# ENERGY STAR® Program Requirements for Computer Servers

## Preliminary Draft Version 1.0 Tier 2

## Document Overview

This Preliminary Draft Tier 2 specification builds off the ENERGY STAR Version 1.0 (Tier 1) Program Requirements for Computer Servers to provide the foundation for development of the second tier of ENERGY STAR requirements for Computer Servers. The Tier 2 specification has been planned with the overarching goals of a) enhancing the requirements set forth in Tier 1 and b) providing the means with which to highlight servers that are the most efficient when completing useful work. This document focuses on the enhancement of Tier 1 requirements, while the accompanying discussion guide on active mode rating tool development was created to foster discussion on active mode efficiency.

The guiding principle of the Computer Server program remains to create requirements that serve the needs of the user community as they seek to improve the efficiency of their servers and data centers. As with EPA's other efforts in the data center, this specification will continue to be developed as a means to achieve these goals, encouraging more informed decisions at time of purchase, installation, and operation.

In the pages that follow, each of the main sections of the existing specification will be discussed. The Tier 1 specification contained a number of references on the direction of future ENERGY STAR computer server program requirements. This draft will cover these references and expand with a discussion of EPA's goals, intended approach, and questions aimed at generating discussion regarding proposed approaches. Please note that these questions are not meant to be comprehensive but rather serve as a starting point in EPA's efforts to develop the specification and requirements for Tier 2. EPA welcomes written comments forwarded to servers@energystar.gov.

The Tier 1 specification represented the first set of ENERGY STAR requirements for the Computer Server market; as such, requirements went into effect immediately upon finalization of the specification. For Tier 2, requirements will take effect approximately nine months after the specification is finalized to allow for a smooth transition to the new requirements. This window between specification finalization and the specification effective date is consistent with EPA standard procedures for specification revisions.

Please note that existing specification text initially intended to carry over to the new Tier 2 specification is marked in **gray font** in this document to highlight changes.

# ENERGY STAR® Program Requirements for Computer Servers

## Partner Commitments

## Commitments

EPA intends to maintain the same Partner Commitments that were set forth in the Tier 1 specification.

The following are the terms of the ENERGY STAR Partnership Agreement as it pertains to the manufacturing of ENERGY STAR qualified Computer Servers. 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 ENERGY STAR qualified Computer Servers and specifying the testing criteria for Computer Servers. 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 Servers' portion of the agreement. When Partner qualifies a product, it must meet the specification (e.g., Tier 1 or 2) in effect at that time;

- 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:

    1. The ENERGY STAR mark will be included on the Computer Server manufacturer's Internet site specification sheet where product information is displayed and configurations are provided:
        - This ENERGY STAR mark will also serve as a link from the manufacturer's specification sheet to the corresponding *Power and Performance Data Sheet* for the qualified configuration or Product Family.
    2. The ENERGY STAR mark will be included on the ENERGY STAR *Power and Performance Data Sheet*; and
    3. The ENERGY STAR mark shall be used to identify qualified Product Families and/or configurations in collateral materials, which could include, but not be limited to: user manuals, product guides, marketing brochures, etc.

    If additional information about the ENERGY STAR program(s) or other products is provided by the Partner on its Web site, the ENERGY STAR Web Linking Policy should be followed. The Web Linking Policy can be found in the Partner Resources section on the ENERGY STAR Web site at www.energystar.gov.

- Work with Value Added Resellers (VARs) of Partner's products to help ensure that Computer Servers remain in compliance with ENERGY STAR requirements. 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 before delivering this product to the end customer. If the

product no longer meets the requirements, it may not be marketed or sold as ENERGY STAR qualified.

If a VAR makes any modifications to a product that was previously qualified under this Version 1.0 specification, re-brands the product, and promotes it as ENERGY STAR, it must become an ENERGY STAR Partner and follow the requirements outlined in this Version 1.0 specification.

- provide to EPA, on an annual basis, an updated list of ENERGY STAR qualifying Computer Server models. 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;

- 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 monitors 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;

- 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 http://www.epa.gov/grnpower.

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**Approach**

EPA intends to formalize definitions early in the specification development process. EPA seeks to maintain existing definitions to the extent possible to support consistency with Tier 1 and provide a foundation for further discussion. Additional definitions will be added as suggested and deemed relevant.

Maintaining consistent Tier 1 definitions related to the overall scope of the existing program (*Computer Server, Blade*-related definitions, *Dual-Node Server,* and all existing definitions in the *Component* and *Other Key Term* categories) will help streamline the transition of qualified products from Tier 1 to Tier 2. For remaining definitions and topics on products outside the scope of Tier 1, EPA believes that existing definitions are detailed enough for continued use in Tier 2, but is open to suggested modifications to further clarify program scope. However, one area for further development will be to better cover the whole range of server categories in the *Computer Server Types* section. While not all types will be covered by the requirements in the program, setting forth this taxonomy of product categories will provide a foundation for future versions of the program, better illustrating the effective scope of the server program.

Finally, on page 13 of the Tier 1 specification, EPA noted that a definition for processor/system utilization would be developed, after which an accuracy requirement would be set. A suggested definition has been included in this section, and a formula based on processor utilization has been included in *Section 3.D* to encourage further discussion on the topic.

Where definitions overlap with other in-process ENERGY STAR development efforts, EPA will work to maintain consistency across programs.

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188 **1) Definitions:** Below are definitions of the relevant terms in this document.
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190 A. Computer Server: A computer that provides services and manages networked resources for client
191 devices, e.g., desktop computers, notebook computers, thin clients, wireless devices, PDAs, IP
192 telephones, other Computer Servers and other networked devices. Computer Servers are sold
193 through enterprise channels for use in data centers and office/corporate environments. Computer
194 Servers are designed to respond to requests and are primarily accessed via network connections,
195 and not through direct user input devices such as a keyboard, mouse, etc. In addition, Computer
196 Servers ***must have all*** of the following characteristics:
197
198 • Marketed and sold as a Computer Server;
199 • Designed for and listed as supporting Computer Server Operating Systems (OS) and/or
200 hypervisors, and targeted to run user-installed enterprise applications;
201 • Support for error-correcting code (ECC) and/or buffered memory (including both buffered
202 DIMMs and buffered on board (BOB) configurations);
203 • Packaged and sold with one or more AC-DC or DC-DC power supply(s); and
204 • All processors have access to shared system memory and are independently visible to a
205 single OS or hypervisor.
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208 **Computer Server Types**
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210 B. Blade Chassis: An enclosure containing shared resources for the operation of Blade Servers and
211 Blade Storage units. These resources may include power supply(s) for power conversion, shared
212 storage, and hardware for DC power distribution, thermal management, system management, and
213 network services. A Blade Chassis features multiple slots which can be populated with blades of

different types.

C. Blade Server: A Computer Server consisting of, at minimum, a processor and system memory that relies on shared resources (e.g., power supplies, cooling, etc.) for operation. Blade Servers are designed to be installed in a Blade Chassis, are hot-swappable and are incapable of operating independent of the chassis.

D. Blade System: A system composed of both a Blade Chassis and one or more removable Blade Servers or Blade Storage units. Blade Systems are designed as a scalable solution to efficiently package and operate multiple Computer Servers or Storage units in a single enclosure, and are designed for technicians to be able to easily add or replace hot-swappable Computer Server boards (e.g., Blade Servers) in the field.

E. Direct Current (DC) Server: A Computer Server with one or more DC-DC power supplies which runs directly off of DC power.

F. Fully Fault Tolerant Server: A Computer Server designed with complete redundancy, in which every computing component is replicated between two nodes running identical and concurrent workloads. If one node fails or needs repair, the second node can run the workload alone to avoid any 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.

G. Managed Server: Computer Servers designed for a high level of availability in a highly managed environment. A Managed Server ***must have all*** of the following characteristics:
   - Capability to operate with redundant power supplies; and
   - An installed dedicated management controller (e.g., service processor).

H. Dual-Node Server: A Dual-Node Server consists of two independent Computer Servers (or nodes) contained in a single enclosure and sharing one or more power supplies. The combined power for all nodes is distributed through the shared power supply(s). Dual-Node Servers are designed and built as a single enclosure and are not designed to be hot-swappable.

I. Multi-Node Server: For purposes of this specification, a Multi-Node Server consists of more than two independent Computer Servers (or nodes) contained in a single enclosure and sharing one or more power supplies. The combined power for all nodes is distributed through the shared power supply(s). Multi-Node Servers are designed and built as a single enclosure and are not designed to be hot-swappable.

J. Server Appliance: A self-contained Computer Server system 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, and are not intended to execute user-supplied software. Example services that may be made available via a Server Appliance include: name services, firewall services, authentication services, encryption services, and voice-over-IP (VoIP) services.

K. High Performance Computing System – A server designed to maximize performance in a large scale construct. Although some use base configurations similar to general purpose systems, HPC systems' power management features are typically removed or disabled, and additional architectural features such as massive memory arrays are used to configure a single compute installation. These configurations are generally used for scientific research and large scale modeling.

L. Resilient Server – A server designed with extensive RAS features, including error self-correction to ensure data resiliency and accuracy. Resiliency, RAS, self–correction, and accuracy features are integrated in the micro architecture of the CPU and chipset functions in a Resilient Server. This type of server is generally a four-socket or greater system, with features such as dual-bit

error detection and correction, automated retries and task-level timeout detection, and machine-check architectures, among others.

