ENERGY STAR® Program Requirements for Computer Servers

Draft 1 Version 2.0

Note: Please note that this Version 2.0 document represents EPA's intended Tier 2 requirements included in the existing Version 1.0 specification.

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ENERGY STAR® Program Requirements for Computer Servers

Draft 1 Version 2.0 Partner Commitments

Commitments

Note: The Partner Commitments section will be expanded in the final specification to include new ENERGY STAR testing requirements and other program changes proposed in the Enhanced Program Plan for ENERGY STAR products. EPA will work with interested stakeholders to develop these new requirements, and will be hosting a series of stakeholder meetings focused specifically on testing. Please visit the ENERGY STAR Web site at www.energystar.gov/mou for additional information on the proposed requirements and planned meetings.

The following are the terms of the ENERGY STAR Partnership Agreement as it pertains to the manufacturing of an ENERGY STAR qualified computer server. The ENERGY STAR Partner must adhere to the following program requirements:

- comply with current ENERGY STAR Eligibility Criteria, defining the performance criteria that must be met for the marketing and sale of an ENERGY STAR qualified computer server and specifying the testing criteria for a computer server. EPA may, at its discretion, conduct tests on products that are referred to as ENERGY STAR qualified. These products may be obtained on the open market, or voluntarily supplied by Partner at EPA's request;
- comply with current ENERGY STAR Identity Guidelines, describing how the ENERGY STAR marks and name may be used. Partner is responsible for adhering to these guidelines and for ensuring that its authorized representatives, such as advertising agencies, dealers, and distributors, are also in compliance;
- qualify at least one ENERGY STAR computer server within one year of activating the computer server portion of the agreement. When Partner qualifies a product, it must meet the specification in effect at that time;

Note: EPA will consider all Partners to be provisional until they have qualified a product under this specification. Once Partner has qualified a server, their organization will be listed on the ENERGY STAR Web site and will be given access to the ENERGY STAR certification and partner logos.

- provide clear and consistent identification of ENERGY STAR qualified computer server families and configurations. Partner must use the ENERGY STAR mark in all of the following ways:
    - the ENERGY STAR mark shall be included on the product specification sheet on the Partner's Internet site where product information is displayed. This mark shall serve as a hyperlink from the manufacturer's specification sheet to the ENERGY STAR Power and Performance Data Sheet for the qualified product configuration or product family;
    - the ENERGY STAR mark shall appear on the ENERGY STAR *Power and Performance Data Sheet*; and
    - the ENERGY STAR mark shall be used to identify qualified Product Families and/or configurations in electronic and printed marketing collateral materials, including but not limited to user manuals, product guides, and marketing brochures.

- work with Value Added Resellers (VARs) of Partner's products to ensure that an ENERGY STAR qualified computer server remains in compliance with ENERGY STAR requirements when sold by the VAR. Any party within the distribution channel of an ENERGY STAR qualified computer server that alters the power profile of a product after its date of manufacture through hardware or software modifications must ensure that the product continues to meet the ENERGY STAR requirements through delivery to the end customer. If the product ceases to meet the requirements, it shall not be marketed or sold as ENERGY STAR qualified;
- if a VAR makes any modifications to a product qualified to this Version 2.0 specification, re-brands the product, and promotes it as ENERGY STAR, the VAR must become an ENERGY STAR Partner and follow the requirements outlined in this Version 2.0 specification;
- provide to EPA, on an annual basis, an updated list of ENERGY STAR qualifying computer server models/families. Once the Partner submits its first list of ENERGY STAR qualified computer servers, the Partner will be listed as an ENERGY STAR Partner. Partner must provide annual updates in order to remain on the list of participating product manufacturers;

Note: Effective March 30, 2010, products may no longer be labeled by manufacturers (including product packaging, product literature, Web sites, etc.) until qualifying product information, including a lab report, is submitted to and approved by EPA.

- provide to EPA, on an annual basis, unit shipment data or other market indicators to assist in determining the market penetration of ENERGY STAR. Specifically, Partner must submit the total number of ENERGY STAR qualified computer servers shipped (in units by model) or an equivalent measurement as agreed to in advance by EPA and Partner. Partner is also encouraged to provide ENERGY STAR qualified unit shipment data segmented by meaningful product characteristics (e.g., capacity, size, speed, or other as relevant), total unit shipments for each model in its product line, and percent of total unit shipments that qualify as ENERGY STAR. The data for each calendar year should be submitted to EPA, preferably in electronic format, no later than the following March and may be provided directly from the Partner or through a third party. The data will be used by EPA only for program evaluation purposes and will be closely controlled. If requested under the Freedom of Information Act (FOIA), EPA will argue that the data is exempt. Any information used will be masked by EPA so as to protect the confidentiality of the Partner;
- notify EPA of a change in the designated responsible party or contacts for computer servers within 30 days.

Performance for Special Distinction

In order to receive additional recognition and/or support from EPA for its efforts within the Partnership, the ENERGY STAR Partner may consider the following voluntary measures and should keep EPA informed on the progress of these efforts:

- consider energy efficiency improvements in company facilities and pursue the ENERGY STAR mark for buildings;
- purchase ENERGY STAR qualified products. Revise the company purchasing or procurement specifications to include ENERGY STAR. Provide procurement officials' contact information to EPA for periodic updates and coordination. Circulate general ENERGY STAR qualified product information to employees for use when purchasing products for their homes;
- ensure the power management feature is enabled on all ENERGY STAR qualified displays and computers in use in company facilities, particularly upon installation and after service is performed;
- provide general information about the ENERGY STAR program to employees whose jobs are

relevant to the development, marketing, sales, and service of current ENERGY STAR qualified product models;

- feature the ENERGY STAR mark(s) on Partner Web site and in other promotional materials. If information concerning ENERGY STAR is provided on the Partner Web site as specified by the ENERGY STAR Web Linking Policy (this document can be found in the Partner Resources section on the ENERGY STAR Web site at www.energystar.gov), EPA may provide links where appropriate to the Partner Web site. The Partner shall comply with the ENERGY STAR Web Linking Policy;
- provide a simple plan to EPA outlining specific measures Partner plans to undertake beyond the program requirements listed above. By doing so, EPA may be able to coordinate, communicate, and/or promote Partner's activities, provide an EPA representative, or include news about the event in the ENERGY STAR newsletter, on the ENERGY STAR Web pages, etc. The plan may be as simple as providing a list of planned activities or planned milestones that Partner would like EPA to be aware of. For example, activities may include: (1) increase the availability of ENERGY STAR labeled products by converting the entire product line within two years to meet ENERGY STAR guidelines; (2) demonstrate the economic and environmental benefits of energy efficiency through special in-store displays twice a year; (3) provide information to users (via the Web site and user's manual) about energy-saving features and operating characteristics of ENERGY STAR qualified products, and (4) build awareness of the ENERGY STAR Partnership and brand identity by collaborating with EPA on one print advertorial and one live press event;
- provide quarterly, written updates to EPA as to the efforts undertaken by Partner to increase availability of ENERGY STAR qualified products, and to promote awareness of ENERGY STAR and its message;
- join EPA's SmartWay Transport Partnership to improve the environmental performance of the company's shipping operations. SmartWay Transport works with freight carriers, shippers, and other stakeholders in the goods movement industry to reduce fuel consumption, greenhouse gases, and air pollution. For more information on SmartWay, visit www.epa.gov/smartway;
- join EPA's Climate Leaders Partnership to inventory and reduce greenhouse gas emissions. Through participation companies create a credible record of their accomplishments and receive EPA recognition as corporate environmental leaders. For more information on Climate Leaders, visit www.epa.gov/climateleaders;
- join EPA's Green Power partnership. EPA's Green Power Partnership encourages organizations to buy green power as a way to reduce the environmental impacts associated with traditional fossil fuel-based electricity use. The partnership includes a diverse set of organizations including Fortune 500 companies, small and medium businesses, government institutions as well as a growing number of colleges and universities, visit www.epa.gov/grnpower.

