ENERGY STAR® Program Requirements for Computers

DRAFT 1

Table of Contents

Partner Commitments 2

Commitments 2

Performance for Special Distinction 3

Eligibility Criteria 5

Section 1: Definitions 5

Section 2: Qualifying Products 9

Section 3: Energy Efficiency and Power Management Criteria 9

Tier I Requirements 10

Tier II Requirements 15

Section 4: Test Procedures 16

Section 5: Effective Date 17

Section 6: Future Specification Revisions 18

Appendix A: Test Conditions for Measuring Sleep Mode Power Levels

Appendix B: Draft Test Procedure for Determining Idle State Power Use of Personal Computers

49

Commitment

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

Note: Beginning in 2001, EPA and DOE began transitioning ENERGY STAR partners to a new streamlined Partnership Agreement. This new Agreement is being phased in as specifications for product categories are revised. As such, computer partners will be expected to meet the requirements of the new Agreement once this new specification is finalized. EPA first presented these new partner commitments to computer stakeholders in February 2004 via the Preliminary Draft specification. EPA's response to feedback received on this transition is provided in the below text boxes.

- comply with current ENERGY STAR Eligibility Criteria, defining the performance criteria that must be met for use of the ENERGY STAR certification mark on computers and specifying the testing criteria for computers. 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 model within one year of activating the computers portion of the agreement. When Partner qualifies the product, it must meet the specification (e.g., Tier 1 or 2) in effect at that time;

- provide clear and consistent labeling of ENERGY STAR qualified computers. The ENERGY STAR mark must be clearly displayed on the top/front of the product, in product literature (i.e., user manuals, spec sheets, etc.), on product packaging, and on the manufacturer's Internet site where information about ENERGY STAR qualified models is displayed;

Note: EPA received a few comments requesting that computer labeling be voluntary. ENERGY STAR is well known by consumers and large purchasers as the symbol for energy efficiency. EPA research shows that the ENERGY STAR mark positively impacts consumers' purchasing decisions. Thus, EPA will require product labeling. The ENERGY STAR mark should be placed in an area of high visibility where the consumer can see that the ENERGY STAR qualified computer will use less energy than an otherwise comparable model. EPA is willing to entertain alternatives to physical labeling of packaging/boxes, particularly in cases where generic boxes are used to ship multiple product models, some of which may not meet the ENERGY STAR specification.

- provide to EPA, on an annual basis, an updated list of ENERGY STAR qualifying computer models. Once the Partner submits its first list of ENERGY STAR qualified computer models, 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 computers 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. Any information used will be masked by EPA so as to protect the confidentiality of the Partner;

> **Note:** The collection of ENERGY STAR shipment data is critical to the evaluation and management of the ENERGY STAR program and is required of all participating manufacturing partners. This data helps EPA gauge penetration of ENERGY STAR qualified products and determine if changes to the program would yield increased sales of more efficient products. Partners can report data directly to EPA or work through a third party to report data. This reporting requirement will continue to be included in these Partner Commitments; however, EPA is willing to work with partners to determine the most effective way to collect this information.

- notify EPA of a change in the designated responsible party or contacts for computers 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 and computers in use in company facilities, particularly upon installation and after service is performed;

- provide general information about the ENERGY STAR program to employees whose jobs are relevant to the development, marketing, sales, and service of current ENERGY STAR qualified product models;

- feature the ENERGY STAR mark(s) on Partner Web site and in other promotional materials. If information concerning ENERGY STAR is provided on the Partner Web site as specified by the ENERGY STAR Web Linking Policy (this document can be found in the Partner Resources section on the ENERGY STAR Web site at www.energystar.gov), EPA may provide links where appropriate to the Partner Web site;

- 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 qualified 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.

ENERGY STAR® Program Requirements for Computers

Eligibility Criteria
DRAFT 1

Below is the **DRAFT 1** Version 4.0 product specification for ENERGY STAR qualified computers. A product must meet all of the identified criteria to earn the ENERGY STAR.

1) Definitions: Below are the definitions of the relevant terms in this document.

A. Computer: A stationary or portable unit, including desktop computers, multimedia computers, gaming consoles, integrated computers, notebook computers, tablet PCs, desktop-derived servers and workstations.

Components

B. Display: A commercially-available, electronic product with a display screen and its associated electronics encased in a single housing, or within the computer housing (e.g., notebook or integrated computer), that is capable of displaying output information from a computer via one or more inputs, such as a VGA, DVI, and/or IEEE 1394. Examples of display technologies are the cathode-ray tube (CRT) and liquid crystal display (LCD).

C. External Power Supply: A component external to the computer casing and designed to convert AC voltage from the mains to a single DC voltage for the purpose of powering the computer. For the purposes of this specification, an external power supply must be contained in a separate physical enclosure from the computer and connect to the computer via a removable or hardwired male/female electrical connection, cable, cord or other wiring. External power supplies must meet the definition contained in the ENERGY STAR Program Requirements for Single Voltage External Ac-Dc and Ac-Ac Power Supplies.

D. Internal Power Supply: A component internal to the computer casing and designed to convert AC voltage from the mains to DC voltage(s) for the purpose of powering the computer components. For the purposes of this specification, an internal power supply must be contained within the computer casing. The power supply must connect to the mains through a single cable with no intermediate circuitry between the power supply and the mains power. In addition, all power connections from the power supply to the computer components must be internal to the computer casing (i.e. no external cables running from the power supply to the computer or individual components). Internal dc to dc converters used to convert a single dc voltage from an external power supply into multiple voltages for use by the computer are not considered internal power supplies.

Computer Types

E. Desktop Computer: A computer where the main unit is intended to be located in a permanent location often on a desk or on the floor. Desktops often share some of the following characteristics: not designed for portability; use an internal power supply; utilize an external monitor, keyboard and mouse. Desktops are designed for basic home and office applications including, email, web browsing, word processing, standard graphics applications, gaming, etc. For the purposes of this specification, desktop computers are further delineated into the following two categories:
   - Basic Performance Desktop: A desktop computer with a single, single-core processor with a

clock speed of less than 2,700 MHz.

- High Performance Desktop: A desktop computer with either dual processors, a multi-core processor, or a single, single-core processor with a clock speed of greater than or equal to 2,700 MHz.