The definitions for *High Performance Computing System* and *Resilient Server* were added based on initial stakeholder suggestions. EPA will consider the fit for these products within the scope of the server program along with the other product types communicated for further study in the Tier 1 specification.

As noted in the introduction to the definitions section, EPA seeks to better cover the full range of server categories through the definitions in this section. Doing so will help provide a roadmap for the program moving forward and better clarify the scope of the program.

**Other Data Center Equipment**

M. Blade Storage: A storage-specific element that relies on shared resources (e.g., power supplies, cooling, etc.) for operation. Blade Storage units are designed to be installed in a Blade Chassis, are hot-swappable and are incapable of operating independent of the chassis.

N. Network Equipment: A product whose primary function is to provide data connectivity among devices connected to its several ports. Data connectivity is achieved via the routing of data packets encapsulated according to Internet Protocol, Fibre Channel, InfiniBand or similar protocol. Examples of network equipment commonly found in data centers are routers and switches.

O. 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, etc.).

The definition for Storage Equipment will be revised to match the version in the Data Center Storage Specification Framework document. It will be further updated during the development process to ensure consistency.

**Computer Server Components**

P. Computer Server Power Supply Unit (PSU): A self-contained Computer Server component which converts a voltage input to one or more DC voltage outputs for the purpose of powering the Computer Server. The input voltage can be from either an AC or DC source. A Computer Server power supply must be separable from the main computer board and must connect to the system via a removable or hard-wired male/female electrical connection, cable, cord or other wiring (i.e. separate from, and not integrated with, the system motherboard).

Q. AC-DC Power Supply: A power supply which converts line voltage AC input power into one or more different DC outputs for the purpose of powering the Computer Server.

R. DC-DC Power Supply: A power supply which converts a DC voltage input to one or more different DC voltage outputs for the purpose of powering the Computer Server. Any DC-to-DC converters (also known as voltage regulators) internal to the product and used to convert low DC voltage (e.g. 12 Volts DC) into other DC voltages for use by Computer Server components are not considered DC-DC power supplies under this specification.

S. Single-Output Power Supply: A power supply which delivers most of its rated power through one primary DC output for the purpose of powering the Computer Server. Single-Output power supplies may include one or more standby outputs which remain active whenever connected to an input power source. There may be additional outputs besides the primary output and standby outputs, however, the combined power from all additional outputs must be no greater than 20 watts. **Note:** Power supplies with multiple outputs at the primary voltage are considered a Single-

Output Power Supply, unless these outputs are either, (1) generated from separate converters or have separate output rectification stages, and/or (2) have independent current limits.

T. Multi-Output Power Supply: A power supply which delivers its power through more than one primary output, including one or more standby outputs which remain active whenever connected to an input power source. For Multi-Output Supplies, the combined power from additional outputs other than the primary and standby outputs is greater than 20 watts. This definition also applies to power supplies with multiple outputs at the same voltage that do not meet the definition of a Single-Output Power Supply, above.

U. I/O Devices: Devices which provide data input and output capability to the Computer Server from other devices. I/O Devices can either be integral to the main computer board or can be separate devices connected though expansion slots such as PCI or PCIe. Examples of I/O Devices include: Ethernet devices, InfiniBand devices, external RAID/SAS controllers and Fibre Channel devices.

V. 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 receptacle that accepts a single connector can service multiple ports of the same interface.

**Other Key Terms**

W. Idle: An operational state in which the operating system and other software have completed loading and 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 processing any useful work).

X. Server Utilization: A server's measured processor activity relative to its maximum ability in the highest frequency state.

As noted at the beginning of the definitions section, a definition for *Server Utilization* has been included as forecast in the Tier 1 specification. Corresponding accuracy requirements based on processor utilization are located in Section 3.D.

This definition was developed using the proposed definition for $U_{server}$ in The Green Grid's *White Paper 15 – The Green Grid Productivity Indicator*, edited by Christian Belady and contributed to by Mike Patterson.

Y. Product Family: A group of Computer Server configurations where every configuration includes base components with the same or similar technical specifications and power specifications. In order to be considered a Product Family, all configurations must:

- Use the same model motherboard;
- Use the same number of processors. All processors must be represented by the same model line and have identical power specifications and core counts (e.g., processors may vary in speed within the same power specification within a given model line); and
- Incorporate the same model, with the same technical and power specifications, for the base components listed below (the relative numbers of these components may vary within the family):
  - Power supplies,
  - Memory DIMMs,
  - Hard drives (including solid state drives) , and
  - I/O Devices.

  A configuration without add-in I/O Devices may be included in a Product Family with any number of additional I/O Devices included in other configurations. In addition, a configuration otherwise identical to the minimum configuration, but without an internal hard drive may also be included in a product family.

Z. Maximum Configuration: The Maximum Configuration is a highly configured system that includes the combination of power supplies, memory, hard drives, I/O Devices, etc. which provide the maximum possible power consumption within a Product Family.

AA. Minimum Configuration: The Minimum Configuration is a minimally configured system that represents the lowest possible power consumption within a Product Family, for configurations with at least one hard drive. Such a system would typically have the minimum number of power supplies, the least amount of system memory, a single hard drive, and a single I/O Device (either integrated or add-in). The Minimum Configuration must be currently available and sold in the marketplace (i.e. the system shall be minimally configured but not under-configured to a point which is unreasonable).

BB. Typical Configuration: An intermediate configuration between the Maximum Configuration and Minimum Configuration of a Product Family. The Typical Configuration shall be representative of a configuration with high volume sales which contains a typical number of hard drives and I/O Devices, an average amount of installed memory, etc.

CC. Base Configuration: The base configuration is a reference configuration which does not qualify for any additional power allowances. Any applicable components above the level defined by the base configuration may qualify for additional power allowance(s) as described in *Table 4*, below. The base configuration includes:

- One hard drive (or solid state drive),
- Four Gigabytes (GB) of system memory,
- The minimum number of power supplies required to operate the Computer Server (i.e. no redundant power supplies), and
- Two ports of 1 Gigabit (Gbit), onboard Ethernet.

**Discussion Questions**

1. What additional terms and definitions should be added to the Tier 2 specification? What is the anticipated effect (if any) on existing program scope and requirements?
2. Are changes to existing Tier 1 definitions suggested for Tier 2? What developments or factors should EPA be aware of that suggest the change? What is the anticipated effect (if any) on existing program scope and requirements?
3. With the goal of defining a broad taxonomy of server categories in the *Computer Server Types* section, what server categories are missing from the current list provided? Do the definitions define a continuum of categories present on the market? Are existing definitions clear enough to avoid overlap between categories?
4. Are there any other sources that the EPA should review for variations of, or additions to, this list of definitions?
5. As “Active Mode” is an anticipated area of effort for Tier 2, are there any standardized or agreed to characteristics that could be referenced as building blocks of an Active Mode definition?

## 2) Qualifying Products:

EPA intends to review additional product types for inclusion in the Tier 2 specification as previously communicated. EPA's intent remains to have widest reasonable/feasible scope under the general definition of Computer Server, allowing the manufacturer community to qualify a diverse array of products that fit primary definition. Specific server types noted for further investigation include *systems with greater than four sockets, Blade Systems, Fully Fault Tolerant Servers, Server Appliances, and Multi-Node Servers*.

Stakeholders have communicated to EPA that the majority of the market is covered by 1S, 2S, and 4S servers in rack, pedestal, and blade configurations. This is largely the same scope as present in Tier 1, with the addition of blades. Because broad coverage remains ideal for the program, EPA will consider information on server types outside of this range before determining a final scope for Tier 2.

A Computer Server must meet the definition provided in Section 1.A to be eligible for ENERGY STAR qualification under this specification.

In addition to those products that do not meet the strict definition provided in Section 1.A, the following product types (as defined in Section 1, above) are **explicitly ineligible** for ENERGY STAR qualification:

- ***TBD***

**Approach: *>4 Socket Servers, Server Appliances, Fully Fault Tolerant Servers, and Multi-Node Servers***

*>4 Socket Servers*, *Server Appliances*, *Fully Fault Tolerant Servers*, and *Multi-Node* servers were identified as possessing high complexity, unusual characteristics, and low relative market share during Tier 1 development. As a result, these product categories were not a focus of requirements or scope. As noted in Tier 1 Draft 4, EPA is with Tier 2 revisiting these product categories in this preliminary draft to seek stakeholder comments. An assessment of stakeholder level of interest will be valuable as EPA considers these product areas, as will information on increasing market share, available data and test procedures, and clear opportunities to improve product energy performance. Below is a review of each of these product categories and the process through which they were originally considered by the program.

