



ENERGY STAR® Program Requirements for Computers

Partner Commitments

Following are the terms of the ENERGY STAR Partnership Agreement as it pertains to the manufacture and labeling of ENERGY STAR qualified products. The ENERGY STAR Partner must adhere to the following partner commitments:

Qualifying Products

1. Comply with current ENERGY STAR Eligibility Criteria, which define performance requirements and test procedures for Computers. A list of eligible products and their corresponding Eligibility Criteria can be found at www.energystar.gov/specifications.
2. **Prior to associating the ENERGY STAR name or mark with any product**, obtain written certification of ENERGY STAR qualification from a Certification Body recognized by EPA for Computers. As part of this certification process, products must be tested in a laboratory recognized by EPA to perform Computer testing. A list of EPA-recognized laboratories and certification bodies can be found at www.energystar.gov/testingandverification.

Using the ENERGY STAR Name and Marks

3. Comply with current ENERGY STAR Identity Guidelines, which define how the ENERGY STAR name and marks may be used. Partner is responsible for adhering to these guidelines and ensuring that its authorized representatives, such as advertising agencies, dealers, and distributors, are also in compliance. The ENERGY STAR Identity Guidelines are available at www.energystar.gov/logouse.
4. Use the ENERGY STAR name and marks only in association with qualified products. Partner may not refer to itself as an ENERGY STAR Partner unless at least one product is qualified and offered for sale in the U.S and/or ENERGY STAR partner countries.
5. Provide clear and consistent labeling of ENERGY STAR qualified Computers.
 - 5.1. Partner shall adhere to the following product-specific commitments regarding use of the ENERGY STAR certification mark on qualified products:
 - 5.1.1. Partner must use the ENERGY STAR mark in one of the following ways:
 - 1) Via permanent or temporary label on the top or front of the product. All temporary labeling must be affixed to the product with an adhesive or cling-type application; or
 - 2) Via electronic labeling. Electronic labeling must meet the following requirements:
 - a. The ENERGY STAR mark in cyan, black, or white must appear at system start-up, and must display for a minimum of 5 seconds;
 - b. The ENERGY STAR mark must be at least 10% of the screen by area, must not be smaller than 76 pixels x 78 pixels, and must be legible.EPA will consider alternative proposals for electronic labeling on a case-by-case basis.
 - 5.1.2. Partner must use the ENERGY STAR mark in product literature (i.e., user manuals, spec sheets, etc.).
 - 5.1.3. Partner must use the ENERGY STAR mark on product packaging for products sold at retail.

- 5.1.4. Partner must use the ENERGY STAR mark on the manufacturer's Internet site where information about ENERGY STAR qualified models is displayed.
 - 1) If additional information about the ENERGY STAR program or other products is provided by the Partner on its website, Partner must comply with the ENERGY STAR Web Linking Policy, which can be found at www.energystar.gov/partners;

Verifying Ongoing Product Qualification

6. Participate in third-party verification testing through a Certification Body recognized by EPA for Computers, providing full cooperation and timely responses, EPA/DOE may also, 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 the government's request.

Providing Information to EPA

7. Provide unit shipment data or other market indicators to EPA annually to assist with creation of ENERGY STAR market penetration estimates, as follows:
 - 7.1. Partner must submit the total number of ENERGY STAR qualified Computers shipped in the calendar year or an equivalent measurement as agreed to in advance by EPA and Partner. Partner shall exclude shipments to organizations that rebrand and resell the shipments (unaffiliated private labelers).
 - 7.2. Partner must provide unit shipment data segmented by meaningful product characteristics (e.g., type, capacity, presence of additional functions) as prescribed by EPA.
 - 7.3. Partner must submit unit shipment data for each calendar year to EPA or an EPA-authorized third party, preferably in electronic format, no later than March 1 of the following year.

Submitted unit shipment 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;
8. Report to EPA any attempts by recognized laboratories or Certification Bodies (CBs) to influence testing or certification results or to engage in discriminatory practices.
9. Notify EPA of a change in the designated responsible party or contacts within 30 days using the My ENERGY STAR Account tool (MESA) available at www.energystar.gov/mesa.