F. Desktop-Derived Server: A desktop-derived server is a computer that fits the typical desktop form factor, but is designed explicitly to be a host for other computers or applications. For the purposes of this specification, a computer must have the following characteristics to be considered a desktop-derived server:

- Designed and placed on the market as a Class B product per EuroNorm EN55022:1998 under the EMC Directive 89/336/EEC and designed and capable of having no more than single processor capability (1 socket on board).

- Designed in a pedestal, tower, or other form factor similar to those of desktop computers such that all data processing, storage, and network interfacing is contained within one box/product.

- Designed and capable of operating in a mission-critical, high-reliability, high-availability application in which use may be 24 hours/day and 7 days/week, and unscheduled downtime is extremely low (on the order of minutes/year).

- Designed and capable of operating in a multi-user environment in which access to the computer or accompanying storage or storage array is not required of the user.

- Capable of utilizing an industry accepted operating system for standard server applications (e.g., Windows NT, Windows 2000 Server, OS/400, OS/390, Linux, Unix and Solaris)

Desktop-derived servers are typically designed to perform functions such as: processing information for other systems, providing network infrastructure services (e.g., archiving), providing gateway or switching services, data hosting, running web servers, etc.

This specification does not cover mid-range or large servers, defined for purposes of this specification as:

- Designed and placed on the market as a Class A product per EuroNorm EN55022:1998 under the EMC Directive 89/336/EEC and designed and capable of having a single or dual processor capability (1 or greater sockets on board); or

- Designed and placed on the market as a Class B product per EuroNorm EN55022:1998 under the EMC Directive 89/336/EEC and designed and capable of having a *minimum* dual processor capability (2 sockets on board).

G. Game Consoles: Game consoles are stand alone computers, primarily used to play games. For the purposes of this draft specification, game consoles must use a hardware architecture based on typical computer components (e.g., processors, system memory, video architecture, hard drives, etc.). The primary input for game consoles is usually a special hand held controller rather than the mouse and keyboard used by conventional computer types. Game consoles are also equipped with audio visual outputs for use with televisions as the primary display, rather than an external monitor or integrated display. These devices do not typically use a conventional operating system, but often perform a variety of other multimedia functions such as: DVD/CD playback, digital picture viewing, and digital music playback.

H. Integrated Computer System: A desktop system in which the computer and visual display are

combined into a single unit. Integrated computers must meet all of the following criteria: (1) it is not possible to measure the power consumption of the two components separately by disconnecting external cables or using mechanical switches; and (2) the system receives its Ac power through a single cable. As a subset of desktop computers, integrated computers are typically designed to provide identical functionality as desktop systems.

I. Notebook and Tablet Computers: A computer designed specifically for portability and to be operated for extended periods of time without a direct connection to an Ac power source. Notebooks and tablets must utilize an integrated monitor and be capable of operation off an integrated battery or other portable power source. In addition, most notebooks and tablets use an external power supply and have an integrated keyboard and pointing device, though tablets use touch sensitive screens. Notebook and tablet computers are typically designed to provide identical functionality to desktops except in a portable device. Notebooks and tablets typically include an integrated wireless device for access to local area networks and the internet. For the purposes of this specification, docking stations are considered accessories and, therefore, the performance levels associated with notebooks and presented in Table 1, below, do not include them.

J. Workstation: For the purposes of this specification, to qualify as a workstation, a computer must not be marketed as a server, be equipped with a keyboard and graphics controller, and meet the minimum number of criteria indicated in the categories listed below:

Performance (must meet minimum of 5)

Supports or available with:

- 2 or more qualified Independent Software Vendor (ISV) products on the system
- A striped RAID configuration
- SCSI or SAS disks and controllers
- 3 or more serial IDE/SATA drives
- A hardware 3D graphics accelerator
- Stereoscopic video output (e.g., 3-dimensional display)
- Buffered or registered DIMMs
- Multi-graphical processing unit (GPU) (ex: SLI or CrossFire)
- Dual Gigabit Ethernet
- Capable of shipping with 2 or more processor packages, or 4 or more cores
- Sold into the HPTC (High Performance Technical Computing) market

Reliability (must meet minimum of 2)

Supports or available with:

- Configurations with calculated system Mean Time Between Failures (MTBF) of 25,000 hours or more
- Error-Correcting Code (ECC) memory
- A mirrored RAID configuration

Operational Modes

K. Active Mode: The mode in which the computer, while connected to a power source, is producing useful work; for example, running application software. To clarify, the low end or minimum power draw of active mode is idle. The high end of active mode would be the maximum power draw

capable by the computer.

L. Idle State: For purposes of testing and qualifying computers under this specification, this is the state in which the operating system and other software have completed loading, the machine is not asleep, and activity is limited to those basic applications that the system starts by default. Idle state is considered a subset of Active Mode.

M. Sleep Mode: A low power state that the computer is capable of entering automatically after a period of inactivity or by manual selection. A computer with sleep capability can quickly "wake" in response to inputs from network connections or user interface devices. For purposes of this specification, sleep mode correlates to ACPI System Level S3 state, where applicable.

N. Standby Level (Off Mode): The power consumption level in the lowest power mode which cannot be switched off (influenced) by the user and that may persist for an indefinite time when the appliance is connected to the main electricity supply and used in accordance with the manufacturer's instructions. For purposes of this specification, off/standby mode correlates to ACPI System Level S4 or S5 states, where applicable.

Networking and Power Management

O. Network Interface: The components (hardware and software) whose primary function is to make the computer capable of communicating over one or more network technologies.

P. Wake Events: A user, programmed, or external event or stimulus that causes the computer to transition from its Sleep Mode to either active or idle mode of operation. Examples of wake events include, but are not limited to, movement of the mouse, keyboard activity, or a button press on the chassis, and in the case of external events, stimulus conveyed via a remote control, network, modem, etc.

Note: Definitions adopted from the ENERGY STAR External Single Voltage Ac-Ac and Ac-Dc Power Supply specification have been added to this draft. The above mentioned specification can be found at www.energystar.gov/powersupplies.

EPA's goal in developing separate definitions for workstations, desktop-derived servers, and game consoles is to determine a means for addressing their unique performance and energy needs. The final and agreed upon definitions should be representative of relevant designs found in the marketplace. EPA remains open to additional options for defining and measuring workstation, desktop-derived server, and game console energy efficiency.