- >4S Servers: In initial conversations with stakeholders, servers falling into this range were identified as beyond the Tier 1 focus on capturing the volume server segment of the market. To investigate this category, EPA is interested in information on relative market share for servers with more than four processor sockets and anticipated trends in the market for the category.
- Server Appliances: This category was ultimately excluded from the scope of Tier 1. Server appliances provide very specific services to their customers and are highly customized. Challenges to inclusion of this product category in Tier 2 include comparing server appliances that have highly specialized uses and evaluating the active efficiency of these products given that they may not be capable of running an efficiency rating tool developed for general purpose servers. To consider server appliances further, EPA will consider the level of stakeholder interest, data on substantial differentiation in product energy performance, the relevance of comparing products with divergent and specialized end uses together, and data on savings potential.
- Fully Fault Tolerant Servers: This category was defined in Tier 1 as an exclusionary measure. The highly specialized nature of these products, small market share (as communicated to EPA), and divergent reliability profile from other servers were noted as challenges. EPA seeks data to investigate the efficiency impact of higher reliability in these systems and to revisit the challenges to including these servers in the ENERGY STAR program.
- Multi-Node Servers: Similar to Fully Fault Tolerant Servers, the Multi-Node category was defined to clearly delineate the category from blade servers and was out of scope in Tier 1. EPA seeks stakeholder comment on continued exclusion of the Multi-Node Server category as defined in Section 1.

**Discussion Topics: > *4 Socket Servers, Server Appliances, Fully Fault Tolerant Servers and Multi-Node Servers***

1. Is there new information on any of these categories (increased market share/interest, test procedure availability, comparable sets of products, market differentiation/energy savings potential) that supports further investigation by ENERGY STAR?
2. EPA received an initial suggestion that the Tier 2 specification continue to focus on volume servers (1S, 2S, or 4S general purpose servers in rack, pedestal, blades, or chassis form factors). With the exception of addressing blade servers, this suggested scope is similar to the initial tier of the program, and includes the majority of products on the market. Are there suggested areas of the market outside of this scope – including the four product classes noted above – that have a critical mass of products to allow effective comparison, represent a large source of energy-saving opportunity, or otherwise present an opportunity for ENERGY STAR to differentiate the market?
3. What is the relevance of servers described by the new definitions for *Resilient Servers* and *High Performance Computing Systems* to the overall scope of the ENERGY STAR Computer Servers program?

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**Approach: *Blades***

Of the product categories included above, blade servers were investigated in the most detail during Tier 1 development. EPA carried out a data collection effort after the Tier 1 Draft 4 specification was released. At that time, power consumption data was requested for a variety of product configurations: an empty blade chassis, a chassis with a single server bay populated, a chassis with half of the available bays populated, and a fully populated chassis. Unfortunately, insufficient data was received and requirements and test procedures for blade servers could not be finalized in time for Tier 1. In subsequent conversations, EPA was informed that data may not routinely be collected for anything but fully-populated chassis configurations and at the per-blade level.

EPA intends to re-engage the discussion of addressing blade servers in the ENERGY STAR program. Following is a brief summary of EPA's goals for blades in the program, initial proposals under consideration, and impact on program schedules.

Options for Blade Servers

As Tier 2 development commences, EPA is considering two options for inclusion of blade servers in the program, namely:

- *Development of a short-term evaluation method for blades to allow for qualification under expanded Tier 1 requirements*. Should test procedures and data analysis be finalized before the rest of the components of the specification, blade server requirements could be added to the Tier 1 scope and be eligible for qualification prior to finalization of Tier 2. This would enable the program to immediately address a greater portion of the server market, but would also be complex and difficult to implement under a compressed timeline.
- *Extended development of requirements for blades under the full Tier 2 development schedule.* As a new product category, Blades would be eligible for qualification immediately upon finalization of the Tier 2 requirements and not be subject to the nine month transition schedule in place for the other categories in the program. An important consideration would be how blades could be evaluated using an Efficiency Rating Tool or active mode approach should one be included for the other product types.

Specification Structure: Comparing Servers across Categories

An important consideration in the decision for including blade server requirements is how to best structure the blade server requirements with respect to those for pedestal/rack mount servers. While continuing to believe that a fair comparison between these architectures and form factors is possible, EPA understands that the decision to move to a blade architecture involves comparison against a series of standalone servers, not a one-to-one comparison. Accordingly, it might become important to avoid out-of-context comparison between these product architectures. A comparison would require that test conditions be standardized from blade to blade, and that power and cooling infrastructure present in a blade configuration is compared fairly with the integrated power and cooling found in standard servers.

Goals for Blades in the ENERGY STAR Program

The modularity and adaptability of blade servers is often cited as an efficiency benefit for the datacenter, as is the shared infrastructure of the blade chassis. This benefit, however, complicates comparison between competing blade implementations. End users may be presented with competing ROI analyses on the same products, each with a different result. EPA aims to standardize test conditions and assumptions about power/cooling overhead such that the ENERGY STAR test procedure, conditions, and results can be trusted by end users as the foundation with which to make an informed procurement decision.

Initial Proposals for Blade Evaluation

- *Further Investigation Using Tier 1 Data Collection Structure*. As initially proposed in Tier 1, development would focus on allowing blade servers to be compared using similar requirements to those present for other servers already in the program. Blades would need to meet Power Supply, Active Power, Standard Information Reporting, and Data Measurement and Output requirements. Evaluation of this approach would require analysis of the differences in chassis performance with respect to the number of installed blades.

[*Continued on next page*]

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- *Fully-Populated Chassis*. A stakeholder proposed the following approach during and after completion of Tier 1. For Active Power under Tier 1 requirements, no blades (including 1S and 2S) would be required to meet idle criteria, but instead would be required to meet the power management criteria and report power consumption for both the blade server (at minimum, maximum & typical configuration) and a blade chassis fully populated with minimally-configured blade servers. This approach would generate the contribution to idle power of each blade, along with an expected "overhead" power contribution at the chassis level. This approach would be intended to standardize data collection to allow for meaningful comparisons, but would involve basic assumptions about how blade chassis are typically populated at time of purchase.

**Discussion Questions: *Blades***

1. What efficiency/power/performance information do purchasers routinely request when investigating a new blade system? Do these requests change at all if the purchase is intended to replace standalone servers rather than other blades?
2. What efficiency/power/performance information would be useful to blade purchasers that is *not* routinely requested that could influence the provisioning process?
3. What assumptions must typically be reported when marketing comparative blade performance and efficiency?
4. Regarding infrastructure overhead (power distribution/supply, cooling), how can the most efficient implementations be identified? What assumptions are fair/relevant to ensure fair comparison?
5. Given the server focus of this specification, what are ways that blade storage and network equipment could be addressed to create stable testing conditions between competing implementations?
6. Is analysis at the chassis level a valid approach to determining requirements for blades?
7. Are there any anticipated purchasing practices when a user moves to a blade architecture (e.g. customers typically purchase blade chassis fully populated, half populated, etc.)?

**3) Efficiency Requirements for Qualifying Products:** A Computer Server must meet all the requirements provided in Sections below, to qualify as ENERGY STAR.

## Tier 2 Requirements: Effective Oct 15, 2010

### A. Power Supply Efficiency Requirements

**Approach**

In preparing this Preliminary Specification, EPA conducted an initial investigation of a Net Power Loss (NPL) approach for Computer Server power supplies. Among the driving factors for an NPL approach are that the existing power supply efficiency approach requires power supplies to perform efficiently in power ranges where they may not operate (e.g., 100%), can give insufficient attention to where they do operate, and ignores the benefits and impacts of right-sizing, redundant power supply installations, and multiple power supply installations.

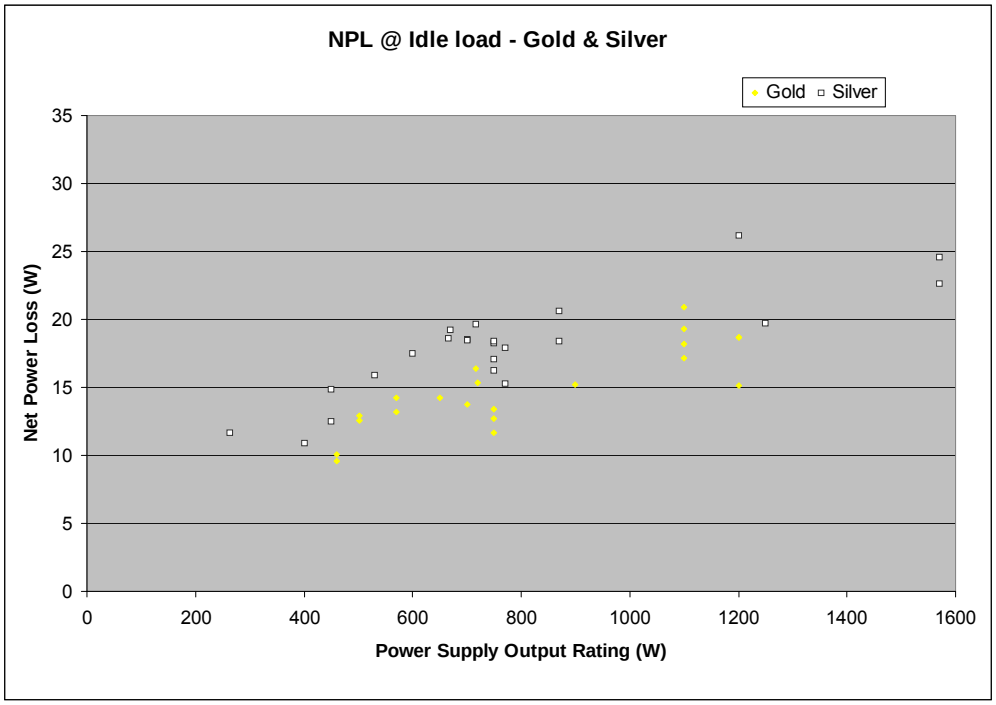
An NPL approach would specify a maximum allowed power loss through the power supply at actual operating conditions of the Computer Server (e.g., Idle and full load power). The existing Tier 1 requirement and reporting structure already requires measurement of power at Idle and full load operating conditions. This would present an opportunity for an additional measurement of NPL to be taken as an added step to the existing test procedure. Alternatively, a power loss curve (losses vs output level) could be derived from pre-existing power supply efficiency data, with the idle and full load operating conditions used to derived expected net losses from the supplies.