ENERGY STAR® Program Requirements for Computer Servers

Draft 1 Version 2.0 Eligibility Criteria

Below is the Version 2.0 product specification for ENERGY STAR qualified computer servers. A product must meet **all** of the identified criteria if it is to earn the ENERGY STAR.

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

4) is packaged and sold with one or more ac-ac or dc-dc power supplies; and

5) is designed such that all processors have access to shared system memory and are independently visible to a single OS or hypervisor.

B. Computer Server Types

Note: The definitions in this section are intended to form the basis for a broad taxonomy of server types. This taxonomy will help to clarify those product types eligible for ENERGY STAR qualification and those product types that are explicitly excluded (*Section 2: Qualifying Products*).

A number of stakeholders suggested adding a volume server definition for purposes of comparison with more specialized server types covered by the specification. EPA is aware of possible conflicts with other uses of this term in the industry. For example, IDC includes systems up to $25,000 in their “volume server” category, a price range which likely encompasses a range of specialized server configurations and management/reliability levels. EPA seeks comments on whether a definition for volume servers would be a valuable addition to this Definitions section along with suggested sources to review regarding content.

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).

Note: The proposed revisions to the Managed Server definition are intended to further clarify those product types already covered by the Version 1.0 specification. EPA seeks comments on whether the following additional features should be added to the definition above: remote power control, remote reset, hardware event logging, and remote server cold start capability independent of OS-based management.

2) Blade System: A system comprised of a blade chassis and one or more removable blade servers and/or other units (e.g., blade storage, blade network equipment). Blade systems provide a scalable means for combining multiple blade server or storage units in a single enclosure, and are designed to allow service technicians to easily add or replace (hot-swap) blades in the field.

   i) Blade Server: A computer server that is designed for use in a blade chassis. A blade server is a high-density device that includes at least one processor and system memory but is dependent upon shared blade chassis resources (e.g., power supplies, cooling) for operation.

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

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

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

   iv) Blade Network Equipment: [***TBD***]

Note: Blade storage and network equipment are included to complete the definition for blade systems. These products will not be covered by the computer server specification. EPA welcomes suggested blade network equipment definitions and suggestions for other blade component definitions to be included here.

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

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

   i) designed to accommodate hot-swappable components;

   ii) designed with multiple physical banks of memory and I/O busses;

   iii) provides machine check architecture;

   iv) provides memory fault detection and system recovery (e.g., DRAM chip sparing, extended ECC, mirrored memory);

   v) provides end-to-end bus retry; and

   vi) provides support for on-line modification of hardware resources (“on-demand” features).

Note: A suggestion was made that the definitions for fully fault tolerant and resilient servers include availability metrics. One option from the Harvard Research Group (HRG) is the *Availability Environment Classification* (AEC) system[1], which defines six categories of availability. EPA will consider adopting this provision after reviewing stakeholder feedback. In addition:

- Fully Fault Tolerant Server: Stakeholders noted that there may be server architectures that can meet the reliability needs for fully fault tolerant servers without the need for complete redundancy of all hardware subsystems.
- Resilient Server: Based on stakeholder comments, the definition for resilient server has been revised to include a list of characteristics found in these product types. EPA seeks further stakeholder comment on this new definition and whether any of the features listed might be optional for a server to be considered "resilient."

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

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

6) Server Appliance: A computer server that is bundled with a pre-installed operating system and application software that is used to perform a dedicated function or set of tightly coupled functions. Server appliances deliver services through one or more networks (e.g., IP or SAN), and are typically managed through a web or command line interface. Server appliance hardware and software configurations are customized by the vendor to perform a specific task (e.g., name services, firewall services, authentication services, encryption services, and voice-over-IP (VoIP) services), and are not intended to execute user-supplied software.

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

Note: EPA has revised the HPC definition based on stakeholder concerns with the previous "large scale construct" language in the definition. Specifically, comments noted that HPC systems can include everything from mainframes to clusters of "off-the-shelf" small servers. Stakeholders also suggested that memory bandwidth, design for parallel workloads, and specialized product marketing are distinguishing features of HPC systems.

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

C. Computer Server Form Factors

Note: Form factor definitions have been added to facilitate the development of unique qualification requirements for various configuration types.

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

1 http://www.hrgresearch.com/pdf/HAS%20Forecast%20rpt%20082301%20p.pdf

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

D. Computer Server Components

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

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

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

Note: "Line-voltage" has been added to the dc-dc PSU definition in order to restrict the definition to PSUs that step down high-voltage facility dc power for delivery to the server.

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

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

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

i) I/O Port: Physical circuitry within an I/O device where an independent I/O session can be established. A port is not the same as a connector receptacle; it is possible that a single connector receptacle can service multiple ports of the same interface.

3) Motherboard: The main circuit board of the server. For purposes of this specification, the motherboard includes connectors for attaching additional boards and includes the following components: processor, memory, BIOS, and expansion slots.

4) Processor: The logic circuitry that responds to and processes the basic instructions that drive a server. For purposes of this specification, the processor is the central processing unit (CPU) of the computer server.

5) Memory: For purposes of this specification, memory is a part of a server external to the processor in which information is stored for immediate use by the processor.

6) Hard Drive (HDD): The primary computer storage device which reads and writes to one or more

rotating magnetic disk platters.

7) Solid State Drive (SSD): A disk drive that uses memory chips instead of rotating magnetic platters for data storage.

Note: Definitions for motherboard, processor, memory, hard drive, and solid state drive have been added to this draft since these components are cited in server product family guidelines.

E. Other Data Center Equipment

1) Network Equipment: A device whose primary function is to pass data among various network interfaces, providing data connectivity among connected devices (e.g., routers and switches). Data connectivity is achieved via the routing of data packets encapsulated according to Internet Protocol, Fibre Channel, InfiniBand or similar protocol.

2) Storage Equipment: A system composed of integrated storage controllers, storage devices (e.g., hard drives or solid state storage) and software that provides data storage services to one or more computer servers. While storage equipment may contain one or more embedded processors, these processors do not execute user-supplied software applications but may execute data-specific applications (e.g., data replication, backup utilities, data compression, install agents).

3) Uninterruptible Power Supply (UPS): A device intended to maintain continuity of power to electrical loads in the event of a disruption to expected utility power supply. The ride-through time of a UPS varies from seconds to tens of minutes. UPS designs offer a range of features, from acting as a temporary power source to the load during a power disruption, to conditioning the power reaching the load under normal operation. UPSs contain energy storage mechanisms to supply power to the attached load in the event of full disruption from the utility.

Note: The UPS definition has been moved from Appendix A in Version 1.0 to this Definitions section and updated to align with the recently released framework document for the ENERGY STAR UPS specification development effort. This definition will be revised as appropriate to maintain consistency between the two specifications. For more information on the UPS effort, please visit www.energystar.gov/newproducts.

F. Computer Server Power States

1) Idle State: The operational state in which the OS and other software have completed loading, the computer server is capable of completing workload transactions, but no active workload transactions are requested or pending by the system (i.e., the computer server is operational, but not performing any useful work).

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

Note: As referenced in a discussion question within the Preliminary Draft, EPA has added a definition for active state to prepare for the eventual inclusion of an efficiency rating tool in the Version 2.0 specification. EPA received a suggestion that a sleep mode be defined to account for hypervisor-commanded shut down of virtualized servers or system-level power management. EPA welcomes suggestions and comments on this proposal and will consider adding definitions for additional modes/states if suggested by stakeholders and/or warranted by requirements in future drafts.

G. Other Key Terms:

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

i) start and stop each segment (phase) of the performance benchmark;

ii) control the workload demands of the performance benchmark;

iii) start and stop data collection from the power analyzer so that power and performance data from each phase can be correlated;

iv) store log files containing benchmark power and performance information;

v) convert raw data into a suitable format for benchmark reporting, submission and validation; and

vi) collect and store environmental data, if automated for the benchmark.

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

Note: The controller system and network client definitions have been added to describe elements of an efficiency rating test rig configuration. The definitions reference the *SPEC Power and Performance Benchmark Methodology V1.1.1* and will be updated as necessary.