A comment was made that the notebook definition should also include models with internal power supplies. EPA understands that this is a small portion of the market. However, in the interest of being inclusive, the description of notebooks in this draft specification now offers external power supply designs as an option for notebooks (not a requirement) and the product category has been added to list of product types required to meet internal power supply requirements.

Where possible, EPA intends to comply with the IEC 62301 definition and test method for determining standby power levels. It is important to note that for some products, the standby level can occur in different power modes. For this reason, this specification will continue to reference the lowest power level as the standby level, while indicating that this power level occurs in the off mode.

2) Qualifying Products: Computers must meet the computer definition as well as one of the product type definitions provided in Section 1, above, to qualify as ENERGY STAR. The following table provides a list of the types of computers that are (and are not) eligible for ENERGY STAR.

Products Covered by Version 4.0 Specification	Products Not Covered by Version 4.0 Specification
• Desktop Computers • Multimedia Computers • Game Consoles • Integrated Computer Systems • Notebook Computers/Tablet PCs • Desktop-Derived Servers • Workstations	• Mid- to Large-Servers (as defined in Section 1F) • Thin Clients /Blade PCs • Clamshell Computers • Handhelds and PDAs

Note: The product types listed as "covered" in the table above represent computers that: (1) are most prevalent in the marketplace (volume and usage); (2) are associated with significant energy use by residential and commercial users; (3) offer the greatest energy savings potential; and/or (4) are supported by significant testing and data. Game consoles are being proposed for inclusion in this specification due to their similarity to desktop computers. EPA is continuing to test and research game consoles to determine which of the proposed operational modes and performance levels are appropriate for purposes of ENERGY STAR qualification. To this end, EPA encourages game console manufacturers to share data relevant to their products.

Thin clients, mid- to large-servers, clamshell, and handhelds/PDAs are not eligible for ENERGY STAR at this time. Given stakeholder interest and availability of performance data, EPA may consider adding these product types under future specification revisions.

3) Energy Efficiency and Power Management Criteria: Computers must meet the requirements below to qualify as ENERGY STAR. Proposed effective dates for Tiers I and II are provided in Section 5 of

this specification.

A) Tier I Requirements

(1) Energy Efficiency Requirements

Table 1: Tier I Energy Efficiency Requirements

Product Type	Tier I Requirements
Desktop/Multimedia Computers	**Standby (Off Mode):** ≤ 2 W **Sleep Mode:** ≤ 5 W **Idle State – Basic Performance**: ≤ 49 W **Idle State – High Performance**: ≤ 74 W **Internal Power Supply:** 80% minimum efficiency at 20%, 50%, and 100% of rated output and Power Factor ≥ 0.9 at 100% of rated output **External Power Supply:** ENERGY STAR qualified external power supply or one that meets the ENERGY STAR specification when tested to the ENERGY STAR single voltage ac-ac and ac-dc external power supply test method
Game Consoles	**TBD**
Integrated Computer Systems	**Standby (Off Mode):** ≤ 3 W **Sleep Mode:** ≤ 7 W **Idle State:** TBD **Internal Power Supply:** 80% minimum efficiency at 20%, 50%, and 100% of rated output and Power Factor of ≥ 0.9 at 100% of rated output **External Power Supply:** ENERGY STAR qualified external power supply or one that meets the ENERGY STAR specification when tested to the ENERGY STAR single voltage ac-ac and ac-dc external power supply test method

Notebook Computers/Tablet PCs	**Standby (Off Mode):** ≤ 1 W **Sleep Mode :** ≤ 5 W **Idle State:** ≤ 21 W **Internal Power Supply:** 80% minimum efficiency at 20%, 50%, and 100% of rated output and Power Factor of ≥ 0.9 at 100% of rated output (*where applicable*) **External Power Supply:** ENERGY STAR qualified external power supply or one that meets the ENERGY STAR specification when tested to the ENERGY STAR single voltage ac-ac and ac-dc external power supply test method
Desktop-Derived Servers	**Idle State:** TBD **Sleep Mode:** N/A **Internal Power Supply:** 75% minimum efficiency at 20% of rated output; 80% minimum efficiency at 50% of rated output; 77% minimum efficiency at 100% of rated output and Power Factor of 0.9 at 100% of rated output
Workstations	**Standby (Off Mode):** ≤ 2 W **Sleep Mode:** ≤ 5 W **Idle State:** ≤ 115 W **Internal Power Supply:** 80% minimum efficiency at 20%, 50%, and 100% of rated output and Power Factor of ≥ 0.9 at 100% of rated output

Note: This draft proposes new criteria for active/idle state. EPA's intention is to recognize models that operate efficiently while idling, as defined by the idle test procedure, in addition to the low power modes set forth in this proposed draft. EPA's research has shown that computers in diverse operating environments spend considerable time in idle state. Moreover, data included with this draft specification highlight the significant differences in idle mode power consumption for models that are similar in performance and class. Highlighting those differences in performance is one of the main goals of this specification.

This draft segments the model data into four distinct product classes. Each product class represents computer models with similar functionality and purpose. EPA's intent is to set different idle mode power consumption criteria for these product classes as opposed to a single level for all product models. This approach recognizes that the various classes of products can have significantly different power needs. EPA is proposing four "bins" for purposes of setting maximum idle requirements: basic performance desktop, high performance desktop, notebooks, and workstations. EPA recognizes that technology is changing rapidly and notes that the Tier I for this draft specification is intended to be temporary.

EPA is proposing these bins to address stakeholder concerns regarding a flat idle requirement that would favor basic performance models over high performing computers. EPA believes that energy efficiency can be achieved in concert with increased functionality but also understands that there are discrete differences in power needs for high level computing. EPA's intent is not to compromise functionality for energy efficiency but rather to set specification levels that encourage manufacturers to incorporate energy efficiency into their designs and engineering decision-making process. Furthermore, consumers/end users should be able to choose an ENERGY STAR model from a variety of different computer functionalities and EPA believes that this new approach to idle will help enable them to do so.

