (i.e., error correction is not used for
690 background scrubbing only);
- 691 (c) Error recovery and containment by means of (1) processor checkpoint retry and
692 recovery, (2) data poison indication (tagging) and propagation, or (3) both. The
693 mechanisms notify the OS or hypervisor to contain the error within a process or
694 partition, thereby reducing the need for system reboots; and
- 695 (d) (1) Capable of autonomous error mitigation actions within processor hardware,
696 such as disabling of the failing portions of a cache, (2) support for predictive
697 failure analysis by notifying the OS, hypervisor, or service processor of the
698 location and/or root cause of errors, or (3) both.
- 699 (2) The processor technology used in resilient and scalable servers is designed to
700 provide additional capability and functionality without additional chipsets, enabling
701 them to be designed into systems with 4 or more processor sockets. The processors
702 have additional infrastructure to support extra, built-in processor busses to support
703 the demand of larger systems.
- 704 (3) The server provides high bandwidth I/O interfaces for connecting to external I/O
705 expansion devices or remote I/O without reducing the number of processor sockets
706 that can be connected together. These may be proprietary interfaces or standard
707 interfaces such as PCIe. The high performance I/O controller to support these slots
708 may be embedded within the main processor socket or on the system board.
- 709 b) *Memory RAS and Scalability* - All of the following capabilities and characteristics shall be
710 present:
- 711 (1) Provides memory fault detection and recovery through Extended ECC;
- 712 (2) In x4 DIMMs, recovery from failure of two adjacent chips in the same rank;
- 713 (3) Memory migration: Failing memory can be proactively de-allocated and data migrated
714 to available memory. This can be implemented at the granularity of DIMMs or logical
715 memory blocks. Alternatively, memory can also be mirrored;
- 716 (4) Uses memory buffers for connection of higher speed processor -memory links to
717 DIMMs attached to lower speed DDR channels. Memory buffer can be a separate,
718 standalone buffer chip which is integrated on the system board, or integrated on
719 custom-built memory cards. The use of the buffer chip is required for extended DIMM
720 support; they allow larger memory capacity due to support for larger capacity DIMMs,
721 more DIMM slots per memory channel, and higher memory bandwidth per memory
722 channel than direct-attached DIMMs. The memory modules may also be custom-
723 built, with the memory buffers and DRAM chips integrated on the same card;
- 724 (5) Uses resilient links between processors and memory buffers with mechanisms to

- 725 recover from transient errors on the link; and
- 726 (6) Lane sparing in the processor-memory links. One or more spare lanes are available
727 for lane failover in the event of permanent error.
- 728 c) *Power Supply RAS*: All PSUs installed or shipped with the server shall be redundant and
729 concurrently maintainable. The redundant and repairable components may also be
730 housed within a single physical power supply, but must be repairable without requiring
731 the system to be powered down. Support must be present to operate the system in
732 degraded mode when power delivery capability is degraded due to failures in the power
733 supplies or input power loss.
- 734 d) *Thermal and Cooling RAS*: All cooling components, such as fans or water-based cooling,
735 shall be redundant and concurrently maintainable. The processor complex must have
736 mechanisms to allow it to be throttled under thermal emergencies. Support must be
737 present to operate the system in degraded mode when thermal emergencies are
738 detected in system components.
- 739 e) *System Resiliency* – no fewer than six of the following characteristics shall be present in
740 the server:
- 741 (1) Support of redundant storage controllers or redundant path to external storage;
- 742 (2) Redundant service processors;
- 743 (3) Redundant dc-dc regulator stages after the power supply outputs;
- 744 (4) The server hardware supports runtime processor de-allocation;
- 745 (5) I/O adapters or hard drives are hot-swappable;
- 746 (6) Provides link level retry (LLR) based protection on processor to memory or processor
747 to processor interconnects;
- 748 (7) Supports on-line expansion/retraction of hardware resources without the need for
749 operating system reboot (“on-demand” features);
- 750 (8) Processor Socket migration: With hypervisor and/or OS assistance, tasks executing
751 on a processor socket can be migrated to another processor socket without the need
752 for the system to be restarted;
- 753 (9) Memory patrol or background scrubbing is enabled for proactive detection and
754 correction of errors to reduce the likelihood of uncorrectable errors; and
- 755 (10) Internal storage resiliency: Resilient systems have some form of RAID hardware in
756 the base configuration, either through support on the system board or a dedicated
757 slot for a RAID controller card for support of the server’s internal drives.
- 758 f) *System Scalability* – All of the following shall be present in the server:
- 759 (1) Higher memory capacity: ≥ 8 DDR3 or DDR4 DIMM Ports per socket, with resilient
760 links between the processor socket and memory buffers; and
- 761 (2) Greater I/O expandability: Larger base I/O infrastructure and support a higher
762 number of I/O slots. Provide at least 32 dedicated PCIe Gen 2 lanes or equivalent I/O
763 bandwidth, with at least one x16 slot or other dedicated interface to support external
764 PCIe, proprietary I/O interface or other industry standard I/O interface.