[*Continued on next page*]

EPA considered a number of factors related to NPL as part of initial analysis:

- Scaling power loss with load is essentially equivalent to specifying efficiency;
- Installing multiple or redundant power supplies in a server compounds power supply losses, an effect not highlighted by efficiency requirements based on single power supplies;
- Since efficiency levels are expected to be greater at higher load points, NPL has an inverse relationship with system utilization; and
- Efficiency is a well-understood and established metric for understanding power supply energy performance.

Attention was focused on analyzing losses for single supplies, under the assumption that losses would multiply in multi-supply scenarios and be straightforward to consider based on the single supply analysis. NPL and efficiency curves were created for the current single-output Climate Savers/80Plus power supply database. Silver and Gold level supplies were used with output values <1500W, with levels extrapolated below the 10% load point if necessary. To map expected losses at Idle and Max power, power data from October 2008 data on servers operating SPECpower_ssj was used to calculate an expected value for each condition. Results for Idle = 126W and Full = 211.76W are plotted below.

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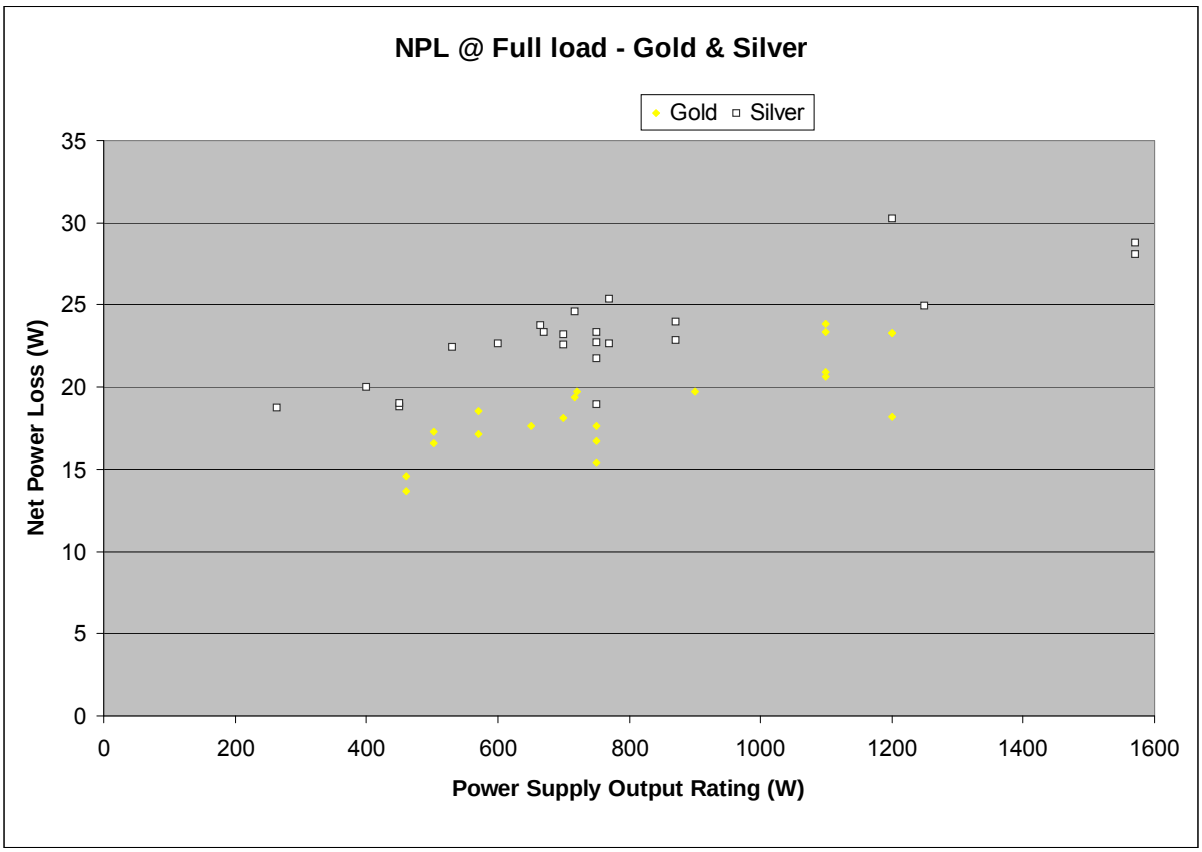


In these two charts, the variability at specific power supply load points between maximum and minimum losses was in the single watts. Additionally, the Silver/Gold efficiency essentially dictated losses at any specific power supply output level, with most of the variability occurring between Silver and Gold categories rather than within each category. While the difference in losses between the best and worst performing power supplies was around 15W, manufacturers in discussion with EPA have advised that the comparison points where this occurs – between ~400W and ~1200W rated supplies – does not represent a typical PSU for a given 1S/2S/4S server. Finally, changing the idle load point to a much lower level (50W) changed the difference between maximum and minimum by only a few watts.

Based on this review, EPA proposes continuing to address power supply requirements in terms of efficiency and power factor, revising efficiency levels as noted below. Additionally, NPL *reporting* at Idle and full load as part of a revised *Power and Performance Datasheet* would be required, using measured power consumption for Idle and full load to derive test points at which system power supply losses for the system would be reported in its as–shipped configuration. NPL reporting would be required using the same family/configuration structure that currently governs creation of P&P Datasheet. This combined approach supports industry's continued work to develop and market more efficient power supplies for servers while providing end users with information on the impact of power supply choice on power profiles and utility costs, information for which an NPL approach is best suited.

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All power supplies used in Computer Servers eligible under this specification must meet the minimum efficiency requirements presented in *Table 1*, below.

**Table 1: Efficiency Requirements for Computer Server Power Supplies**

| 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% |

*Multi-Output Efficiency Requirements:* The revised requirements in *Table 1* for power supply efficiency reference CSCI Silver levels for Multi-Output power supplies. This corresponds to target requirements for July 2009 for CSCI. Despite the apparent incongruity with the anticipated Tier 2 timeline, Silver Multi-Output supplies represent only 7% of the current database of available supplies and the additional year of development time should allow for greater market penetration and additional products on the market for selection by server manufacturers.

*Single-Output Efficiency Requirements:* The Single-Output requirements reference CSCI Gold levels for 20/50/100% load. Additionally, the Single-Output requirements have been condensed to a single level. This eliminates the lower Tier 1 efficiency requirement for Single-Output power supplies less than or equal to 1000 W output. These efficiency levels correspond to CSCI target levels in 2010, prior to the anticipated effective date of the Tier 2 Server specification. In addition, Gold Single-Output supplies currently represent 41% of the approved supplies in the database, just less than the percentage for Silver, more than 6 months before the new CSCI requirements become effective.

In addition, power supplies must meet the minimum power factor requirements **for all loading conditions presented in *Table 2*, below, where the output power is greater than or equal to 75 watts.** Manufacturers are still required to measure and report power factor values for applicable loading conditions less than 75 watts to qualify for ENERGY STAR.

**Table 2: Power Factor Requirements for Computer Server Power Supplies**

| Power Supply Type | Rated Output Power | 10% Load | 20% Load | 50% Load | 100% Load |
|---|---|---|---|---|---|
| DC-DC (All) | All Output Levels | N/A | N/A | N/A | N/A |
| AC-DC Multi-Output | All Output Levels | N/A | 0.80 | 0.90 | 0.95 |
| AC-DC Single-Output | ≤ 500 watts | N/A | 0.80 | 0.90 | 0.95 |
| | > 500 - 1,000 watts | 0.65 | 0.80 | 0.90 | 0.95 |
| | > 1,000 watts | 0.80 | 0.90 | 0.90 | 0.95 |

EPA received early comments that the existing power factor levels from Tier 1 remain stringent requirements. *Table 2* has not been modified.

**Discussion Questions**

1. What is the current level of availability for power supplies meeting the proposed efficiency levels?
2. What level of effort will be required to comply with the NPL Calculation and Measurement? Are there implementation issues or concerns the EPA should consider with this approach?

## B. Active Power Requirements

**Approach**

Assessment of active mode across a broad range of operating conditions is an important goal of the Tier 2 specification. The Tier 1 specification set the stage for this effort with Active Power requirements that centered on idle power limits for 1-Socket and 2-Socket server, power management requirements for 3-Socket and 4- Socket servers, and mandatory reporting of idle and max load power.

For Active mode requirements moving forward, EPA will investigate two general options *in parallel* for Tier 2 requirements:

1) *Refined idle requirements* - As communicated in the Tier 1 specification, EPA will take a renewed look at idle requirements, including application of idle requirements for all Computer Server types covered by the specification. In addition, EPA will consider power management as a requirement across all server types.