Over the last few months, input has been gathered from stakeholders to refine the idle mode test procedure. Additional testing was completed by EPA and other parties on numerous new computer models using this test procedure in order to expand the idle mode energy consumption data set. The idle performance levels provided in Table 1 were determined by taking approximately the top 40% of models for each "bin". EPA believes its proposed idle mode levels for Tier 1 are modest. Initially implementing a more modest idle performance level allows for the inclusion of an idle level in Tier I rather than developing a more complex definition and a more rigorous level which would likely significantly delay implementation of an idle level. EPA believes that a less complex definition, in concert with appropriate power allowances for varying classes of products, would still approximate relevant user conditions. It is EPA's intent that when combined with the sleep, standby, and power supply requirements the proposed ENERGY STAR specification will represent the top 25% of the market. Data used to set the proposed idle state levels provided in Table 1 will be made available for review on the ENERGY STAR Product Development Web site at www.energystar.gov/productdevelopment. Manufacturers are encouraged to compare this data and the levels proposed in Table 1 to their own models to determine whether they are appropriate for each product type and to furnish data to the ENERGY STAR program so that the data set can contain the most representative sample possible.

SPEC Benchmark Option

After reviewing a number of near-term approaches to distinguishing between basic and high performance desktop systems, EPA has recently become aware of the $SPEC_{INT}$ public domain, cross-platform benchmark and sees value in this approach. The Standard Performance Evaluation Corporation (SPEC) is a non-profit corporation formed to establish, maintain and endorse a standardized set of relevant benchmarks that can be applied to the newest generation of high-performance computers. SPEC develops benchmark suites and also reviews and publishes submitted results from its member organizations and other benchmark licensees. While stakeholders may disagree whether a computer with twice the SPEC score of another computer actually delivers twice the functional performance or capability, using this benchmark in the near term merely to distinguish between broad categorical differences in computing power appears to have merit. EPA is considering this new approach because: (1) it allows widely varying computer types to be compared against each other; (2) it is managed and updated with some regularity by a broadly representative group of industry stakeholders; and (3) its early consideration in Tier 1 of this specification helps to pave the way toward an eventual energy efficiency performance benchmark. EPA is requesting feedback on the possibility of employing the SPEC benchmark to differentiate products' performance and, thus, their power allowances rather than the "bin" approach included in this draft.

Power Supply Requirements
According to recent research conducted by EPRI Solutions for California's Public Interest Energy Research program, the use of highly efficient, power factor corrected power supplies in computers leads to greater energy savings in the electrical distribution system than first estimates might suggest. Power factor correction and greater power supply efficiency cut I-squared R losses in building distribution wiring significantly, yielding an additional 15 to 20% savings in commercial and governmental buildings. For example, if the efficiency gain alone were expected to cut computer power use by 20 watts, the actual reduction including building wiring impacts can be estimated at 23 to 24 watts, largely due to the inclusion of a power factor correction requirement. These savings are dependent on the length of building distribution wiring, so could be higher in very large buildings and lower in residential buildings. Thus, power factor correction requirements are proposed in this draft.

Desktop-Derived Servers
After further refining the desktop-derived server definition, EPA has removed the separate requirements for EPS1U rack mount servers. It has been brought to EPA's attention that these products no longer fit the definition for desktop-derived server, and should not be included under this specification. EPA remains open to determining a method for including an idle requirement for EPS12V desktop-derived servers which adequately addresses their unique functionality and use. Possible methods under consideration are: including desktop-derived servers with the present workstation requirements or developing an idle requirement based on a percentage of full load power consumption. Stakeholders are encouraged to provide suggestions on defining the idle state for these products and suggestions, with supporting data, for appropriate idle state levels for these product types.

Internal Power Supply Requirements
EPA, in concert with a number of other countries, is strongly encouraging the use of more efficient power supplies. EPA has communicated this desire to power supply manufacturers and to their customers on many occasions. EPA and its international peer organizations believe that the market for more efficient power supplies has been growing. These changes present EPA with an opportunity to propose a Tier I criterion for more efficient power supplies. Over the last year, multiple power supply manufacturers, including suppliers to leading OEMs, have developed more than 15 models that meet the proposed 80% minimum efficiency level set fourth in this draft. We expect this encouraging trend to continue such that manufacturers will be able to meet market demand in advance of Tier 1 of this specification. This suggests that the internal power supply efficiencies proposed in Table 1 will be both technically and economically feasible by the Tier I effective date of January 1, 2007.

In regards to the proposed power factor requirement, EPA is also open to considering compliance with IEC 61000-3-2, which restricts the harmonic currents created by the power supply. Both options seek to address power quality on the supply side. While power supply efficiency and power factor are not directly related, EPA recognizes that it would be more cost effective to the manufacturer to design and couple the costs associated with high efficiency and high power factor in the internal power supply.

Low Power Modes
Because standby power can be achieved in many different modes of operation for any given design, this draft specification now references the ACPI System for the Sleep Mode (S3) and Standby (S4 or S5) definitions. EPA understands that while the ACPI System may not support all computer systems in the marketplace, it does serve as a relevant and recognizable industry reference.

Standby Level (Off Mode) Requirement
EPA is considering raising the maximum level for Standby (Off Mode) to respond to stakeholder concern that a 2 Watt Standby level will be difficult to achieve if the system has Wake On LAN (WOL) functionality. WOL is an important element of power management enabling, which is also a requirement in this specification. EPA is currently conducting research to identify the additional power draw needed to support WOL functionality while the computer is in Standby (Off Mode).

Sleep Mode Requirement
The existing Version 3.0 computer specification allows sleep levels of 15 – 40 Watts, which provides a range of 7 – 15% of power supply rating. EPA is open to providing a sliding scale or slightly higher values for workstations and high performance desktops but has limited data on these products. Furthermore, EPA is interested in proposals for how to structure a sliding scale other than the power supply rating (which may not represent the maximum amount of power actually used by the computer).

(2) Power Management Requirements

Manufacturers must set the default to activate the display's low-power or sleep mode within 15 minutes of user inactivity. Manufacturers must set the default to activate the CPU's low power or sleep mode within 30 minutes of user inactivity. Products may have more than one low power mode but these proposed criteria address sleep mode as defined in this specification.

User Education Requirement: In order to ensure that purchasers/users are properly educated on the benefits of power management, the manufacturer will include with each computer, one of the following:

- Information on ENERGY STAR and the benefits of power management in either a hard copy or electronic copy of the user manual. This information should be near the front of the user guide.
- A package or box insert on ENERGY STAR and the benefits of power management.