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

i) *Reliability Features*: Features that support a server's ability to perform its intended function without interruption due to component failures (e.g., component selection, temperature and/or voltage de-rating, error detection and correction).

ii) *Availability Features*: Features that support a server's ability to maximize operation at normal capacity for a given duration of downtime (e.g., redundancy [both at micro- and macro-level]).

iii) *Serviceability Features*: Features that support a server's ability to be serviced without interrupting operation of the server (e.g., hot plugging).

Note: RAS definitions have been added in support of the revised definition for resilient server. EPA has included initial proposals for reliability, availability and serviceability and seeks further comment from stakeholders.

4) Server Processor Utilization: The ratio of instantaneous processor computing activity to full-load processor computing activity at a specified voltage and frequency.

Note: Stakeholders provided several comments regarding the server utilization definition: (1) the use of "maximum ability" is ambiguous, (2) utilization is typically measured by the operating system, a factor that may make utilization reporting more difficult as virtualization disassociates the physical server from OS measurement capability, and (3) "utilization" should refer to the processor rather than to the system, given the structure of subsequent data measurement and output requirements. The definition has been revised to refer to "activity" instead of the more subjective "ability." This is intended to encompass processing of logical instructions. While it is understood that there is no industry standard definition for "utilization", the definition proposed here supports EPA's goal of improving and standardizing the reporting of server efficiency data.

H. System Configuration

1) Product Family: A group of product configurations that is comprised of base components with the same technical and power specifications. In order to be considered a product family for the purpose of this specification, (1) the family may contain only rack-mounted, only pedestal, or only blade servers (not a combination) and (2) **all** product configurations within the product family must include a combination of base components as specified in Table 1.

Table 1: Product Family Component Requirements

Base Component	Same Part Number Required in All Product Family Configurations	Same Technical & Power Specs Required in All Product Family Configurations	Quantity Required in All Product Family Configurations	Notes
Motherboard	YES	YES	Same across family	
Processor	YES*	YES*	Same across family	* Processors must all be from the same model line. * Processors must have the same core count and power specifications. * Processor speed may vary within a product family.
Power Supply	YES	YES	May vary within the product family	
I/O Device	NO	YES	May vary within the product family	
HDD or SSD	NO	NO*	May vary within the product family	* HDD, SSD, and Memory capacity may vary. If so, minimum, typical, and maximum configurations must represent the full range of capacity options.
Memory (DIMM)	NO	NO*	May vary within the product family	

Note: Table 1 presents the various combinations that any one server model may have to be represented under one Product Family. This table is intended as an initial proposal and may be modified based on analysis of data acquired as part of the specification development process and future stakeholder discussions dedicated to the topic of product families. The goal of the family structure in all ENERGY STAR specifications is to balance testing/reporting burden with assurance that qualified products deliver promised energy savings. For servers, EPA aims to ensure disclosure of sufficient test data to cover a range of representative configurations that would be meaningful to an end user who is evaluating a specific product configuration. The following are some significant changes compared to the Version 1.0 specification and reflect initial manufacturer feedback received as a result of the Version 1.0 qualification and administrative process and EPA's evaluation of initial product submittals:

- Part Number: Version 1.0 required that all components in a product family share the same model number. This condition has been relaxed for memory, storage, and I/O components, with Version 1.0 restrictions remaining in place for motherboard, processor, and power supply components.
- Power and Metrics: Version 1.0 required that all product components in a product family share the same power and technical specifications. EPA seeks to assess whether some degree of variation may be allowed while still maintaining confidence that all configurations in a product family are accurately represented by submitted test data. Specifically, EPA is interested in (1) industry practices used to determine component worst-case efficiency and (2) metrics that could identify relative component efficiency for the purpose of modifying family criteria.
- Capacity: To reduce the number of required testing permutations, EPA has proposed an allowance for storage and memory capacity to vary within a product family (e.g., DIMMs with the same power profile may differ in GB/DIMM).

2) Maximum Configuration: A product configuration that includes the combination of base components that generates the maximum possible active mode efficiency within a product family.

3) Minimum Configuration: A product configuration that includes the combination of base components that generates the least possible active mode efficiency within a product family. The minimum configuration must include at least one HDD or SSD and must be representative of an actual product configuration that is currently offered for sale to end users.

4) Typical Configuration: A product configuration that lies between the minimum and maximum configurations and is representative of a product with high volume sales.

5) Base Configuration: A product configuration that does not qualify for additional power allowances. The base configuration consists of:

   i) [***TBD***]

Note: The definitions for maximum and minimum configurations have been revised to reference active mode efficiency. The base configuration definition will be based on the results of an analysis of data collected during specification development.

2. Qualifying Products

2.1. Included Products

A product must meet the definition of a Computer Server provided in *Section 1* of this document to be eligible for ENERGY STAR qualification under this specification. Eligibility under Version 2.0 is limited to blade-, rack-mounted, or pedestal form factor computer servers with no more than four processor sockets. Products explicitly excluded from Version 2.0 are identified in *Section 2.2*.

2.2. Excluded Products

Products that are covered under other existing ENERGY STAR product specifications are not eligible for qualification under the ENERGY STAR Computer Server specification. The list of specifications currently in effect can be found at www.energystar.gov/products.

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

- Fully Fault Tolerant Servers;
- Server Appliances;
- Storage Equipment including Blade Storage; and
- Network Equipment.

Note: The majority of stakeholders recommended limiting the scope of the Version 2.0 specification to pedestal, rack-mounted, and blade servers with no more than 4 processor sockets. EPA intends to continue evaluation of resilient servers for inclusion in Version 2.0. Two additional product categories being considered for inclusion in this specification include multi-node servers and blade servers:

- Multi-node Servers: Stakeholder comments ranged from suggestions that multi-node systems operate "under a significantly different energy profile than the general purpose 1S-4S servers," to the possibility of multi-node systems being addressed by simply dividing the power/performance results of all nodes by the number of operational nodes to calculate a per-node result. EPA intends to include multi-node servers in the scope of the program.

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- Blade servers: Blade servers now proposed for inclusion in this Draft 1 version. The following sections are applicable to blade servers and should be reviewed in regards to ENERGY STAR qualification requirements:

1. *Power supply requirements*: apply to all servers, including blades;
2. *Active mode efficiency requirements and power management*: apply generally to blade servers, along with blade chassis requirements located in *Section 3*;
3. *Standard information reporting and data measurement and output*: apply to blade servers; and
4. *Appendix A*: the test procedure has been revised to detail both a single blade test procedure and partially-populated chassis tests methodology to evaluate chassis power consumption and the blade active mode efficiency.

- Other categories: All other product categories identified in the preliminary draft (>4 socket servers, server appliances, and fully fault tolerant servers) continue to be excluded in this Version 2.0, but may be considered for inclusion in subsequent versions of the specification.

3. Energy Efficiency Criteria

Products must meet the requirements specified below to be eligible for ENERGY STAR qualification under this specification.

3.1. PSU Efficiency Criteria

Note: EPA has added blade system PSU requirements that are equivalent to the PSU requirements for pedestal and rack-mounted servers.

a) Pedestal and Rack-mounted Servers: To qualify for ENERGY STAR, a pedestal or rack-mounted computer server must be configured with **only** PSUs that meet or exceed the applicable efficiency requirements specified in Table 2 **prior to shipment**.

b) Blade Servers: To qualify for ENERGY STAR, a blade server shipped with a chassis must be configured with **only** PSUs included in the chassis that meet or exceed the applicable efficiency requirements specified in Table 2 **prior to shipment**.

Table 2: 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%

3.2. PSU Power Factor Criteria

a) Pedestal and Rack-mounted Servers: To qualify for ENERGY STAR, a pedestal or rack-mounted computer server must be configured with **only** PSUs that meet or exceed the applicable power factor requirements specified in Table 3 **prior to shipment**, under all loading conditions for which output power is greater than or equal to 75 watts. Partners are required to measure and report PSU power factor under loading conditions of less than 75 watts, though no minimum power factor requirements apply.

b) Blade Servers: To qualify for ENERGY STAR, a blade server shipped with a chassis must be configured with **only** PSUs included in the chassis that meet or exceed the applicable power factor

requirements specified in Table 3 **prior to shipment**, under all loading conditions for which output power is greater than or equal to 75 watts. Partners are required to measure and report PSU power factor under loading conditions of less than 75 watts, though no minimum power factor requirements apply.