   EPA anticipates the following steps for investigation of Idle requirements:
   - *Refinement of the Appendix A test procedure*. EPA will accept comments on the existing test procedures, both from ENERGY STAR Partners qualifying servers under Tier 1 requirements and received in response to the Tier 2 draft process. These suggestions will be evaluated for incorporation into updates of the Tier 2 methodology.
   - Once the test procedure has been finalized, EPA will initiate data collection for Idle on all servers, (including 3S and 4S servers not subject to idle criteria in Tier 1) to enhance the existing Tier 1 data set for further analysis. Updates will be provided to stakeholders when this process is ready to begin.

2) *Active mode efficiency rating tool* – EPA's initial thoughts on development of an "active" mode rating tool for server energy efficiency are summarized in an accompanying discussion document. It is EPA's intent that even under an active mode rating system, Idle will remain present as a disclosure requirement. EPA encourages a review of the discussion document and welcomes comments from stakeholders on proposed approaches. Comments will also be collected in the September 25th stakeholder workshop, where this topic will be a prominent portion of the meeting.

This dual approach will set the stage for transition to full active mode efficiency requirements while generating a robust data set on which provisional Tier 2 Idle State requirements would be set, should they be warranted.

**The specification text following this note references Idle requirements to illustrate how a provisional approach noted in #1, above, would be implemented; a structure to implement active mode rating tool requirements would appear in this section if available**.

Table 3 includes continued use of Tier 1 requirements for 1S and 2S servers. For these server types, EPA believes that these levels should continue to serve as a baseline given that Tier 1 criteria are still new, with server submittals continuing to arrive. Upon availability of more submittal data, and data collected as part of the draft development process, levels will be adjusted accordingly.

Placeholders are included for servers with greater than or equal to 3 sockets. Lastly, a placeholder column for blade servers is included; these requirements will be modified based on finalization of the blade test procedure and data collection.

**1. Idle Power Requirements:** Products must meet the power management requirements detailed below and be tested as shipped.

Maximum Idle power consumption requirements are included in *Table 3* and *Table 4*, below. Maximum allowable levels are based on the components installed in the system. **Please note the following:**

- Categories for Idle power limits are defined based on processor sockets in the system, regardless of the number of processors (e.g., a three or four socket system with only one or two processors installed would not be subject to this requirement); and
- All quantities in *Table 3* and *Table 4* refer to the number of components installed in the system, not the maximum number of components the system can support (e.g. installed processors, not processor sockets; installed memory, not supported memory; etc.).

During Tier 1 development, EPA received suggestions noting that higher numbers of cores resulted in greater performance opportunity in active mode and therefore a more energy efficient solution for servicing the same workload when compared to a corresponding increase in the number of discrete processors. EPA continues to believe that the best indicator of base Idle level for servers is the number of discrete processors, and not the total number of cores, a conclusion supported by the Tier 1 dataset. EPA also anticipates that active mode efficiency metric development will help investigate the suggested operational efficiency benefits of higher core count technology.

*Table 3* presents the Idle power allowance for base or lower configurations. Categories designated for Managed Servers are applicable to Computer Servers meeting the definition for Managed Servers in Section 1.G, above. Any Computer Server not meeting the definition for Managed Servers (i.e. "Standard" servers) must meet the Standard Server levels in the applicable category based on Installed Processor characteristics.

**Note:** The levels provided in *Table 3* below are for Computer Servers that must be tested and qualified with a minimum of one hard drive. Computer Servers sold without a hard drive may still qualify as ENERGY STAR if the configuration was originally tested and qualified with a single hard drive installed. In this case, the qualified configuration when shipped without a hard drive may also be marketed and sold as ENERGY STAR.

**Table 3: Base Configuration Idle Power Requirements**

| Computer Server Type | Idle Power Limit (W) | Idle Power per Blade (W) |
|---|---|---|
| ***Single and Dual Processor Socket Computer Servers (1S & 2S)*** | | |
| Category A: Standard Single Installed Processor (1P) Servers | 55.0 watts | ***TBD*** watts |
| Category B: Managed Single Installed Processor (1P) Servers | 65.0 watts | ***TBD*** watts |
| Category C: Standard Dual Installed Processor (2P) Servers | 100.0 watts | ***TBD*** watts |
| Category D: Managed Dual Installed Processor (2P) Servers | 150.0 watts | ***TBD*** watts |
| ***Triple and Quad Processor Socket Computer Servers (3S & 4S)*** | | |
| ***TBD*** | ***TBD*** watts | ***TBD*** watts |
| ***Greater than 4 Socket Computer Servers (>4S)*** | | |
| ***TBD*** | ***TBD*** watts | ***TBD*** watts |

*Table 4* presents additional Idle power allowances for Computer Servers with additional capabilities above that of a base configuration. The maximum Idle power level should be determined by applying as many additional power allowances as are appropriate.

**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[1] | ***TBD*** |
| Additional Hard Drives (including solid state drives) | Installed hard drives greater than one | ***TBD*** |
| Additional Memory | Installed memory greater than 4 GB[2] | ***TBD*** |
| Additional I/O Devices | Installed Devices greater than two ports of 1 Gbit, onboard Ethernet [3] | ***TBD*** |

**Table 3 and 4**: The format of Tables 3 and 4 have been revised to combine idle requirements for all product categories. As forecast in the Tier 1 requirements, EPA will investigate Idle for servers with greater than 2 processor sockets should provisional Idle requirements be necessary. All Idle Levels are to be determined pending collection and analysis of data.

**Additional Idle Power Allowances**: EPA will reinvestigate the allowances based on data received for related components and the existing I/O dataset. As an example, a stakeholder presented recent data on the power requirements for memory, which they believed could help inform the development of a power allowance for Tier 2.

*** Notes on Additional Power Allowances:**

1. Idle power allowances are granted for power supplies **in addition to** the minimum number needed to operate the Computer Server. For example, if a Computer Server requires two power supplies to operate, and the configuration includes three power supplies, the server would receive an additional 20.0 watt Idle power allowance. If the same server were instead shipped with four power supplies installed, it would receive an additional Idle power allowance of 40.0 watts.
2. For the purposes of determining Idle power allowances, all memory capacities shall be rounded to the nearest GB.
3. Idle power allowances are granted for all I/O Devices over the base configuration listed in Section 1.Z, including all add-in devices installed through expansion slots and all onboard devices above the base configuration.
4. I/O Device allowances are dependant on the rated link speed of a single connection, with speeds rounded to the nearest Gbit. Devices with speeds less than 1 Gbit do not qualify for any additional I/O Device allowances.
5. In order to claim an additional allowance, I/O Devices must be active (enabled) upon shipment and must be capable of functioning when connected to an active switch.

To determine the maximum Idle power consumption levels for ENERGY STAR qualification, manufacturers shall use the base configuration Idle level from *Table 3*, based on installed processors and level of manageability, and then add power allowances from *Table 4*, where appropriate. An example is provided in *APPENDIX B*.

To enhance clarity of the requirements of Section 3, an Appendix B has been added to compile all calculation examples.

**Dual-Node Servers:** Dual-Node Servers with one or two sockets per node must meet the above Idle power levels on a per node basis, provided each node in the system is identical in configuration and uses identical components. In this case, the Idle power per node would be found by measuring the combined Idle power of the whole unit (including both Computer Server nodes), as outlined in the Idle power test procedure in Appendix A of this specification, and dividing that total Idle power by two. For example, if two Computer Server nodes share a single power supply, the combined Idle power of the two Computer Servers (measured through the single power supply) would be measured and then the result would be divided by two. The resulting Idle power per node would need to meet the requirements presented in *Table 3* and *Table 4*, above, based on the per node configuration, to qualify for ENERGY STAR. However, the full Idle power of the complete system (including both nodes) must also be reported on the *Power and Performance Data Sheet*, as presented in Section 3.C of this specification.

**Discussion Topics: Provisional Idle**

1. Should Idle criteria be required, are any modifications to the existing test procedure suggested?
2. Is there power consumption data available on server components or options that could inform the evaluation of additional idle allowances?

**2. Power Management Requirements:** Products must meet the power management requirements detailed below and be tested in the configuration in which they are shipped to end users.

*Table 5* lists the existing power management requirements from the Tier 1 specification. While the requirements have not changed, they have been extended to *all* servers covered under the Tier 2 specification (contingent on the applicability conditions in column 3). EPA welcomes comments on each requirement, relevance of each feature, and new or emerging power management features that should be considered for inclusion in Tier 2.

**Table 5: Power Management Features**

| Feature | Requirement | Applicability |
|---|---|---|
| **Power Management Functionality** | All Computer Servers must enable processor level power management to reduce power use of the processor during times of low utilization (e.g. Idle)**.** | All Computer Servers |
| **Power Management Shipment** | Systems must be shipped with power management functionality enabled in the system BIOS, and/or a management controller or service processor. | All Computer Servers |
| **Supervisor Power Management** | Systems shipping with a preinstalled supervisor system must have power management functionality enabled by default in the supervisor system. | All systems shipping with a preinstalled supervisor system (operating system or hypervisor) |
| **Processor Features** | All installed processors must be able to reduce power consumption in times of low utilization, by either:<br>• Reducing voltage and/or frequency through Dynamic Voltage and Frequency Scaling (DVFS), or<br>• Using processor or core reduced power states when a core or socket is not being used. | All Computer Servers |
| **Power Management Disclosure** | All power management techniques that are enabled upon product shipment must be listed on the *Power and Performance Data Sheet* described in Section 3.C of this specification. | All Computer Servers |

**Discussion Topics**

1. What additional power management features are candidates for inclusion under Tier 2? How can this list be better presented to include sufficient description of features and intended uses?