Either option must include the following information:

- Notice that the computer has been shipped enabled for power management and what the time settings are
- How to properly wake the computer from sleep mode
- Energy saving benefits
- Money saving benefits
- Environmental benefits
- Some information on ENERGY STAR and a link to www.energystar.gov
- ENERGY STAR logo

In addition, the manufacturer will have similar information with a link to www.energystar.gov/powermanagement on the company Web site, readily accessible from computer product pages, product specifications, and related content pages.

At the manufacturer's request, EPA will supply suggested facts and figures related to the above criteria, template elements, or a complete template suitable for use in user guides or box inserts.

EPA's goal is to achieve a 40% enabling rate nationally by 2010; 60% by 2012; and $\geq$ 80% by 2014. EPA recognizes the importance of documenting enabling rates and encourages industry to develop a collective strategy for securing and funding this research, and sharing findings with EPA and the public.

Shipment Requirement: Systems shall be shipped with Wake On LAN (WOL) enabled from both Sleep and Standby/Off modes, as applicable and defined in this specification and as qualified for ENERGY STAR. For example, if using S5 to qualify a model for the standby/off requirement then the WOL feature needs to be enabled, and tested, for that particular state. Any directed packet filters shall be enabled and set to an industry standard default configuration. All bundled and optional hardware and software shall be stable after transitions through low-power modes and work within a larger power managed environment.

Note: Currently, power management enabling rates are approximately 5% in the commercial setting. This low enabling rate is due to challenges with current technologies but is also a result of confusion and lack of credible information regarding the benefits of and myths surrounding power management. EPA is open to additional suggestions for increasing awareness and educating end users about power management. EPA will host a conference call with stakeholders on February 13, 2006, to develop a plan for getting to immediate improvements in enabling rates for power management.

EPA believes that there is presently no industry standard default direct packet filter configuration. Thus, EPA is collecting default configurations and will relay a recommended default at the stakeholder meeting in February.

(B) Tier II Requirements

(1a) Tier II Performance Benchmark: All computers will be required to meet the following minimum performance per unit energy metric.

Performance Benchmarking Software and Associated Levels: **TBD**

- OR -

(1b) Provisional Tier II Idle State Requirements: If an energy efficiency performance benchmark, and associated performance levels, is not ready to go into effect **by January 1, 2008**, the following idle state levels will automatically go into effect and will remian in effect until such a benchmark is established. In this case, all other Tier I requirements will remain in effect. EPA will re-examine these levels, once finalized, at least six months prior to the efective date for Tier II.

Table 2: Provisional Tier II Idle Requirements

Product Type	Tier II Requirements
Desktops and Integrated Computers	≤ 46 W Basic Performance ≤ 65 W High Performance high end
Notebooks	≤ 19 W
Workstations	≤ 105 W
Desktop-Derived Servers	TBD
Game Consoles	TBD

(2) Power Management Requirements: In addition to the requirements provided under Tier I, above, ENERGY STAR qualified computers must retain full network connectivity while in sleep mode, according to a platform-independent industry standard.

Note: EPA's ultimate goal for this Version 2.0 computer specification is to build an energy efficiency performance benchmark that would be implemented in Tier II of this specification. EPA is working to develop such a benchmark that specifically identifies energy efficiency for computers in all modes of operation and believes that a successful one will:

(1) Approximate the amount of energy an ENERGY STAR qualified computer can use while performing work;
(2) Provide a consistent platform for comparison across a number of different product types and capabilities, even as products evolve and change in the marketplace;
(3) Provide manufacturers flexibility in designing for energy efficiency while maintaining performance; and
(4) Allow EPA to move away from prescriptive specifications and avoid setting individual component levels to measure and recognize whole product energy efficiency performance

By developing an energy efficiency performance benchmark, EPA hopes to create an energy efficiency metric that will remain relevant regardless of changing technologies or application. EPA has implemented other ENERGY STAR specifications that take into consideration the primary function of the products such that performance is not compromised for performance including: imaging equipment, monitors, air cleaners, ventilating fans, and ceiling fans. EPA is evaluating energy efficiency performance benchmarks currently available in the marketplace and is coordinating those efforts with manufacturers and other stakeholders. The hope is that EPA can identify an existing energy efficiency performance benchmark, or a newly developed benchmark of this kind, that can be applied broadly to the computer market. EPA's goal is to have an energy efficiency performance benchmark available and ready for implementation by the time proposed Tier II goes into effect (January 1, 2008). However, EPA is including a "provisional tier" in this draft specification, that proposes more challenging idle levels and represents approximately the top 25% of EPA's idle data set for computers, to allow for continuation of the computer specification should a benchmark not be ready in time. In lieu of an energy efficiency performance benchmark, lower idle levels will ensure that as technology progresses, energy efficiency continues to be a consideration in new product designs. **EPA will hold a stakeholder workshop in March of this year to discuss the development of a Tier II energy efficiency performance benchmark.**

C) Voluntary Requirements

User Interface: Although not mandatory, manufacturers are strongly recommended to design products in accordance with the Power Control User Interface Standard — IEEE 1621 (formally known as "Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments"). Compliance with IEEE 1621 will make power controls more consistent and intuitive across all electronic devices. For more information on the standard see http://eetd.LBL.gov/Controls

4) Test Procedures: Manufacturers are required to perform tests and self-certify those models that meet the ENERGY STAR guidelines.

- In performing these tests, partner agrees to use the test procedures provided in Table 2, below.
- The test results must be reported to EPA using the Computer Version 4.0 Qualifying Product Information (QPI) Form.

Table 3: Test Procedures for Measuring Operational Modes

Specification Requirement	Test Protocol**	Source
Standby (Off Mode)	IEC 62301	*International Electrotechnical Commission (IEC): www.iec.ch
Sleep Mode	Existing ENERGY STAR test protocol	APPENDIX A
Idle State	Draft Idle Test Procedure (dated 9/22/05)	APPENDIX B
Power Supply Efficiency	IPS: Draft Test Protocol for Testing the Energy Efficiency Internal Power Supply Test Protocol	IPS: www.efficientpowersupplies.org
	EPS: ENERGY STAR External Power Supply Protocol	EPS: www.energystar.gov/powersupplies

***Note on IEC 62301 Standby Test Procedure:** For purposes of testing standby power in notebook computers under this specification, batteries should be removed and the unit being tested should remain connected to the power supply throughout the procedure.