Table 3: 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

Note: EPA is no longer pursuing Net Power Loss (NPL) requirements for Version 2.0. Stakeholders expressed broad concern with the approach, both in terms of testing burden and the limited understanding of NPL in both manufacturer and end user communities. EPA continues to believe that power supply requirements should take into account the impact of power supply sizing and sourcing practices, and intends to address this in future versions of the specification. EPA also urges further research or pilot programs on NPL to evaluate benefits of the metric to end users.

3.3. Server Power Management Criteria

Note: The provisions in this section replace Table 5 of the preliminary draft specification. All ENERGY STAR qualified servers, including blades, will be required to meet the power management requirement. For blades, EPA intends to require power management to be independent of the chassis selected for installation.

a) Server Processor Power Management: To qualify for ENERGY STAR, a server must offer processor power management that is enabled by default in the BIOS and/or through a management controller or service processor. **All** processors must be able to reduce power consumption in times of low utilization by; (1) reducing voltage and/or frequency through Dynamic Voltage and Frequency Scaling (DVFS), or (2) enabling processor or core reduced power states when a core or socket is not in use.

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

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

3.4. Blade System Criteria

Review of Stakeholder Comments: EPA received detailed stakeholder input on proposed methods to evaluate blade servers and systems. A summary of key issues and proposals is listed below.

Evaluation Method: Stakeholder opinion was divided between (1) adopting the Version 1.0 3S/4S power management requirements for blades, and (2) aligning active mode efficiency requirements with other server types by using an efficiency rating tool.

Unique system efficiency requirements for blades could lead to market confusion if efficiency data under different structures was compared. **Therefore, EPA currently favors Option 2**, since a unified requirements structure will ensure that the same "language" is used to discuss server efficiency, regardless of form factor.

Populating the Blade Chassis: The modularity of blade systems presents a challenge to development of representative test scenarios. Several stakeholders have suggested a combination of tests, including testing a partially populated chassis for efficiency, and testing a single blade as a means to derive chassis power. EPA also received a suggestion to first test a chassis fully populated with minimally-configured blades, and then retest with a single blade to evaluate chassis power.

EPA proposes the following to satisfy the need for a representative test scenario and a moderate testing burden: first, test an individually-metered single blade in a compatible chassis – measure Idle and full power of the blade only. Second, test a chassis 1/2-populated with homogeneous (and representative) blades for qualification purposes. **Active mode efficiency data from the partially-populated test would be used to evaluate blade server efficiency**. If a chassis is tested for qualification, single blade power would be compared with the partially-populated measurements to derive full and idle chassis power. A graphic describing this proposal is available on slide 25 of EPA's presentation from the February 2, 2010 update meeting at the Green Grid Technical Forum and can be found at www.energystar.gov/RevisedSpecs.

Comparing Blades to Other Server Types: Stakeholders suggested either (1) allowing blade servers to compete directly with traditional pedestal and rack-mounted server types or (2) creating a separate category for blade systems.

EPA intends to complete data collection for Blade Systems before making a final determination of blade server categorization for ENERGY STAR. If data indicates that there is an inherent difference between blades and other server types, EPA will consider creating separate requirements for this product type.

a) Blade Chassis Power Consumption: A blade chassis (1) shipped with an ENERGY STAR qualified blade server or (2) marketed for use with an ENERGY STAR qualified blade server must not exceed the sum of the limits for each applicable product feature specified in Table 4 and Table 5.

Table 4: Power Allowances for Blade Chassis in Idle State

Product Feature	Chassis Idle Power Limit (W)
Base Power Allowance	[***TBD***]
Product Feature	**Additional Chassis Idle Power Allowance (W)**
PSU Installed in Redundant Configuration	[***TBD***]
I/O Devices >2 ports of 1 Gbit, onboard Ethernet	[***TBD***]

572 **Table 5: Power Allowances for Blade Chassis at Full Load**

Product Feature	Full Load Power Limit (W)
Base	[***TBD***]
Product Feature	**Additional Full Load Power Allowance (W)**
PSU Installed in Redundant Configuration	[***TBD***]
I/O Devices >2 ports of 1 Gbit, onboard Ethernet	[***TBD***]

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

577 c) Blade Server Shipping Documentation: To qualify for ENERGY STAR, a blade server that is shipped
578 to a customer independent of a blade chassis must be packaged with documentation to inform the
579 customer that the blade server is ENERGY STAR qualified only if it is installed in a blade chassis
580 meeting requirements in *Section 3.4.a)* and *3.4.b)* of this document. A list of qualifying blade chassis
581 and ordering information must also be provided as part of product collateral provided with the blade in
582 either a printed format or an alternative format approved by EPA.

583 **Note:** Stakeholders suggested that minimum ENERGY STAR requirements be set for blade chassis. EPA
584 understands that chassis-level management, cooling, and powering techniques differ widely and have a
585 direct effect on the resulting efficiency of a blade system. Chassis requirements are included to ensure
586 that options are available that allow blade servers to deliver performance with optimal energy efficiency at
587 the system level. Tables 4 and 5 provide base chassis power allowances at Idle and full load, with
588 allowances for redundant power supplies and I/O capability.

589 ▪ Thermal Management: Efficient thermal management can contribute to the overall efficiency of the
590 datacenter. As written, the requirement is specific to fans. EPA is open to suggestions about how to
591 address other efficient cooling technologies (e.g., water cooling, heat pipes) in this specification.

592 ▪ Shipping Documentation*:* The shipping documentation requirement is intended to provide purchasers
593 of independently-purchased blade servers with a list of blade chassis that meet ENERGY STAR
594 requirements. This structure is intended to allow partners to ship ENERGY STAR qualified blades
595 outside of a chassis, while providing guidance to end users who wish to find the most efficient chassis
596 solution for their purchase.

597 EPA anticipates the need to develop power allowances for discrete chassis-level components that are
598 typically integrated in stand-alone servers (e.g., network switches). EPA seeks further comment on Tables
599 4 and 5 as well as test methodology (Appendix A) for blade systems. Once the structure is finalized, EPA
600 will engage stakeholders in a data collection effort with the intent of developing chassis-level power
601 consumption requirements.

3.5. Active Mode Efficiency Criteria

Note: Active mode efficiency is a new component of the ENERGY STAR computer server program. This set of requirements builds upon existing core elements of the program (i.e., power supply efficiency, standard information reporting, and data measurement and output) and supports EPA's overarching goal to provide insight into the energy efficiency of a server as it completes computing tasks.

EPA's objective in including active mode is to institutionalize reporting of server energy efficiency, such that standardized energy efficiency data is available to purchasers by default rather than by special request. To this end, EPA seeks to establish an active mode efficiency rating - applicable to a wide variety of servers and applications - to generate reliable and comparable energy efficiency data. A broadly-accepted tool to produce such an efficiency rating is not currently available. Greater availability of active mode efficiency data, in conjunction with the core ENERGY STAR criteria from the Version 1.0 specification, will provide purchasers with sufficient information to select the most efficient server for their needs.

A broadly-accepted tool to produce such an efficiency rating is not currently available in the marketplace. EPA has been working with the Standard Performance Evaluation Corporation (SPEC) over the past several months to develop a rating tool that can serve this purpose. SPEC (http://www.spec.org/) is an industry consortium formed in 1988 to develop independent and standardized metrics for IT equipment. Besides establishing industry standards for measuring compute performance, SPEC has over three years of experience adapting performance benchmarks to the evaluation server efficiency, and created the first industry-standard server efficiency benchmark, *SPECpower_ssj2008*.

In this specification, EPA is proposing requirements for the disclosure of active mode efficiency data, as generated by the rating tool developed by EPA and SPEC, via the ENERGY STAR Power and Performance Data Sheet.

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

   1) final rating tool results; and

   2) intermediate rating tool results over the entire test run at **all** of the following load levels: [***TBD***].