Training and Consumer Education

10. Partner shall agree to complete steps to educate users of their products about the benefits of power management by including the following information with each Computer (i.e., in the user manual or on a box insert):
 - 10.1. Energy saving potential;
 - 10.2. Financial saving potential;
 - 10.3. Environmental benefits;
 - 10.4. Information on ENERGY STAR and a link to www.energystar.gov; and
 - 10.5. ENERGY STAR logo (used in accordance with "The ENERGY STAR Identity Guidelines" available at www.energystar.gov/logos).
11. In addition, a link should be made available to www.energystar.gov/powermanagement from Computer product pages, product specifications, and related content pages.
12. 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.

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:

- 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.
- Consider energy efficiency improvements in company facilities and pursue benchmarking buildings through the ENERGY STAR Buildings program.
- 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.
- Feature the ENERGY STAR mark(s) on Partner website and other promotional materials. If information concerning ENERGY STAR is provided on the Partner website as specified by the ENERGY STAR Web Linking Policy (available in the Partner Resources section of the ENERGY STAR website), EPA may provide links where appropriate to the Partner website.
- Ensure the power management feature is enabled on all ENERGY STAR qualified displays and computers in use in company facilities, particularly upon installation and after service is performed.
- Provide general information about the ENERGY STAR program to employees whose jobs are relevant to the development, marketing, sales, and service of current ENERGY STAR qualified products.
- 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, and communicate Partner's activities, provide an EPA representative, or include news about the event in the ENERGY STAR newsletter, on the ENERGY STAR website, etc. The plan may be as simple as providing a list of planned activities or milestones of which Partner would like EPA to be aware. For example, activities may include: (1) increasing the availability of ENERGY STAR qualified products by converting the entire product line within two years to meet ENERGY STAR guidelines; (2) demonstrating the economic and environmental benefits of energy efficiency through special in-store displays twice a year; (3) providing information to users (via the website and user's manual) about energy-saving features and operating characteristics of ENERGY STAR qualified products; and (4) building awareness of the ENERGY STAR Partnership and brand identity by collaborating with EPA on one print advertorial and one live press event.
- Join EPA's SmartWay Transport Partnership to improve the environmental performance of the company's shipping operations. The SmartWay Transport Partnership 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 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. For more information on Green Power, visit www.epa.gov/greenpower.



ENERGY STAR® Program Requirements Product Specification for Computers

Eligibility Criteria Version 5.2

Following is the Version 5.2 ENERGY STAR Product Specification for Computers. A product shall meet all of the identified criteria if it is to earn the ENERGY STAR.

1 DEFINITIONS

A) Product Types:

- 1) Computer: A device which performs logical operations and processes data. For the purposes of this specification, computers include both stationary and portable units, including desktop computers, integrated desktop computers, notebook computers, small-scale servers, thin clients, and workstations. Although computers are capable of using input devices and displays, such devices are not required to be included with the computer upon shipment. Computers are composed of, at a minimum:
 - a) A central processing unit (CPU) to perform operations;
 - b) User input devices such as a keyboard, mouse, digitizer or game controller; and
 - c) An integrated display screen and/or the ability to support an external display screen to output information.
- 2) Desktop Computer: A computer whose main unit is designed to be located in a permanent location, often on a desk or on the floor. Desktop computers are not designed for portability and are designed for use with an external display, keyboard, and mouse. Desktop computers are intended for a broad range of home and office applications.
 - a) Integrated Desktop Computer: A desktop computer in which the computing hardware and display are integrated into a single housing, and which is connected to ac mains power through a single cable. Integrated desktop computers come in one of two possible forms: (1) a system where the display and computer are physically combined into a single unit; or (2) a system packaged as a single system where the display is separate but is connected to the main chassis by a dc power cord and both the computer and display are powered from a single power supply. As a subset of desktop computers, integrated desktop computers are typically designed to provide similar functionality as desktop systems.
- 3) Notebook Computer: A computer designed specifically for portability and to be operated for extended periods of time both with and without a direct connection to an ac mains power source. Notebook computers include an integrated display and are capable of being powered by an integrated battery or other portable power source. In addition, most notebooks use an external power supply and have an integrated keyboard and pointing device. Notebook computers are typically designed to provide similar functionality to desktops, including operation of software similar in functionality as that used in desktops. For purposes of this specification:
 - a) tablet computers, which use both a touch-sensitive screen and a physical keyboard, are considered Notebook Computers; and

- b) slate computing devices, defined here as a type of computer lacking a physical keyboard, relying solely on touchscreen input, having solely a wireless network connection (e.g., Wi-Fi, 3G), and primarily powered from an internal battery (with connection to the mains for charging, not primary powering of the device) are considered handhelds and are not considered notebook computers. Consequently, slates are not eligible for this version of the ENERGY STAR computer program.