### 3. Other Requirements:

**Energy Efficient Ethernet:** All physical layer Ethernet in servers covered by the Computer Server specification must meet the Energy Efficient Ethernet (IEEE 802.3az) standard upon its approval by the IEEE.

Included above is a provision to require implementation of the Energy Efficient Ethernet standard upon availability of appropriate hardware. EPA understands that products meeting the 802.3az standard are expected to be adequately available on the market around the expected effective date in October 2010. EPA plans to commence future specification development to improve the efficiency of network equipment. Inclusion of this Energy Efficient Ethernet requirement in Tier 2 for Servers will help set the stage for those efforts and help set a foundation for a more efficient network ecosystem.

This requirement will not apply to physical layers unable to support 3az, including fiber and 40 and 100 Gbps copper. The EEE standard requires Link Layer Discovery Protocol (LLDP) for 10 Gbps Ethernet, but is optional for 1 Gbps. ENERGY STAR will evaluate LLDP support for 1 Gbps Ethernet in preparation of future Tier 2 drafts.

## C. Standard Information Reporting Requirements

**Approach**

EPA remains committed to the Standard Information Reporting requirements set forth in Tier 1 as a means to provide customers with consistent and comparable information to support provisioning practices and data center operation. The *Power and Performance Datasheet*, as currently formatted, lists information on system configuration, reported power levels, active performance (via a vendor-selected benchmark value), power saving features, power/temperature reporting, and thermal information.

In comments received since finalization of Tier 1, EPA is aware of stakeholder concerns with some of the data presented. Family information and power/sizing information were noted as areas of conflict. In the first case, family and configuration information is included to highlight the specific configuration information tied to the rest of the data presented in the document. In the second case, stakeholders noted that the Datasheet might request power and sizing data that conflicts with individual vendors' energy saving calculators and related support tools. EPA is open to comments on how appropriate data can be generated and presented in alignment with industry-standard practices, but remains committed to use of the P&P Datasheet as a standardized source of data that can be compared from vendor to vendor.

These and other comments on the current format of the P&P Datasheet will be investigated for possible revisions. EPA may consider suggestions found relevant to Tier 1 for immediate incorporation into the P&P Datasheet. Further development of the datasheet will be completed with the goal of presenting data in a useful format for the end user audience and in a format compatible with server partners' data systems such that creation of the Datasheet is a limited burden.

Partners must provide a standardized *Version Power and Performance Data Sheet* with each ENERGY STAR qualified Computer Server. This information must be posted on the Partner's Web site where information on the qualified model, or qualified configurations, is posted. Partners are encouraged to provide one data sheet per qualified configuration, but may also provide one data sheet per Product Family (as defined in Section 1.Y above) with data on the Computer Server's power and performance in Maximum, Minimum and Typical configurations as defined in Sections 1.Z through 1.BB.

If one data sheet is used to represent many configurations under one Product Family, partners shall, when available, also provide a link to a more detailed power calculator where information on the power consumption of specific system configurations can be found.

Templates for the *Version Power and Performance Data Sheet* can be found on the ENERGY STAR Web page for Computer Servers at www.energystar.gov/products. Partners are encouraged to use the referenced data sheet template, but may also create their own template provided that it is identical in format and design as the referenced template, and has been approved by EPA. EPA may periodically revise this template, as necessary, 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.

Each *Power and Performance Data Sheet* must include the following information:

1. Model name and number, identifying SKU and/or configuration ID;
2. System characteristics (form factor, available sockets/slots, power specifications, etc.);
3. System configuration(s) (including maximum, minimum and typical configurations for product family qualification);
4. Power data for Idle and full load, estimated kWh/year, link to power calculator (where available);
5. Additional power and performance data for at least one benchmark chosen by the Partner;
6. Available and enabled power saving features (e.g., power management);
7. Information on the power measurement and reporting capabilities of the Computer Server;
8. Select thermal information from the ASHRAE thermal report; and
9. A list of additional qualified SKUs or configuration IDs, along with specific configuration information (for Product Family qualification only).

**Discussion Topics**

1. Are there additional items that are suggested for addition to the P&P Datasheet?
2. Are there items on the existing P&P Datasheet that are less important to a server purchaser? Why?

### D. Data Measurement and Output Requirements

**Approach**

For Tier 2, EPA intends to enhance electronic reporting requirements by further defining accuracy and resolution requirements. EPA has received feedback that common industry data reporting capabilities may remain limited to the three areas addressed in the Tier 1 specification: Input Power, Processor Utilization, and Inlet Air Temperature.

The following requirements have been amended as indicated in the Tier 1 specification:

- The Data Measurement and Output Requirements have been extended to all servers covered by the specification;
- Accuracy of reporting requirements for input power have been made more stringent as forecast in the Tier 1 specification;
- The processor utilization definition proposed in the Tier 1 final draft has been included as a starting point from which to better define this condition; and
- The 30 second rolling average suggestion for sampling has been made a requirement.

EPA welcomes stakeholder feedback on how to improve the consistency of data reporting from server to server and how the specification can further support industry efforts to generate power and performance information for input into management systems.

**Standardized Data Measurement:** All servers covered by this Tier 2 specification must have the ability to provide data on input power consumption in watts, inlet air temperature, and utilization of all logical CPUs during normal operation.

To meet the data measurement and output requirements, Computer Servers may rely on a service processor, embedded power or thermal meter (or other out-of-band technology shipped with the Computer Server), or preinstalled operating system to collect data and make it available for collection and dissemination over a standard network to third-party management systems such as a data center management software suite. Data must be made available in a published or user accessible format so as to be readable by third-party, non-proprietary management systems. All systems shipped with preinstalled operating systems must have all necessary drivers/software installed to make this information openly available. For systems not shipped with an operating system, documentation of how to access the registers containing the relevant sensor information must be provided in user manuals and online documentation. In addition, when an open and universally available standard becomes available to report and collect this data, manufacturers should incorporate the universal standard into their systems. Computer Servers may meet this requirement through embedded components or add-in devices included with the server on shipment.

**Measurement Accuracy:**

- Input power measurements: EPA recommends the following Accuracy requirements for input power measurements on a system level:
  - ± 5% accuracy with a cutoff of ± 5 watts (i.e. accuracy is never required to be better than ± 5 watts) through the operating range from Idle to full power.

**Note:** The above accuracy levels are solely in reference to the Power Measurement and Output Requirements included in this section. Accuracy requirements for Idle power and full load power tests are included in the test procedure in Appendix A of this specification.

The input power measurement requirement has been made more stringent as indicated in the Tier 1 specification.

- Processor utilization measurements: +/-(***TBD)***% accuracy for CPU utilization, where utilization ($Ut_{proc}$) is expressed for each logical CPU (equivalent to the number of independent CPUs presented to the OS), per core, per socket, and defined as:

$$\mathbf{Ut_{proc} = (1 - T_{IDLE}\%) * (F_A / F_S)}$$

Where:

$\mathbf{T_{IDLE}\%}$ = OS idle time% for the time slice
$\mathbf{F_A}$ = average frequency for the time slice (average frequency of the CPU during the time slice including any overclocking of the CPU during that time)
$\mathbf{F_S}$ = CPU frequency specification (i.e. maximum frequency not accounting for any temporary bursts of clock frequency)

The structure and definition included above references the proposal made in the Final Draft Tier 1 Computer Server Specification. It has been reintroduced to raise discussion on the merits of this proposal and encourage proposals as to alternative that could provide a relevant baseline definition for Partners to reference in meeting required processor utilization reporting.

- Inlet air temperature measurements: Computer Servers must meet an accuracy of ± 3° C on all air temperature measurements.

**Sampling Requirements:** Data must be averaged on a rolling basis over a time period of ≤ 30 seconds.

The sampling requirement has been modified as indicated in the Tier 1 specification.

**Reporting Requirements:** Manufacturers must report the following on the *Power and Performance Data Sheet*:

- Guaranteed accuracy levels for power and temperature measurements, and
- The time period used for data averaging.

**Discussion Topics**

1. *Processor Utilization*: At the end of Tier 1 development, it was noted that there is no standard definition of processor utilization accuracy that accounts for advanced features like multithreading and dynamic voltage and frequency scaling. The final requirement allowed for estimation instead of calculation of the $Ut_{proc}$ figure included above. Have there been any developments on this topic since Tier 1 was finalized that provide an alternative to this approach?
2. *Sampling requirements*: The time period used for data sampling is recorded as a component of the *Power and Performance Data Sheet* under Tier 1. To support standardization of sampling requirements, is there a reasonable alternative baseline sampling period that could be referenced for Tier 2 in lieu of the proposed 30 second rolling average requirement?
3. EPA received comments that inclusion of sensor accuracy requirements would provide a useful baseline for Partners. What are appropriate levels of accuracy for input power and inlet air temperature sensors that would provide sufficient accuracy for data center managers to monitor the environmental conditions of their equipment?
4. Are there industry standard methodologies available that could be cited for assessment of the three reporting requirements included in this section?