****Models Capable of Operating at Multiple Voltage/Frequency Combinations:** Manufacturers shall test their products based on the market(s) in which the models will be sold and promoted as ENERGY STAR qualified. For products that are sold as ENERGY STAR in multiple international markets and, therefore, rated at multiple input voltages, the manufacturer must test at and report the required power consumption or efficiency values at all relevant voltage/frequency combinations. For example, a manufacturer that is shipping the same model to the United States and Europe must

measure, meet the specification, and report test values at both 115 Volts/60 Hz and 230 Volts/50 Hz in order to qualify the model as ENERGY STAR in both markets. If a model qualifies as ENERGY STAR at only one voltage/frequency combination (e.g., 115 Volts/60 Hz), then it may only be qualified and promoted as ENERGY STAR in those regions that support the tested voltage/frequency combination (e.g., North America and Taiwan).

Standby Testing: EPA proposes that notebooks not be treated as rechargeable products as defined in Section 5 of the IEC 62301 standby test procedure, which requires products with rechargeable batteries to be disconnected at the time of test. The purpose of requiring the connection is to address additional energy used by Wake On LAN and other circuitry drawing power during Standby (Off mode). This proposed measurement will better represent the Standby level for the notebook as a "system" rather than simply representing the no load power draw of the external power supply, as proposed in the previous framework document. Thus, EPA is proposing a Standby (Off mode) level for notebook computers of 1 Watt in Table 1. The previous 0.5W requirement was proposed to harmonize with the ENERGY STAR external power supply level.

Internal Power Supply Testing: EPA proposes adopting the Internal Power Supply Test Procedure being developed on behalf of the California Energy Public Interest Energy Research Program (PIER). This test procedure is currently in draft form and should be finalized prior to the release of this specification. To follow the development of this test procedure and view the latest version of the document visit: http://www.efficientpowersupplies.org/ips_workshop.html.

Idle State Test Procedure: The proposed test procedure provided in Appendix B of this specification reflects a number of suggestions shared by stakeholders. Computer manufacturers are encouraged to use this test procedure to determine if they have additional concerns prior to it being finalized.

5) Effective Date: The date that manufacturers may begin to qualify products as ENERGY STAR, under this Version 4.0 specification, will be defined as the *effective date* of the agreement. Any previously executed agreement on the subject of ENERGY STAR qualified computers shall be terminated effective December 31, 2006.

A. Qualifying Products Under Tier 1 of the Version 4.0 Specification: The first phase of this specification is proposed to commence on **January 1, 2007**. All products, including models originally qualified under Version 3.0, with a **date of manufacture** on or after **January 1, 2007**, must meet the new (Version 4.0) requirements in order to qualify for ENERGY STAR. The **date of manufacture** is specific to each unit and is the date (e.g., month and year) of which a unit is considered to be completely assembled.

B. Qualifying Products Under Tier 2 of the Version 4.0 Specification: The second phase of this specification, Tier 2, is proposed to commence on **January 1, 2008**. All products, including models originally qualified under Tier I, with a **date of manufacture** on or after **January 1, 2008**, must meet the Tier II requirements in order to qualify for ENERGY STAR.

C. Elimination of Grandfathering: EPA will not allow grandfathering under this Version 4.0 ENERGY STAR specification. **ENERGY STAR qualification under previous Versions is not automatically granted for the life of the product model.** Therefore, any product sold, marketed, or identified by the manufacturing partner as ENERGY STAR must meet the current specification in effect at the time of manufacture of the product.

Note: As noted in the framework documents, once this specification is finalized, EPA will allow manufacturers a minimum of 9 months to phase-out models that do not meet the new Tier I Version 4.0 requirements. **On February 15, 2006, EPA will hold a stakeholder meeting in Washington, DC to discuss any addition comments or concerns regarding the proposed requirements.** EPA plans to finalize this Version 4.0 specification (Tier I) by March of 2006.

As explained in Section 3 of this specification, if a performance benchmark is not developed by the time Tier II is scheduled to go into effect, ENERGY STAR qualified computers will be required to meet idle levels provided in Table 2, above.

6) Future Specification Revisions: EPA reserves the right to revise the specification should technological and/or market changes affect its usefulness to consumers or industry or its impact on the environment. In keeping with current policy, revisions to the specification will be discussed with stakeholders. 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 qualify as ENERGY STAR, a product model must meet the ENERGY STAR specification in effect on the model's date of manufacture.

APPENDIX A
Test Conditions for Measuring Sleep Mode Power Levels

In order to reduce confusion and increase consistency, the following protocol should be followed when measuring power consumption levels of computers for compliance with the sleep mode levels provided in the ENERGY STAR Version 4.0 Computer specification.

Outlined below are the minimum test conditions that should be established when performing the sleep mode power measurement. These are necessary in order to ensure that ENERGY STAR compliance is based on common characteristics of computers.

A description of the test conditions and a discussion of testing equipment can also be found below.

I. TEST CONFIGURATION

Sleep mode power consumption of a computer shall be measured and tested from an AC source to the system. Partner must measure a representative sample of the configuration that it ships to the customer, but the Partner does not need to consider power consumption changes that may result from component additions made by the computer user after sale of product.

II. TEST CONDITIONS

Line Impedance: < 0.25 ohm
Total Harmonic Distortion: < 5%
Input AC Voltage[1]: 115 VAC RMS +/- 5V RMS
Input AC Frequency[1]: 60 Hz +/- 3 Hz
Ambient Temperature: 25 deg. C +/- 3 deg. C

III. TESTING EQUIPMENT

The goal is to accurately measure the true power consumption[2] of the computer. This necessitates the use of a true RMS wattmeter. There are many models to choose from, but Partners will need to exercise care in selecting an appropriate model. The following factors should be considered when purchasing a meter and setting up the actual test.

Crest Factor[3]

Computers that contain switching power supplies draw current in a waveform different from typical sinusoidal current. While virtually any wattmeter can measure a standard current waveform, it is more difficult to select a wattmeter when irregular current waveforms are involved.