Note: Slates are an emerging group of devices marketed independently of the notebook computer and smartphone designations. Slates are excluded from qualification under this version of the computer specification.

It is important that EPA consider closely the usage modes and power profile of any computer type within the ENERGY STAR computer program to ensure efficiency levels and requirements are appropriate and fair. EPA will proceed with further review of slates with the intent to address such products in the next revision to this specification.

- 4) Small-scale Server: A computer that typically uses desktop components in a desktop form factor, but is designed primarily to be a storage host for other computers. Small-scale Servers are designed to perform functions such as providing network infrastructure services (e.g., archiving) and hosting data/media. These products are not designed to process information for other systems or run web servers as a primary function. A Small-scale Server has the following characteristics:
 - a) 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;
 - b) Designed to operate 24 hours/day, 7 days/week, with minimal unscheduled downtime (on the order of hours/year);
 - c) Capable of operating in a simultaneous multi-user environment serving several users through networked client units; and
 - d) Designed for an industry accepted operating system for home or low-end server applications (e.g., Windows Home Server, Mac OS X Server, Linux, UNIX, Solaris).
- 5) Thin Client: An independently-powered computer that relies on a connection to remote computing resources to obtain primary functionality. Main computing functions (e.g., program execution, data storage, interaction with other Internet resources) are provided by the remote computing resources. Thin Clients covered by this specification are (1) limited to devices with no rotational storage media integral to the computer and (2) designed for use in a permanent location (e.g. on a desk) and not for portability.
- 6) Workstation: A high-performance, single-user computer typically used for graphics, CAD, software development, financial and scientific applications among other compute intensive tasks. Workstations covered by this specification (a) are marketed as a workstation; (b) provide mean time between failures (MTBF) of at least 15,000 hours (based on either Bellcore TR-NWT-000332, issue 6, 12/97 or field collected data); and (c) support error-correcting code (ECC) and/or buffered memory. In addition, a workstation meets three or more of the following criteria:
 - a) Provide supplemental power support for high-end graphics (e.g., PCI-E 6-pin 12V supplemental power feed);
 - b) Wired for greater than x4 PCI-E on the motherboard in addition to the graphics slot(s) and/or PCI-X support;

- c) Do not provide support for Uniform Memory Access (UMA) graphics;
 - d) Provide 5 or more PCI, PCI-E, or PCI-X slots;
 - e) Provide multi-processor support for 2 or more processors (shall support physically separate processor packages/sockets, i.e., requirement cannot be met with support for a single multi-core processor); and/or
 - f) Qualification by 2 or more Independent Software Vendor (ISV) product certifications; these certifications can be in process, but shall be completed within 3 months of qualification.
- B) Product Category: A second-order classification or sub-type within a product type that is based on product features and installed components. Product categories are used in this specification to determine qualification and test requirements.
- C) Computer Components:
- 1) Display: A display screen and its associated electronics encased in a single housing, or within the computer housing (e.g., notebook or integrated desktop computer), that is capable of displaying output information from a computer via one or more inputs, such as a VGA, DVI, Display Port, and/or IEEE 1394. Examples of computer display technologies are the cathode-ray tube (CRT) and liquid crystal display (LCD).
 - 2) Discrete Graphics Processing Unit (GPU): A graphics processor with a local memory controller interface and local graphics-specific memory.
 - 3) External Power Supply (EPS): Also referred to as External Power Adapter. A component contained in a separate physical enclosure external to the computer casing, designed to convert line voltage ac input from the mains to lower dc voltage(s) in order to provide power to the computer. An external power supply shall connect to the computer via a removable or hard-wired male/female electrical connection, cable, cord or other wiring.
 - 4) Internal Power Supply (IPS): 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 shall be contained within the computer casing but be separate from the main computer board. The power supply shall 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, with the exception of a DC connection to a display in an Integrated Desktop Computer, shall 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.
- D) Operational Modes:
- 1) Off Mode: 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 systems where ACPI standards are applicable, Off Mode correlates to ACPI System Level S5 state.