   Public disclosure and formatting requirements are discussed in *Section 4* of this specification.

b) Incomplete Disclosure: Partners are prohibited from selectively reporting individual workload module results, or otherwise presenting efficiency rating tool results in any form other than a complete test report, in customer documentation or marketing materials.

Note: Background

EPA intends for the active mode efficiency rating tool to be applicable to all products covered under the scope of Version 2.0. A design document for the rating tool will be made available to ENERGY STAR stakeholders by SPEC that describe a broad set of testing considerations including test setup, workload content and structure, data measurement procedures, and data output.

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Acceptance Criteria

For EPA to incorporate SPEC's rating tool, it will need to meet a set of EPA's core standards. EPA recognizes SPEC's existing work to develop power-performance benchmark tools capable of operation on volume servers (including pedestal, rack-mounted, and blade configurations), openness to broad industry participation, and development of general measurement methodologies. EPA is committed to adopting the SPEC efficiency rating tool as an element of the ENERGY STAR specification if the tool meets EPA's acceptance criteria. Acceptance criteria for the tool include:

- architecture and operating system (OS) agnostic;
- provides accurate, repeatable, unbiased results;
- available in an acceptable timeframe to the program;
- provides open access to the underlying testing process, including results from specialized portions of the total workload;
- developed through an open and transparent process with EPA and ENERGY STAR stakeholders, through the ENERGY STAR specification development process.

EPA believes that SPEC's commitment to long-term maintenance of the tool provides an advantage for the program that will allow ENERGY STAR to keep pace with rapid technology advancements in the server industry.

Architecture and OS Considerations for the Rating Tool

EPA has held extensive discussions on the topic of architecture and operating system support. EPA believes that broad architecture/OS support is necessary to ensure fairness and open participation for all computer servers covered by the scope of the ENERGY STAR specification.

EPA received strong feedback from some stakeholders that initial development should focus on support for both x86 and RISC systems. EPA also believes that the effect an operating system has on overall system efficiency should be considered in the ENERGY STAR efficiency evaluation, though under a structured system that supports comparable results and avoids unrealistic super-tuning.

Development of a tool that is both architecture and OS agnostic requires technical input and development resources from interested parties in the stakeholder community. EPA understands that a lack of resources to support either issue might lead to these expectations being unrealized. EPA will closely monitor the development process and participation, and will adjust expectations accordingly. If necessary, EPA will consider alternative approaches, timing options, or alternative benchmark tools. EPA strongly encourages stakeholders to provide feedback these points and encourages a detailed assessment of the SPEC rating tool design document in light of these issues.

Requirement Structure

- Requirement Format: For Version 2.0, EPA intends to require only the disclosure of active mode efficiency ratings. EPA continues to maintain the long-term goal of setting pass/fail efficiency rating criteria in future versions of the specification, however at this point, solely requiring disclosure of standardized active mode efficiency ratings will serve a valuable purpose in the market. EPA believes that efficiency ratings, along with the other ENERGY STAR criteria specified in this document, will provide purchasers with the information they need to help choose the most efficient product for their intended use.

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- Idle Measurement: EPA received several suggestions for how to incorporate Idle into the efficiency rating tool. The Idle component may be addressed by (1) dedicating a portion of the workload to automated Idle testing, or (2) fully incorporating Idle as a factor in the overall system efficiency rating. Stakeholders suggested that full incorporation of Idle would allow Idle power to scale along with the capability of the server. While this approach would reduce the complexity of the specification, EPA does not believe that Idle power should be tied solely to top-level performance, as this could lead to a systematic increase in Idle power consumption over time and dissuade manufacturers from improving efficiency at lower levels of utilization. EPA also received proposals to consider a scaling requirement for server power as an alternative to a cap on Idle power. The objective of this type of requirement is to incentivize manufacturers to design systems with a linear relationship between power consumption and workload performance and near-zero power consumption at Idle. EPA will review this approach in future discussions with stakeholders.

3.6. Additional System Requirements

Note: In the Preliminary Draft Specification, EPA proposed including Energy Efficient Ethernet (IEEE 802.3az) as a requirement for all physical layer Ethernet protocols. Stakeholders commented that approved hardware was not likely to be available for evaluation until after the specification went into effect. In response to these concerns, EPA has removed this requirement in the Version 2.0. However, EPA is interested in finding ways to this protocol once hardware is made available. Therefore, the test procedure includes provisions to engage IEEE 802.3az during the testing of servers supporting the technology (Appendix A, 5.2.6). With this approach, the efficiency benefits of the protocol will be realized during ENERGY STAR testing for systems adopting related hardware. EPA will continue to engage stakeholders regarding the availability of compliant hardware and alternative proposals that encourage adoption of EEE technology in ENERGY STAR servers under a reasonable timeframe.

4. Standard Information Reporting Requirements

A standardized Power and Performance Data Sheet (PPDS) must be published for each ENERGY STAR qualified computer server. The PPDS must be posted on the Partner's Web site alongside information on qualified product configurations.

Partners are encouraged to provide one data sheet for each ENERGY STAR qualified product configuration, though EPA will also accept a data sheet for each qualified product family. A product family PPDS must include data for Maximum, Minimum and Typical configurations as defined in *Section 1* of this document. Whenever possible, Partners must also provide a hyperlink to a more detailed power calculator on their Web site that purchasers can use to understand power and performance data for specific configurations within the product family.

Templates for the Power and Performance Data Sheet can be found on the ENERGY STAR Web site at www.energystar.gov/products. EPA may periodically revise the template, and will notify Partners of the revision process. Partners should always use the most recent version of the data sheet posted to the ENERGY STAR Web site.

Partners are encouraged to use the template provided by EPA, but may also create their own template provided that it has been approved by EPA and contains the following information, at a minimum:

- model name and number, identifying SKU and/or configuration ID;
- system characteristics (form factor, available sockets/slots, power specifications, etc.);
- system configuration(s) (including maximum, minimum and typical configurations for product family qualification);
- power data for Idle and full load, estimated kWh/year, link to power calculator (where available);

- additional power and performance data for at least one benchmark as chosen by the Partner from the EPA list of power-performance benchmarks;

Note: EPA intends to tighten the requirements for disclosure of supplemental power and performance benchmark results. The presence of a refined version of this disclosure requirement is intended to complement the active mode efficiency rating tool by providing users with insight into efficiency under more specific server applications scenarios.

The Version 1.0 specification allowed partners to select their choice of benchmark for disclosure. To further standardize PPDS content for end users, EPA has proposed setting guidelines for benchmarks that may be selected to meet this disclosure requirement. Given the rapid development and revision of benchmarks on the market, it is anticipated that a list of approved benchmarks will be hosted external to the specification to allow for updates outside of the normal specification revision cycle, as necessary. EPA will open a dialogue with stakeholders to discuss benchmarks for consideration. Following are candidate benchmarks that have been identified to date: SPECpower_ssj, SPECweb_power2009, SPEC's planned virtualization benchmark, TPC-C, TPC-E, and RPE2. EPA recommends that any candidate benchmark be evaluated based on (1) presence of an integrated power measurement methodology, (2) applicability to, and widespread use by the end-user community, and (3) applicability to all servers in the ENERGY STAR scope, or at least a full subset of servers intended for a specific end-use application.

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

Note: EPA has added a disclosure requirement for blade servers to provide end users with a list of compatible blade chassis that meet ENERGY STAR requirements. EPA anticipates the need to develop a new version of the PPDS for blade systems. Manufacturers will be provided with a draft of the blade system data sheet for stakeholder review once blade requirements are formalized in future drafts.

5. Standard Performance Data Measurement and Output Requirements

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

Note: The standard data measurement requirements have been revised to include blade servers and are thus applicable to all servers covered by the specification.

It was suggested that pedestal servers be exempt from these requirements on the grounds that many are deployed in small office / home office (SOHO) environments that do not currently make use of real-time performance data. However, EPA is aware of some pedestal servers with capability to operate in standard

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managed data center facilities. Additionally, numerous end users have requested that ENERGY STAR drive wider availability of sustained data measurement throughout the industry. As such, EPA intends to maintain data measurement requirements for pedestal servers.