**4) Test Criteria:** Manufacturers are required to perform appropriate tests, as outlined below, in order to determine ENERGY STAR qualification for a given configuration or Product Family. These required tests include:

- **Power Supply Efficiency Testing** as outlined in *Section 4.A* for power supply efficiency and power factor requirements and reporting on the *Power and Performance Data Sheet* for all Computer Servers.
- **Idle Testing** as outlined in *Section 4.B* for Idle power requirements of Single and Dual socket Computer Servers, and for Idle power and full load power reporting of all Computer Servers on the *Power and Performance Data Sheet*.

The results of those tests may be self-certified by the ENERGY STAR Partner, or by a third-party laboratory on behalf of the Partner, and must be reported to EPA using the most current procedures put in place by EPA at time of submittal (e.g. Qualified Product Information [QPI] form or Online Product Submittal [OPS]). Models that are unchanged or that differ only in finish from those sold in a previous year may remain qualified without the submission of new test data assuming the specification remains unchanged.

**Facility Quality Control:**

In order to conduct testing in support of qualification for ENERGY STAR, the product must be tested in a facility that has quality control procedures for monitoring the validity of tests and calibrations. ENERGY STAR recommends conducting these tests in a facility that follows the general requirements for the competence of testing and calibration laboratories as described in the International Standard ISO/IEC 17025.

The Facility Quality Control language above has been added per guidance from the Tier 1 specification (*Tier 2 Accreditation Requirement for Testing Laboratories, page 14*). The *ISO/IEC 17025* laboratory requirement has been referenced in other ENERGY STAR IT specifications including Version 5.0 of the Computer and Displays/Monitors specifications. This standard pertains to general requirements for laboratories that carry out testing and/or equipment calibrations. Various accreditation bodies exist to evaluate a facility's ability to meet the provisions of this standard.

EPA intends to update this requirement as appropriate should further details on an appropriate Scope of Accreditation reflecting a facility's specific competence to carry out the test procedures in this section become available.

**A. Power Supply Testing**

Computer Server manufacturer Partners are required to guarantee power supplies have been tested and found to comply with the power supply efficiency levels in Section 3.A of this specification. Testing shall be conducted as follows:

- A Computer Server power supply 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.

**Additional Guidance on Power Supply Testing**

1. Power supplies shall be tested using the input test conditions specified in *Table 6*, below, and as indicated in the above referenced test procedure. For AC-DC Multi-Output power supplies capable of operating at both 230 and 115 Volts input, ***testing shall be conducted 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.

**Table 6: Input Conditions for Power Supply Efficiency Testing**

| Power Supply Type | Input Test Conditions |
|---|---|
| AC-DC Single-Output | 230 Volts, 50Hz or 60 Hz |
| AC-DC Multi-Output | 115 Volts, 60 Hz and/or 230 Volts, 50Hz or 60Hz |
| DC-DC | 53 Volts DC or -53 Volts DC |

2. **10% Loading Condition:** As referenced in the power supply efficiency requirements in Section 3.A, all Single-Output power supplies must be tested at 10% loading in addition to the standard 20%, 50% and 100% loading conditions indicated in the test procedure.

3. **Fan Power:** As indicated in the power supply test procedure referenced above, Multi-Output power supplies must be tested with internal fan power included in the measurement and efficiency calculation. Single-Output power supplies must exclude fan power from the measurement and the efficiency calculation.

4. **Efficiency and Power Factor Reporting:** Power supplies must meet the levels presented in *Table 3* and *Table 4* without the assistance of rounding. When submitting power supply efficiency and power factor results, manufacturer shall report to the first decimal place (e.g. 85.2%) and three decimal points (e.g., 0.856), respectively.

**B. Idle and Full Load Power Testing**

Partners must use the *ENERGY STAR Test Procedure for Determining the Power Use of Computer Servers at Idle and Full Load,* included in **APPENDIX A** of this specification to measure Idle and full load power consumption for purposes of ENERGY STAR qualification. All Computer Servers must meet the Idle power levels presented in *Table 3* and *Table 4* in section 3.B.1, depending on system configuration. The Partner must test and report Idle and full load power consumption test results for all Computer Servers.

1. **Test as shipped:** Computer Servers must be tested in their "as-shipped" configuration, unless otherwise indicated in the referenced test procedures. For power consumption testing, all power supplies must be connected and operational, and the as-shipped operating system or a representative operating system (see 4.B.3, below) must be installed. For all tests, manufacturers must ensure that the only power management techniques and/or power saving features enabled on systems under test are those which are also enabled on shipment.

2. **Computer Server shipped without a preinstalled hard drive:** Computer Servers shipped without hard drives may carry the ENERGY STAR mark only if (1) an otherwise identical configuration was tested and qualified with at least one hard drive installed.

3. **Computer Servers shipped without a preinstalled operating system:** For Computer Servers shipped without a pre-installed operating system, manufacturers must clearly indicate on the *Power and Performance Data Sheet* (Section 3.C) which operating system was used in testing for the purposes of ENERGY STAR qualification. In addition, as outlined in Appendix A, 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. Manufacturers must also clearly indicate on the *Power and Performance Data Sheet* which power management features were active during testing.

4. **Idle Reporting:** Computer Servers must meet the Idle power consumption levels determined from *Table 3* and *Table 4* without the assistance of rounding. When submitting Idle results, manufacturer shall report power consumption to the first decimal place (e.g. 125.6 watts).

### C. Qualifying Computer Servers Through Value Added Resellers (VARs)

In some cases, ENERGY STAR qualfied Computer Servers may be shipped from the Original Equipment Manufatcurer (OEM) to a VAR that then determines the end configuration which is ultimately sold to the end user. In order for the VAR to sell the Computer Server as ENERGY STAR qualified under the OEM brand name, one of two conditions must be met:

1. The end configuration sold by the VAR must have been originally qualified by the OEM, or
2. In the case that the end configuration has not been qualified by the OEM, the VAR must become an ENERGY STAR partner, and test and qualify the configuration.

OEM partners selling Computer Servers to VARs must provide the VAR with a list of qualified configurations for that model, using approved components, which have been initially qualified and reported to EPA by the OEM Partner.

Ultimately, the party (i.e. the OEM or VAR) that markets and sells the ENERGY STAR Computer Server to the end user is responsible for ensuring the configuration has been qualified either by the party itself or by the OEM. If a VAR markets and sells a Computer Server under one of its own brands, that VAR must become an ENERGY STAR Partner and qualify the Computer Server under their own brand name.

### D. Qualifying Configurations and Families Under this Specification

Partners are encouraged to test and submit qualified product data on all individual configurations for ENERGY STAR. However, a partner may qualify multiple configurations under one Product Family designation as long as all of the configurations within that Product Family meet one of the following requirements:

- Subsequent units are built on the same platform and are identical in every respect to the tested, representatitve model except for housing and color.
- Subsequent units meet the requirements of a Product Family, as defined in Section 1.Y, above. In this case, partners must test and submit power data on a maximum and minimum configuration, as defined in Sections 1.Z and 1.AA of this specification. Partners are also required to include a *Power and Performance Data Sheet* for each Product Family as described in Section 3.C of this specification.

All configurations associated with a Product Family, for which a Partner is seeking ENERGY STAR qualification, must meet the ENERGY STAR requirements, including those for which data was not reported. If a Partner wishes to qualify individual configurations within a Product Family for which non-qualifying configurations exist, the Partner must assign the qualifying configurations an identifier in the model name/number that is unique to ENERGY STAR qualified configurations. This identifier must be used consistently in association with the qualifying configurations in marketing/sales materials and on the ENERGY STAR list of qualified products (e.g. model A1234 for baseline configurations and A1234-ES for ENERGY STAR qualifying configurations).

**5) Effective Date:** The date that products must meet the requirements specified under the Version 1.0 Tier 2 Computer Server specification will be defined as the effective date of the agreement.

A. Tier 2 Requirements: Tier 2 of this specification will commence on **October 15, 2010**. All products, including models originally qualified under Tier 1, with a **date of manufacture** on or after **October 15, 2010**, must meet the Tier 2 requirements in order to qualify for ENERGY STAR.

6) **Future Specification Revisions:** EPA reserves the right to change 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 product manufacture.

# APPENDIX A:

## ENERGY STAR Test Procedure for Determining the Power Use of Computer Servers at Idle and Full Load

The following protocol shall be followed when testing Computer Servers for compliance with the Idle power consumption requirements provided in the ENERGY STAR Version 1.0 Computer Server Specification, and when acquiring test data for reporting Full Load power on the *Power and Performance Data Sheet*. Partners must measure a representative sample of the configuration as it would be shipped to the customer. However, the Partner does not need to consider power consumption changes made by the end-user that may result from component additions, BIOS and/or software settings made by the Computer Server end-user after purchase of the product. *This procedure is intended to be followed in the specified sequence.*

*Computer Servers must be tested with configuration and settings as shipped, unless otherwise specified. Partners wishing to qualify Computer Servers that are shipped without operating systems must test the Computer Server with a representative operating system and make clear in all program literature which operating system and power management settings were used to qualify the model.*

### I. Definitions

Unless otherwise specified, all terms used in this document are consistent with the definitions contained in the Version 1.0 ENERGY STAR Eligibility Criteria for Computer Servers.

**UUT**
UUT is an acronym for "unit under test," which in this case refers to the Computer Server being tested.

**UPS**
UPS is an acronym for "Uninterruptible Power Supply," which refers to a combination of converters, switches and energy storage means, for example batteries, constituting a power supply for maintaining continuity of load power in case of input power failure.