- 2) Sleep Mode: A low power mode that the computer enters automatically after a period of inactivity or by manual selection. A computer with Sleep capability can quickly “wake” in response to network connections or user interface devices with a latency of less than or equal to 5 seconds from initiation of wake event to system becoming fully usable including rendering of display. For systems where ACPI standards are applicable, Sleep Mode most commonly correlates to ACPI System Level S3 (suspend to RAM) state.
- 3) Idle State: The power state in which the operating system and other software have completed loading, a user profile has been created, activity is limited to those basic applications that the system starts by default, and the computer is not in Sleep Mode.
- 4) Active State: The power state in which the computer is carrying out useful work in response to a) prior or concurrent user input or b) prior or concurrent instruction over the network. Active State includes active processing, seeking data from storage, memory, or cache, including Idle State time while awaiting further user input and before entering low power modes.

E) Networking and Additional Capabilities:

- 1) Additional Internal Storage: Any and all internal hard disk drives (HDD) or solid state drives (SSD) shipping with a computer beyond the first. This definition does not include external drives.
- 2) Network Interface: The components (hardware and software) whose primary function is to make the computer capable of communicating over one or more network technologies. Examples of Network Interfaces are IEEE 802.3 (Ethernet) and IEEE 802.11 (Wi-Fi).
- 3) Wake Event: A user, scheduled, or external event or stimulus that causes the computer to transition from Sleep Mode or Off Mode to an active state of operation. Examples of wake events include, but are not limited to: movement of the mouse, keyboard activity, controller input, real-time clock event, or a button press on the chassis, and in the case of external events, stimulus conveyed via a remote control, network, modem, etc.
- 4) Wake On LAN (WOL): Functionality which allows a computer to transition from Sleep Mode or Off Mode to an Active State of operation when directed by a network Wake Event via Ethernet.
- 5) Full Network Connectivity: The ability of the computer to maintain network presence while in Sleep Mode or another low power mode of equal or lower power consumption (“LPM”) and intelligently wake when further processing is required (including occasional processing required to maintain network presence). Presence of the computer, its network services and applications, is maintained even though the computer is in a LPM. From the vantage point of the network, a computer with full network connectivity that is in LPM is functionally equivalent to an idle computer with respect to common applications and usage models. Full network connectivity in LPM is not limited to a specific set of protocols but can cover applications installed after initial installation. Also referred to as “network proxy” functionality.
 - a) Network Proxy - Base Capability: To maintain addresses and presence on the network while in LPM, the system handles IPv4 ARP and IPv6 NS/ND.
 - b) Network Proxy - Remote Wake: While in LPM, the system is capable of remotely waking upon request from outside the local network. Includes Base Capability.
 - c) Network Proxy - Service Discovery/Name Services: While in LPM, the system allows for advertising host services and network name. Includes Base.
 - d) Network Proxy - Full Capability: While in LPM, the system supports Base Capability, Remote Wake, and Service Discovery/Name Services.

F) Marketing and Shipment Channels:

- 1) Enterprise Channels: Sales channels typically used by large and medium-sized business, government, educational, or other organizations to purchase computers for use in managed client/server environments.
- 2) Model Number: A unique marketing name or identification reference that applies to a specific hardware and software configuration (e.g., operating system, processor type, memory, GPU), and is either pre-defined or selected by a customer.
- 3) Model Name: A marketing name that includes reference to the computer model number, product description, or other branding references.
- 4) Product Family: A high-level description referring to a group of computers typically sharing one chassis/motherboard combination that often contains hundreds of possible hardware and software configurations.

2 SCOPE

2.1 Included Products

2.1.1 Products that meet the definition of a Computer and one of the following Product Type definitions, as specified herein, are eligible for ENERGY STAR qualification, with the exception of products listed in Section 2.2:

- i. Desktop Computers,
- ii. Integrated Desktop Computers,
- iii. Notebook Computers,
- iv. Workstations,
- v. Small-scale Servers that are marketed and sold for non-data center use,
- vi. Thin Clients.

2.2 Excluded Products

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

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

- i. Computer Servers, as defined in ENERGY STAR Computer Server specification,
- ii. Small-scale Servers that are marketed and sold for use in data centers,
- iii. Handheld Computers (including slate computing devices),
- iv. Game Consoles,
- v. Personal Digital Assistant devices (PDAs),
- vi. Smart Phones,
- vii. Handheld gaming devices, typically battery powered and intended for use with an integral display as the primary display.