A stakeholder noted to EPA that server airflow reporting has the potential to improve HVAC efficiency by allowing cooling supply to be matched to actual demand. EPA plans to investigate the addition of airflow reporting requirements, possibly derived from system speed, for a future draft of this specification.

b) Reporting Implementation: To qualify for ENERGY STAR:

- products may use either embedded components or add-in devices that are packaged with the computer server to make data available to end users (e.g., a service processor, embedded power or thermal meter (or other out-of-band technology), or pre-installed OS);
- products that include a pre-installed OS must include all necessary drivers and software for end users to access standardized data as specified in this document. Products that do not include a pre-installed OS must be packaged with printed documentation of how to access registers that contain relevant sensor information;
- when an open and universally available data collection and reporting standard becomes available, manufacturers should incorporate the universal standard into their systems.

c) Measurement Accuracy: To qualify for ENERGY STAR:

- *Input power*: Measurements must be reported with accuracy of at least ±5% of the actual value, with a maximum level of accuracy of ±10W for each installed PSU (i.e., power reporting accuracy for each power supply is never required to be better than ± 10 watts) through the operating range from Idle to full power;
- *Processor utilization*: Utilization must be estimated for each logical CPU that is visible to the OS and must be reported to the operator or user of the computer server through the operating environment (OS or hypervisor);
- *Inlet air temperature*: Measurements must be reported with an accuracy of at least ±2°C.

Notes:

- Input Power: Following stakeholder discussions, the input power measurement accuracy requirements have been revised in response to concerns regarding (1) measurement difficulty at low loads, and (2) the impact of fixed error in systems with more than one PSU. For example, a measurement of 1000 would require an accuracy level of at least ±50 W (5% of 1000 W) while a measurement of 100 W (assuming 100 W is within the idle-to-full power range) would require an accuracy level of at least ±10 W (since 5% of 100 W is below the 10 W threshold).
- Processor Utilization: Requirements are maintained from Version 1.0. Stakeholders noted only limited progress toward standardization of processor utilization measurements across platforms and that research is underway to understand the correlation between utilization and emerging processor features. EPA maintains its goal of providing tools for end users to identify under-utilized servers and to allow for adaptive data center management under virtualized or decentralized workloads, and EPA supports further industry research into processor utilization measurement accuracy.
- Inlet Air Temperature: The accuracy requirement has been changed from ±3°C to ±2°C. EPA received examples of current-generation servers supporting the revised accuracy level.
- Measurement Resolution: EPA has not included requirements for measurement resolution in the specification, and welcomes further stakeholder comment on this topic.

d) Sampling Requirements: To qualify for ENERGY STAR:

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

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

Note: EPA has refined sampling requirements based on stakeholder comments that a rolling average is overly restrictive for temperature measurements since many data centers monitor system information intervals of 15-minutes or more.

The rolling average requirement remains in place for power and utilization requirements, where EPA believes that the frequency of fluctuations in power and utilization are more closely tied to workload activity, and that a high frequency measurement is necessary to identify transient activity. A sampling frequency requirement was also added to the requirements.

The proposals above are based on stakeholder suggestions, though EPA is also considering a suggestion for 10-second sampling for all measurements.

6. Testing

Partners are required to perform tests and self-certify those products or product families that meet the ENERGY STAR guidelines. A representative sample of computer server products shall be tested to ensure that all units will meet ENERGY STAR criteria. Test results must be reported to the EPA, European Commission, or other international governing body using the format set in place by EPA at the time of reporting (e.g., Computer Server Qualifying Product Information (QPI) Form or Online Product Submittal (OPS) tool). The qualification submittal for each product must also include a completed Power and Performance Data Sheet. All testing shall be performed per the ENERGY STAR Computer Server Test Procedure included as Appendix A of this document. Products must meet specified qualification criteria without the assistance of rounding.

Note: EPA has moved all testing criteria to Appendix A for clarity and to allow the Appendix to serve as a stand-alone document.

7. Product Qualification

7.1. Product Family Qualification Requirements

Partners are encouraged to test and submit data on individual product configurations for qualification to ENERGY STAR. However, a Partner may qualify multiple product configurations under one Product Family designation if each configuration within the family meets one of the following requirements:

1. individual products are built on the same platform and are identical in every respect to the tested, representative product configuration except for housing and color; or

2. individual products meet the requirements of a product family, as defined in *Section 1.H.1)*, above. In this case, partners must test and submit power data on a maximum and minimum configuration, as defined in *Section 1.H.2)* and *Section 1.H.3)* of this specification.

Partners are required to submit a Power and Performance Data Sheet for each product family that is submitted for qualification.

All product configurations within a product family that is submitted for qualification must meet ENERGY STAR requirements, including products for which data was not reported.

If a Partner wishes to qualify individual product configurations within a product family that contains non-qualifying products, the Partner must assign a unique identifier to ENERGY STAR qualified product configurations. This identifier must be used consistently in association with qualifying configurations in marketing collateral and on the ENERGY STAR Qualified Product List (e.g., model A1234 for baseline configurations and A1234-ES for ENERGY STAR qualifying configurations).

7.2. Value Added Reseller (VAR) Product Qualification Requirements

Note: EPA plans to closely review the reporting and qualification framework for the Value Added Reseller (VAR) market channel and incorporate a structure for review in future drafts of this specification. EPA intends to develop a structure that maintains the requirement for accurate communication of qualified server offerings with the constraints and characteristics of the channel.

8. Effective Date

The date that products must meet the requirements specified under the Version 2.0 ENERGY STAR Computer Server specification will be defined as the effective date of the agreement. Any previously executed agreement on the subject of ENERGY STAR qualified computer server products shall be terminated effective [***TBD***] for products eligible under the Version 1.0 Program Requirements.

Qualifying and Marking Products under the Version 2.0 Specification: For products eligible for Version 1.0 of the Computer Server program the effective date for this specification is [***TBD***]. For products not previously covered by the program, the specification is effective on [***TBD***]. All products with a date of manufacture on or after this effective date must meet applicable Version 2.0 requirements in order to qualify for ENERGY STAR (including additional shipments of products originally qualified under Version 1.0). The date of manufacture is specific to each unit and is the date (e.g., month and year) on which a unit is considered to be completely assembled.

Grandfathering: When ENERGY STAR specifications are revised, EPA does not automatically grant continued qualification to products submitted under previous specification versions. Any product sold, marketed, or identified by the manufacturing Partner as ENERGY STAR must meet the specification in effect on the date of manufacture of the product.

Note: EPA's goal is to complete specification development under an aggressive timeline to ensure that active mode efficiency data is available to purchasers as soon as possible. Typically, manufacturers are given at least nine months after finalization of a revised specification to transition to the new program requirements. EPA's goal is to finalize the structure of the specification by fall 2010.

One of the primary factors driving this timeline is the completion of the active mode efficiency criteria in *Section 3.5*. While EPA is willing to allow time to investigate methods of evaluating the active mode efficiency of servers, it may be necessary to truncate the efficiency tool development process so that ENERGY STAR can continue to keep pace with the demands of the server market. If a truncated development cycle becomes necessary, EPA will consider adapting existing benchmark resources in the near-term to provide active mode efficiency data using the disclosure approach described in *Section 3.5*. EPA believes that the development and incorporation of active mode efficiency metrics into the ENERGY STAR program will require several iterations through successive specification revisions.