### II. Testing Requirements

**Required Power Analyzer Attributes**
Approved analyzers will include the following attributes:

- Ability to measure true RMS power for all AC sources;
- An available current crest factor of 3 or more at its rated range value. For analyzers that do not specify the current crest factor, the analyzer must be capable of measuring an amperage spike of at least 3 times the maximum amperage measured during any 1-second sample;
- Frequency response of at least 3 kHz; and
- Calibration with a standard that is traceable to the U.S. National Institute of Standards and Technology (NIST) or similar relevant standards for other countries. Calibration must be current and within the past year.

Approved analyzers also must have the capability to either:

- Average power accurately over any user selected time interval (this is usually done with an internal calculation dividing accumulated energy by time within the analyzer, which is the most accurate approach); or
- Be capable of integrating energy over any user selected time interval and integrating time displayed with a resolution of 1 second or less.

**Accuracy**

Measurements of power of 0.5 W or greater shall be made with an uncertainty of less than or equal to 2% at the 95% confidence level. For all applicable loads, the power measurement instrument shall have a resolution of:

- 0.01 W or better for power measurements of 10 W or less;
- 0.1 W or better for power measurements of greater than 10 W up to 100 W; and
- 1 W or better for power measurements of greater than 100 W.

The power measurement instrument must only meet the accuracy requirements above for loads experienced during testing (i.e. tests which do not include measurements at 10 watts or below do not have to be capable of meeting the 0.01 W accuracy requirement at these power levels).

**Note:** Multiple power analyzers may be used for measurements above of the rated capacity of a single analyzer, provided that the above accuracy requirements are maintained for the overall measurements.

All power figures shall be reported in watts and rounded to the first decimal place.

**Test Conditions**

Idle power consumption must be tested with the test conditions specified in the table below. Input voltage and frequency conditions for AC Powered Computer Servers are based on the power supply type (i.e. Single-Output vs. Multi-Output). **Computer Servers with Multi-Output PSUs must be tested at all applicable conditions (e.g., 115 V and/or 230 V) where the unit is capable of operating.**

| | | |
|---|---|---|
| **Supply Voltage:** | Servers with AC-DC Single-Output PSUs: | 230 (± 1%) Volts AC, 50 Hz or 60 Hz (± 1%) |
| | Servers with AC-DC Multi-Output PSUs: | 230 (± 1%) Volts AC, 50 Hz or 60 Hz(± 1%) and/or, 115 (± 1%) Volts AC, 60 Hz (± 1%) |
| | DC Servers: | ± 53 (± 1 V) Volts DC |
| | Optional Testing Conditions For AC-DC Japanese Market†: | 100 (± 1%) Volts AC, 50 Hz / 60 Hz (± 1%)<br><br>*Note:* For products rated for > 1.5 kW maximum power, the voltage range is ± 4% |
| **Total Harmonic Distortion (THD) (Voltage):** | < 2% THD (< 5% for products which are rated for > 1.5 kW maximum power) | |
| **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 at the above referenced 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, for Idle and full load power testing.

**Test Configuration**

Power consumption of the UUT shall be measured and tested from an external AC or DC source to the UUT.

The UUT must have at least one port connected to an Ethernet network switch capable of the UUT's highest and lowest network speeds. The network connection must be live during all tests, and although the link must be ready and able to transmit packets, no specific traffic is required over the connection during testing.

**Dual-Node Servers** must have identical configurations for each node including all hardware components and software/power management settings. These systems must also be measured in a way to ensure that all power from both nodes is being captured by the analyzer during the entire test.

## III. Test Procedure for All Computer Server Products in Rack or Pedestal Configurations

The Title of Section III has been amended to specify the scope of this test. A new Section IV will be devoted to testing of blade servers.

Measurement of AC or DC power consumption of a Computer Server shall be conducted as follows. All measurements may be manually or automatically recorded.

**A. UUT Preparation**

1. Record the manufacturer and model name of the UUT. Also record all basic information about the UUT's configuration including, operating system name and version, processor type and speed, installed power supply(s), physical memory, hard drive configuration, installed I/O Devices, power management features enabled, etc.
2. Ensure that the UUT is connected to a live Ethernet (IEEE 802.3) network switch as specified in Section II., "Test Configuration," above. The UUT must maintain this live connection to the switch for the duration of testing, disregarding brief lapses when transitioning between link speeds.
3. Connect an appropriate power analyzer or analyzers (as defined in Section II, Testing Requirements) to an AC or DC voltage source set to the appropriate voltage for the test. AC sources shall also be set to the appropriate frequency for the test.
4. Plug the UUT into the measurement power outlet on the power analyzer, as follows:
   a. No UPS units may be connected between the power analyzer and the UUT.
   b. UUTs with multiple power supplies must have all power supplies connected and operational during the test. If necessary, a PDU, or Power Distribution Unit (such as a simple plug multiplier or power strip), may be used to connect multiple power supplies to a single source. In this case, any overhead electrical use from the PDU must be included in the measurement of Idle power for the UUT.
   c. For a valid test to take place the analyzer shall remain in place until all Idle and full load power data is fully recorded.
5. Install the benchmark software intended for use to acquire power at full load. This benchmark shall be run when testing for full load power in Section B., below, and shall not significantly impact the power levels during the Idle power measurement (e.g. automated benchmark software may automate a system Idle state, but this simulated Idle state must be functionally equivalent to the Idle state achieved in step 8, below). Record the installed benchmark workload and configuration, including any custom parameters or settings.
6. Record the AC or DC input voltage. Record the frequency for AC voltage sources.

**B. Measuring Full Load and Idle Power**

1. Boot the UUT and wait until the operating system has fully loaded. If necessary, run the initial system setup and allow all one-time/periodic processes to complete.
2. Ensure that the UUT is in an as-shipped configuration, including the operating system and all other software included with the UUT by default. Maintain configuration and tuning parameters throughout the testing process for both full load power and Idle power.
3. The UUT must be configured using the following requirements for all tests:

a. The UUT must be configured with any applicable operating systems installed, and all user-configurable options should be set to their as-shipped settings. All other software must also be configured as shipped by default. If the UUT is shipped without an operating system, it must be tested with a representative operating system configured with only default settings.
b. Only those power management features that are enabled by default by the Partner upon shipment may be enabled during testing. All power management features used during the test must be noted on the test report.
c. If the UUT is shipped without accessories, it shall be configured with a standard mouse, keyboard and external computer display (if server has display output functionality), or accessed through a remote access application that is appropriate for the UUT's operating system to monitor UUT Idle status.
d. Ensure the UUT is configured to boot from the primary installed boot device (hard drive or solid state drive). The UUT may not boot from external storage devices.
e. Primary storage devices integral to the UUT must not be power managed ("spun-down") during Idle testing unless they contain non-volatile cache memory integral to the drive (e.g. "hybrid" hard drives). If more than one internal hard drive is installed as-shipped, the non-primary hard drive(s) must be tested with hard drive power management enabled as-shipped. If these additional drives are not power managed when shipped to customers, they must be tested without power management features enabled.

4. Shut down the UUT.
5. Switch on the UUT and begin recording elapsed time, starting either when the UUT is initially switched on, or immediately after completing any log in activity necessary to fully boot the system. Dual-Node Servers shall be booted and logged on concurrently. Once logged in with the operating system fully loaded and ready, close any open windows so that the standard operational desktop screen or equivalent ready screen is displayed.
6. 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 operation at the greatest possible output (e.g., 100% load). For benchmarks that measure multiple load points, only the greatest load point should be measured.
7. At the end of benchmark operation, calculate and record the average (arithmetic mean) power observed during benchmark operation at maximum load.
8. Between 5 and 15 minutes after the full load benchmark test has been completed, 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., computer sleep or hibernate states).

## IV. **Test Procedure for All Computer Server Products in a Blade Configuration**

Section IV of the Appendix A test procedure will contain an incremental methodology to set up and test blade servers. It will have a similar structure to the existing test procedure.

All test results must be reported to the EPA, European Commission or other relevant international body, as appropriate, taking care to ensure that all required information has been included, for purposes of ENERGY STAR qualification.

# APPENDIX B:

## Sample Calculations

Appendix B has been added to bring together sample calculations for the requirements throughout the specification. This reference appendix will be revised based on stakeholder suggestions and to reflect revisions made to requirements during the draft development process.

This Appendix includes sample calculations for the requirements included in *Section 3) Efficiency Requirements for Qualifying Products.*

### I. Determining Maximum Idle Power Consumption (*Table 3* and *Table 4*)

EXAMPLE: A standard single processor Computer Server with 4 GB of memory and a single hard drive could consume no more than 55.0 watts in Idle to qualify for ENERGY STAR. The same Computer Server with an additional hard drive would be provided with an additional 8.0 watt allowance and therefore, could consume no more than 63.0 watts of Idle power to qualify. If this server was then upgraded to 8.0 GB of memory, it would be granted another 8.0 watts (4 extra GB x 2.0 watts/GB) and would be expected to consume no more than 71.0 watts Idle power to qualify.

The example above was moved from its previous location under Table 4. The values in this example reference Tier 1 criteria and would be updated accordingly based on established Tier 2 levels, should a set of provisional Idle requirements be adopted.