It is critical that the wattmeter selected be capable of reading the current drawn by the computer without causing internal peak distortion (i.e., clipping off the top of the current wave). This requires a

[1] *If products will be sold in Europe or Asia, testing should also be performed at the appropriate machine-rated voltage and frequency. For example, products destined for European markets might be tested at 230 V and 50 Hz.*

[2] *True power is defined as the product of the voltage, current and the power factor (volts x amps x power factor), and is typically reported as Watts. Apparent Power is defined as the product of voltage and current (volts x amps) and is usually expressed in terms of VA or volt-amps. The power factor for equipment with switching power supplies is always less than 1.0, so true power is always less than apparent power.*

[3] *The crest factor for a sinusoidal 60 Hz current waveform is always 1.4. The crest factor for a current waveform associated with a computer containing a switching power supply will always be greater than 1.4 (though typically no higher than 8). The crest factor of a current waveform is defined as the ratio of the peak current (amps) to the RMS current (amps).*

review of the meter's crest factor[4] and of the current ranges available on the meter. Better meters will have higher crest factors, and more choices of current ranges.

When preparing the test, the first step should be to determine the peak current (amps) associated with the computer being measured. This can be accomplished using an oscilloscope. Then a current range must be selected that will enable the meter to register the peak current. Specifically, the full scale value of the current range selected multiplied by the crest factor of the meter (for current) must be greater than the peak current reading from the oscilloscope.

For example, if a wattmeter has a crest factor of 4, and the current range is set on 3 amps, the meter can register current spikes of up to 12 amps. If measured peak current is only 6 amps; the meter would be satisfactory. The other concern to be aware of is that if the current range is set too high in order to register peak current, it may lose accuracy in measuring the non-peak current. Again, with more current range choices and higher crest factors, manufacturer will get better results.

Frequency Response

Another issue to consider when selecting a wattmeter is the frequency response rating of the meter. Electronic equipment that contains switching power supplies causes harmonics (odd harmonics typically up to the 21st). These harmonics must be accounted for in power measurement, or the power consumption data will be inaccurate. Accordingly, EPA recommends that Partners purchase wattmeters that have a frequency response of at least 3 kHz. This will account for harmonics up to the 50th, and is recommended by IEC 555.

Resolution

Partners should choose a meter that can provide resolution of 0.1 W.

Accuracy

Catalogues and specification sheets for wattmeters typically provide information on the accuracy of power readings that can be achieved at different range settings.

Calibration

To maintain their accuracy, wattmeters should be calibrated with a standard that is traceable to the U.S. National Bureau of Standards (NBS).

Continuing Verification

This testing procedure (protocol) describes the method by which a single unit may be tested for compliance. An ongoing testing process is highly recommended to ensure that products from different production runs are in compliance with ENERGY STAR. A model may qualify as ENERGY STAR qualified if testing indicates that 95 percent of the units sold under this model name/number will meet the sleep mode requirements included in the ENERGY STAR Version 4.0 Computer specification.

[4] *The crest factor of a wattmeter is often provided for both current and voltage. For current, it is the ratio of the peak current to the RMS current in a specific current range. When only one crest factor is given, it is usually for current. An average true RMS wattmeter has a crest factor in the range of 2:1 to 6:1.*

APPENDIX B
Draft Test Procedure for Determining Idle State Power Use of Personal Computers

December 28, 2005 (Version 2)

The purpose of this test procedure is to provide a standard methodology for measuring the power use of computers in *Idle State*.5 Computers are normally characterized as operating in one of three *modes: off, sleep*, or *active*. Within the *active mode* is a state described as *Idle State* in which the computer is on and active, but there is little utilization of the central processing unit (CPU) (See *Idle State* definition below). What follows is the proposed methodology for measuring power use of computers in *Idle State.*

Definitions

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

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

Approved Meter
As described in IEC 62301 Ed 1.0: Measurement of Standby Power, approved meters include the following attributes:

- Power resolution of 1 mW or better;
- An available current crest factor of 3 (or more) at its rated range value;
- Minimum current range of 10mA (or less).

It is also desirable for measurement instruments to be able to average power accurately over any user selected time interval (this is usually done with an internal math's calculation dividing accumulated energy by time within the meter, which is the most accurate approach). As an alternative, the measurement instrument would have to be capable of integrating energy over any user selected time interval with an energy resolution of less than or equal to 0.1 mWh and integrating time displayed with a resolution of 1 second or less.

Off Mode
Off mode, also characterized as "*standby*," refers to the condition in which a computer has been switched off by means of the operating system software or a physical switch on the computer itself. Typically, some power consumption is still occurring in this situation, because the off switch is placed "downstream" of the power supply, thus causing some power to flow through the power supply even when the computer itself is off.

Sleep Mode
Sleep mode can correspond to a variety of different processor states, but is generally characterized as a condition under which a computer is not operating, but can rapidly return to normal operation following a wake signal from the keyboard, mouse, or local area network. Power use during sleep mode will often be slightly higher than in *off mode*, corresponding to the operation of circuitry that watches for a wake signal and then restores the computer to the set of operating conditions in which it was engaged prior to going to

5 This draft test procedure was prepared by NRDC and its consultant for consideration by the computer industry, ENERGY STAR, and other stakeholders. It includes collection of additional data about computer hardware and software configurations intended to inform specification-setting processes.. After such policies are adopted, the final test procedure may end up being substantially simpler.

sleep. This test procedure refers to *sleep mode* by the computer itself, rather than the *sleep mode* experienced by the monitor to which it is attached. Computers can trigger monitors to go to sleep without themselves being asleep. *Sleep mode* can further be subdivided to specify which components are powered down:

ACPI S-States for PCs	Common Terminology	Power Saving Action
S-1	"Standby"	Processor is halted but remains powered.
S-2	**No longer in use**	
S-3	"Suspend to RAM"/ "Sleep"	CPU powered down and contents moved to RAM
S-4	"Suspend to Disk"/ "Hibernate"	CPU powered down along with RAM, contents moved to disk
S-5	"Soft Off"/ "Shut Down"	System is powered down but could supply power to certain devices to trigger wake event, such as start up from LAN or USB device.

Active Mode

Active mode corresponds to a wide range of operating conditions that a computer may experience. At the high end (of both activity and power use), such operating conditions could include full CPU utilization, ongoing changes to information being displayed on the screen, hard drive and optical drive activity, network activity, data input from the keyboard or mouse, etc. More typically, only some of these activities might be occurring simultaneously, so power use would be somewhat lower.