On the following page is a roadmap of anticipated requirements for the Version 2.0 and future specification versions. After Version 2.0 is completed, EPA anticipates ongoing discussions with stakeholders about

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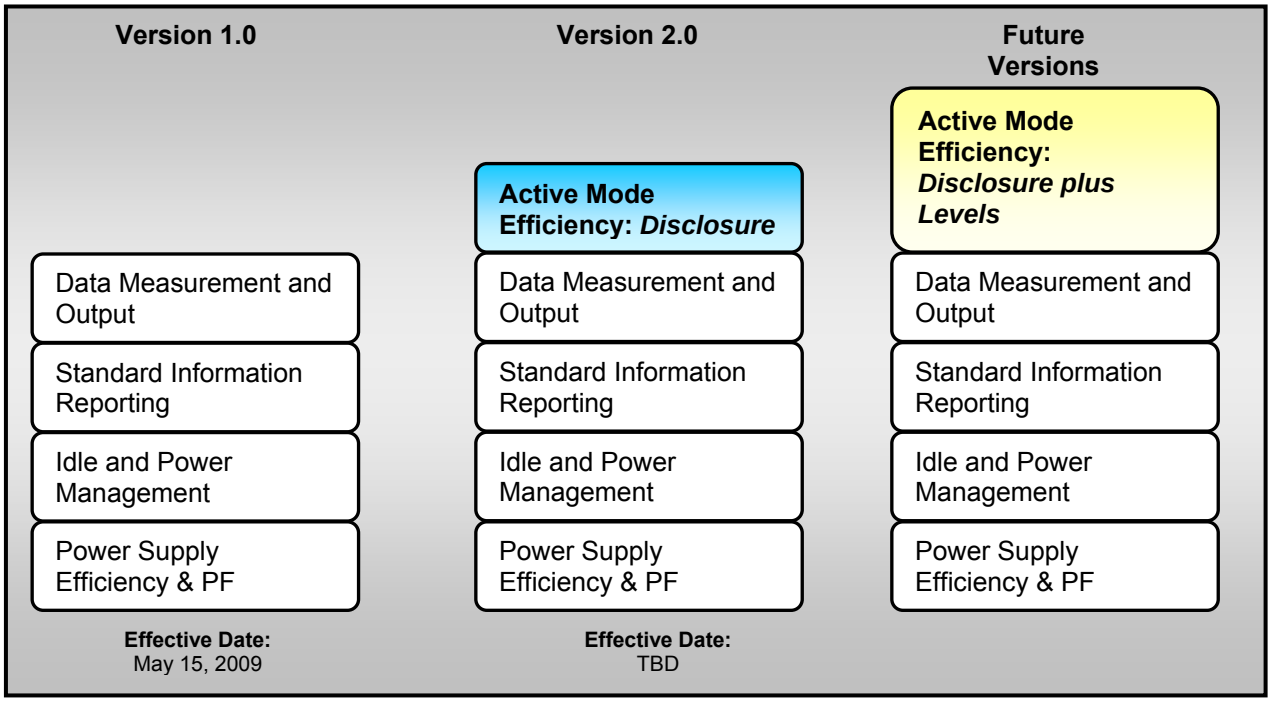
future revisions to the program. One scenario, included in the right column of the diagram, is to use active mode efficiency data generated from Version 2.0 disclosure as a basis for the development of minimum active mode efficiency levels in future specification revisions.



9. Future Specification Revisions

EPA reserves the right to revise the specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to the specification are arrived at through industry discussions. In the event of a specification revision, please note that ENERGY STAR qualification is not automatically granted for the life of a product model. To carry the ENERGY STAR mark, a product model must meet the ENERGY STAR program requirements that are in effect on the date of manufacture of the product.

Appendix A:
ENERGY STAR Computer Server Test Procedure

1. Overview

The following protocol shall be followed when testing products for compliance with the ENERGY STAR Version 2.0 Computer Server specification, and when acquiring test data for completion of the ENERGY STAR Power and Performance Data Sheet.

2. Applicability

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

Note: The requirement to test products in their as-shipped configuration remains in Draft 1 to ensure that test data is as representative as possible of actual product performance.

3. Definitions

Unless otherwise specified, all terms used in this test procedure are consistent with the definitions in the Version 2.0 ENERGY STAR Eligibility Criteria for Computer Servers.

4. Test Setup

4.1. Quality Control

EPA recommends that all testing be conducted in facilities that follow quality control guidelines specified in ISO/IEC 17025, and that all test equipment be annually calibrated by an accredited laboratory.

Note: In limited comments, EPA received support for maintaining the facility quality control requirement with standard provisions recommended rather than required at this stage. A stakeholder noted that some vendors may not be able to equally apply the standard and this flexibility was warranted.

4.2. Reporting

a) Power Measurements: All power measurements shall be recorded in watts, accurate to one decimal place.

b) Temperature Measurements: All temperature measurements shall be recorded in degrees Celsius, accurate to one decimal place.

4.3. Instrumentation

a) Power Analyzer: Power analyzers used for testing must meet the following requirements:

1. capable of measuring true RMS power for all ac sources;
2. current crest factor of ≥ 3 throughout the rated operating range. Analyzers that do not specify current crest factor must be capable of measuring a current spike of at least 3 times the maximum amperage measured during any 1-second sample;

3. frequency response ≥ 3 kHz; and

4. capable of averaging power measurements over any user-selected time interval; or capable of integrating energy over any user-selected time interval with a resolution of 1 second or less.

Note: EPA is aware of power analyzer criteria in place for the SPEC benchmark process. As EPA continues to evaluate the rating tool, this section may be updated to reference additional requirements as necessary to ensure that the requirements support uniform testing.

b) Measurement Accuracy: All measurements must be made with the following accuracy:

1. 0.01 W or better for power measurements of 10 W or less;

2. 0.1 W or better for power measurements of greater than 10 W up to 100 W; and

3. 1 W or better for power measurements of greater than 100 W.

c) Test Conditions

Note: Table 6 is consistent with conditions placed in the preliminary draft and in Version 1.0. During development of Draft 1, EPA received feedback that the voltage tolerance is overly-restrictive for in-situ testing. These requirements are intended to prevent input voltage variations from introducing unreasonable impacts on the test results. EPA will consider these tolerances further should data be provided that shows the impact of supply voltage variation on the results of ENERGY STAR testing. EPA will not accept test voltage variation as a valid explanation for failure of a server in a compliance audit and will maintain the provisions in *Section 4.2*.

Table 6: Test Conditions

	Maximum Server Power Measurement:	**≤1.5 kW**	**> 1.5 kW**
Supply Voltage	Servers with Ac-Dc Single-output PSUs:	230 (± 1%) V ac, 50 Hz or 60 Hz (± 1%)	230 (± 4%) V ac, 50 Hz or 60 Hz (± 1%)
	Servers with Ac-Dc Multi-output PSUs:	230 (± 1%) V ac, 50 Hz or 60 Hz(± 1%) and/or, 115 (± 1%) V ac, 60 Hz (± 1%)	230 (± 4%) V ac, 50 Hz or 60 Hz(± 1%) and/or, 115 (± 4%) V ac, 60 Hz (± 1%)
	Dc Servers:	± 53 (± 1 V) V dc	± 53 (± 1 V) V dc
	Optional Testing Conditions For Ac-Dc Japanese Market†:	100 (± 1%) V ac, 50 Hz / 60 Hz (± 1%)	100 (± 4%) V ac, 50 Hz / 60 Hz (± 1%)
Total Harmonic Distortion (THD) (Voltage)		< 2% THD	< 5% THD
Ambient Temperature	18°C - 27°C		
Low End Moisture	5.5°C Dew Point		
High End Moisture	60% Relative Humidity, 15°C Dew Point		

References:

- IEC 62301: Household Electrical Appliances – Measurement of Standby Power, Sections 4.2, 4.3, 4.4;
- 2008 ASHRAE Environmental Guidelines for Datacom Equipment, Table 1;
- ANSI ATIS-0600315-2007; and
- Generalized Test Protocol for Calculating the Energy Efficiency of Internal Ac-Dc and Dc-Dc Power Supplies – Revision 6.4.2, Section 5.2.

†Note on Japanese Test Voltage: Partners must test standard voltages for products with Single-output or Multiple-output power supplies. However, products sold into the Japanese market may also be tested at the optional 100V testing condition, in addition to the 115V/230V conditions.

5. UUT Configuration

5.1. PSU Test Configuration

Power supplies must be tested for ENERGY STAR qualification using the most recent version of the *Generalized Internal Power Supply Efficiency Test Protocol* maintained by the Electric Power Research Institute (EPRI) and found at http://efficientpowersupplies.epri.com/methods.asp. Testing shall be conducted as follows:

1. Test Conditions: Power supplies shall be tested using the input test conditions specified in *Table 6*. Ac-dc multi-output power supplies capable of operating at both 230 and 115 volts input shall be tested at both input voltages for purposes of ENERGY STAR qualification. Ac-dc multi-output power supplies capable of operating at only one of these indicated voltages must test only at the applicable voltage. Testing at 230 volts may be done at either 50Hz or 60Hz.
2. 10% Loading Condition**:** Single-output power supplies shall be tested at 10% loading in addition to the standard 20%, 50% and 100% loading conditions indicated in the test procedure.
3. Fan Power: When testing Multi-output power supplies, internal fan power must be included in the measurement and efficiency calculation. When testing Single-output power supplies, internal fan power must not be included in the measurement and the efficiency calculation.
4. Efficiency and Power Factor Reporting: Power supplies must meet the levels presented in the Version 2.0 specification without the assistance of rounding. When submitting power supply efficiency and power factor results to ENERGY STAR, manufacturer shall report to the first decimal place (e.g., 85.2%) and three decimal points (e.g., 0.856), respectively.

5.2. Active Mode Efficiency Test Configuration

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

1. Power Supplies: All PSUs must be connected and operational.
2. Power Management and Operating System: The as-shipped operating system or a representative operating system must be installed. Products that are shipped without operating systems must be tested with a representative OS installed. For all tests, manufacturers must ensure that only the power management techniques and/or power saving features which are enabled on shipment are those enabled on systems under test. Any power management features which require the presence of an operating system (i.e. those that are not explicitly controlled by the BIOS or management controller) must be tested using only those power management features enabled by the operating system by default. Partners must include details about OS and power management settings used for ENERGY STAR qualification in all program literature.
3. Storage (HDD, SSD): Products that do not include pre-installed hard drives (HDD or SSD) must have an identical hardware and software configuration as a product that was tested and qualified with at least one installed hard drive; and

4. Blade and Dual/Multi-Node Servers: A Blade or Dual/Multi-Node Server must have identical configurations for each node or blade including all hardware components and software/power management settings. These systems must also be measured in a way to ensure that all power from all tested nodes/blades is being captured by the analyzer during the entire test. If multiple power analyzers are used to monitor the test, each analyzer must meet all required attribute and analyzer conditions set forth in this test procedure.

5. Blade Chassis: [***TBD***]

6. BIOS and UUT System Settings: [***TBD***]

Note: A blade chassis section has been added above to host guidelines on chassis settings, setup, and features engaged during blade testing in order to ensure uniform testing of blade servers.

A system settings provision has been included to host any limited BIOS or hardware optimizations allowable during testing. With the expanded role of software evaluation in Version 2.0, these conditions will establish a consistent testing basis and prevent unrealistic settings from being engaged simply to improve workload performance ("super-tuning"). EPA plans to work with stakeholders to identify a limited list of hardware optimizations allowed for ENERGY STAR testing.

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

Note: This condition has been added to allow the efficiency benefits of hardware compliant with the Energy Efficient Ethernet standard to impact the energy-performance of the tested server.

5.3. UUT Preparation

Note: This section details UUT preparation for active mode efficiency testing of all server types. Included are special considerations for testing of a partially-populated blade chassis for active mode efficiency and testing of a single blade to allow for blade chassis power calculation.

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

1. Record the UUT manufacturer, model name, and configuration details, including; operating system name and version, processor type and speed, installed power supplies, physical memory, hard drive configuration, installed I/O devices, power management features enabled, etc.
    a. When testing a blade server, also record the blade chassis model.
2. Install the UUT in a test rack or location. The UUT shall not be physically moved until testing is complete. If the UUT is a blade system, populate the chassis as follows:
    a. All blade servers installed in the chassis must be identical.
    b. When testing a single blade, install the blade in a top corner position in the chassis.
    c. When testing a partially-populated blade system, populate 1/2 of available chassis bays, rounding up to the nearest whole blade if necessary. Populate bays using the following guidelines:
        i. Fill the top row of the chassis first, then proceeding downward. For partially-populated rows, fill from the center outward. For example, when installing six blades in a chassis with 3 rows and 4 bays per row, four blades must be installed into the top row, and two blades must be installed into the center two positions of the middle row.

d. Fill all empty bays with blanking panels or an equivalent airflow restriction for the duration of testing.

Note: The configuration described above is intended to standardize placement of the Blade Server during testing and represent worst-case thermal conditions for the blade population. EPA welcomes further suggestions on Blade Server placement and temperature considerations.

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

Note: EPA will update this portion of the procedure with specific instructions for controller system setup as necessary.

4. Connect the power analyzers to an ac or dc voltage source set to the appropriate voltage and frequency for the test.
5. Plug the UUT into the measurement power outlet on the power analyzer, as follows:
   a. no UPS units shall be connected between the power analyzer and the UUT;
   b. the power analyzer shall remain connected until all testing is complete;
   c. when testing a single blade server, the UUT shall be metered independently of the blade chassis;
   d. when testing a partially-populated blade chassis, power shall be measured at the input of the blade chassis.
6. Connect the data output interface of the power analyzer(s) to the appropriate input of the measurement server. When testing a single blade, this step is optional if the workload for Idle and full load testing does not require use of a controller system.
7. Install the workload software on the UUT. Record the installed benchmark workload and configuration, including any custom parameters or settings.

Note: EPA will update this step with specific instructions for loading workload and harness software as necessary.

8. Record the input voltage and frequency.
9. Verify that the UUT is configured in its as–shipped configuration.
10. Verify that only those system and hard drive power management features that are enabled upon shipment to a customer are enabled for testing.

6. Test Procedure

6.1. Power and Efficiency Testing

Note: This section contains provisions for the anticipated adoption of an efficiency rating tool. It is preliminary and will be updated to incorporate sequential steps necessary to operate and monitor the rating tool as it completes evaluation of the UUT.

1. Power up the UUT, either by switching it on or connecting it to mains power.

2. If necessary, power up the controller system.
3. Begin recording elapsed time.
4. Between 5 and 15 minutes after the initial boot or log in, set the analyzer to begin accumulating power values at an interval of greater than or equal to 1 reading per second and commence benchmark workload operation.
    a. When testing using a controller system, the controller system may automate data accumulation and benchmark workload operation provided the measurement interval requirements are met.
5. Engage workload operation.
    a. If the workload does not automate measurement of Idle power, between 5 and 15 minutes after the workload has completed operation, accumulate Idle power values for 5 additional minutes and record the average (arithmetic mean) value observed during that 5 minute period. The UUT must maintain an Idle state throughout this period and must not enter lower power states with limited availability (e.g., server sleep or hibernate states).
6. Record the following data at the end of workload operation:
    a. Average Idle power (arithmetic mean);
    b. Full power (the maximum power value measured during benchmark workload operation);
    c. Intermediate and final workload results at all tested load levels, as applicable.

6.2. Chassis Power Testing

1. Complete testing of a representative single blade tested in the selected blade chassis. Average Idle power is defined as $P_{Single\ Blade(Idle)}$, and full power is defined as $P_{Single\ Blade(FullP)}$.
2. Complete testing of the selected blade chassis partially-populated with blades of the same model.
3. Record measured Idle power ($P_{Chassis(Idle,\ 1/2\ populated)}$) and full power ($P_{Chassis(FullP,\ 1/2\ populated)}$) at the chassis power input.
4. Calculate Chassis Power using the following formulas:

$$P_{Chassis(FullP)} = P_{Chassis(FullP,\ 1/2\ populated)} - [\#\ bays\ populated]*[P_{Single\ Blade(FullP)}]$$
$$P_{Chassis(Idle)} = P_{Chassis(Idle,\ 1/2\ populated)} - [\#\ bays\ populated]*[P_{Single\ Blade(Idle)}]$$

5. Proceed with additional efficiency testing.

Appendix B:
Sample Calculations

This Appendix includes sample calculations for the requirements included in *Section 3: Energy Efficiency Criteria.*

Note: EPA will add sample calculations as energy efficiency criteria are formalized. This appendix will likely include calculation examples for blade chassis power, active mode efficiency, and application of additional power allowances.