Idle State

This test procedure refers to the lowest end of the active mode as *idle state* – a condition in which:

- The operating system has fully loaded
- No windows are open
- No user input is occurring from the keyboard or mouse
- No hard drive or optical drive activity is occurring and no floppy discs, optical discs, tapes, or flash memory cards are inserted in their respective drives
- The computer is connected to only one mouse, keyboard, and monitor
- No other USB or Firewire (IEEE 1394) peripherals are attached
- No change is occurring to the information displayed on screen (though a monitor is attached)
- No network connection is established via Ethernet, wireless, or modem sources6

Measurement Approach

Measurement of ac power consumption of a computer in the idle state should be conducted as follows:

1. Record the manufacturer and model name of the UUT.
2. Record basic information about the computer's configuration – computer type, operating system name and version, processor type and speed, front side bus speed, L2 Cache size, and total and available physical memory.7
3. Record basic information about the video card, including video card name, resolution, amount of onboard memory, and bits per pixel.8
4. Ensure that any power-throttling features for the system's processor(s) are enabled both in the operating system and in the BIOS. This may involve setting the computer to a specific power management scheme under certain operating systems.
5. Ensure that power management settings in the operating system that allow the computer to automatically power down hard drive(s) and monitor(s) and that place the entire system into a sleep state (see above) are set to 15 minutes.
6. Make the following initial preparations, depending on computer type:

Computer Type	Actions
Laptop/Tablet PC	1. Switch off the computer 2. Remove the laptop from its docking station (if applicable) 3. Remove the battery or ensure the battery is fully charged 4. Switch on the computer 5. Use power management settings to set screen to full brightness (adjust no other power management settings) and complete test below 6. Using power management settings, set the monitor to power down after 1 minute (adjust no other power management settings) and repeat test below
Integrated Desktop9	1. Use power management settings to set screen to full

6 Testing by Ecos Consulting and Lawrence Berkeley Laboratories has confirmed that network connections can contribute varying loads to idle state, depending on interface type, connection speed, and degree of activity. Removing active network connections entirely represents the most straightforward way to ensure repeatable, accurate results.

7 On Windows-based machines, this can be found by selecting the following window: Start / Programs / Accessories / System Tools / System Information.

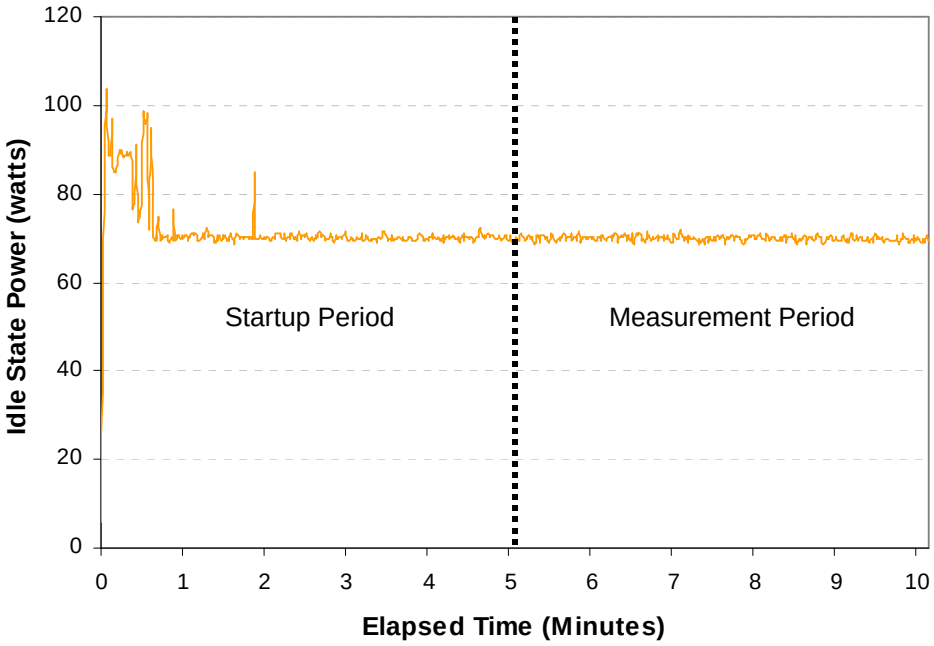
8 On Windows-based machines, this can be found by selecting the following window: Start / Programs / Accessories / System Tools / Components / Display.

9 An integrated desktop is a computer whose monitor has no separate ac power source. The computer's power cord also draws power to operate its integrated monitor.

	brightness (adjust no other power management settings) and complete test below 2. Using power management settings, set the monitor to power down after 1 minute (adjust no other power management settings) and repeat test below
Conventional Desktop	No preparations needed
Desktop Derived Server	No preparations needed

735
736

Idle State Power After Start Up



737 7. Connect an approved meter10 capable of measuring true power to an ac line voltage source set
738 at 120 volts, 60 Hz. Plug the UUT into the measurement power outlet on the meter. No power
739 strips or UPS units should be connected between the meter and the UUT. Record the ac voltage.
740 Switch on the computer and begin recording elapsed time. After the operating system has fully
741 loaded, close any windows that may be open. Exactly 5 minutes after the computer was switched
742 on, set meter to begin accumulating true power values at an interval of 1 reading per second.
743 Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value
744 observed during that 5 minute period.11 The data-recording period should not be more than 5
745 minutes so as to prevent potential data collection after power management settings have taken
746 effect.
747

10 Recently calibrated, laboratory grade metering equipment from Yokogawa, Voltech, etc. will tend to yield the highest precision, especially with readings of less than 5 watts. These meters can integrate over user-selected intervals to determine average power use for readings that are changing rapidly. Low cost plug load meters are not recommended for idle state measurements because they are often inaccurate when measuring reactive loads.

11 Laboratory-grade, full-function meters can integrate values over time and report the average value automatically. Other meters would require the user to capture a series of changing values every 5 seconds for a five minute period and then compute the average manually.

8. Record date, location of test, and testing organization, as well as name of technician conducting the test. If multiple computers of the same model are being tested, record serial number or other unique identifying information.

All data shall be entered into a standardized form in the following spreadsheet to facilitate analysis and ensure comparable results.