3 QUALIFICATION CRITERIA

3.1 Significant Digits and Rounding

- 3.1.1 All calculations shall be carried out with actual measured or observed values. Only the final result of a calculation shall be rounded. Calculated results shall be rounded to the nearest significant digit as expressed in the corresponding specification limit.
- 3.1.2 Unless otherwise specified, compliance with specification limits shall be evaluated using exact values without any benefit from further rounding.

3.2 Power Supply Requirements

- 3.2.1 Power supply test data and test reports from testing entities recognized by EPA to perform power supply testing shall be accepted for the purpose of qualifying the ENERGY STAR product.
- 3.2.2 Internal Power Supplies (IPS): Internal Power Supplies used in Computers eligible under this specification must meet the following requirements when tested using the *EPRi Generalized Internal Power Supply Efficiency Test Protocol, Rev. 6.4.2* (available at www.efficientpowersupplies.org).
- i. IPS with maximum rated output power less than 75 watts shall meet minimum efficiency requirements as specified in Table 1.
 - ii. IPS with maximum rated output power greater than or equal to 75 watts shall meet both minimum efficiency requirements and minimum power factor requirements, as specified in Table 1.
- 3.2.3 External Power Supplies (EPS):
- i. EPS with integral cooling fans shall meet minimum efficiency requirements and minimum power factor requirements, as specified in Table 1, when tested using the *EPRi Generalized Internal Power Supply Efficiency Test Protocol, Rev. 6.4.2*.

Table 1: Requirements for Internal Power Supplies and External Power Supplies with Integral Cooling

Loading Condition (Percentage of Nameplate Output Current)	Minimum Efficiency	Minimum Power Factor
20%	0.82	-
50%	0.85	-
100%	0.82	0.90

- ii. EPS without integral cooling fans shall meet the level V performance requirements under the International Efficiency Marking Protocol and include the level V marking. Additional information on the Marking Protocol is available at www.energystar.gov/powersupplies.
 - Single-output EPS without integral cooling fans shall meet level V requirements when tested using the *Test Method for Calculating the Energy Efficiency of Single-Voltage External Ac-Dc and Ac-Ac Power Supplies, Aug. 11, 2004*.
 - Multi-output EPS without integral cooling fans shall meet the level V requirements when tested using the *EPRi Generalized Internal Power Supply Efficiency Test Protocol, Rev. 6.4.2*.

3.3 Power Management Requirements

3.3.1 Products shall include power management features in their “as-shipped” condition as specified in Table 2, subject to the following conditions:

- i. For Thin Clients, the WOL requirement shall apply products designed to receive software updates from a centrally managed network while in Sleep Mode or in Off Mode. Thin Clients whose standard software upgrade framework does not require off-hours scheduling are exempt from the WOL requirement.
- ii. For Notebooks, WOL may be automatically disabled when the product is disconnected from ac mains power.
- iii. For all products with WOL, directed packet filters shall be enabled and set to an industry standard default configuration.

Table 2: Power Management Requirements

Mode or Mode Transition	Requirement	Desktops	Integrated Desktops	Notebooks	Workstations	Small-scale Servers	Thin Clients
Sleep Mode	(1) Sleep Mode shall be set to activate after no more than 30 minutes of user inactivity. (2) The speed of any active 1 Gb/s Ethernet network links shall be reduced when transitioning to Sleep Mode or Off Mode.	Yes	Yes	Yes	Yes	No	No
Display Sleep Mode	(1) Display Sleep Mode shall be set to activate after no more than 15 minutes of user inactivity.	Yes	Yes	Yes	Yes	Yes	Yes
Wake on LAN (WOL)	(1) Computers with Ethernet capability shall provide users with an option to enable and disable WOL for Sleep Mode. (2) Computers with Ethernet capability that are shipped through enterprise channels shall either: (a) be shipped with WOL enabled by default for Sleep Mode, when the computer is operating on ac mains power; or (b) provide users with the ability to enable WOL that is accessible from both the client operating system user interface and over the network.	Yes	Yes	Yes	Yes	Yes	Yes

Mode or Mode Transition	Requirement	Desktops	Integrated Desktops	Notebooks	Workstations	Small-scale Servers	Thin Clients
Wake Management	(1) Computers with Ethernet capability that are shipped through enterprise channels shall: (a) be capable of both remote (via network) and scheduled (via real-time clock) wake events from Sleep Mode, and (b) provide clients with the ability to centrally manage (via vendor tools) any wake management settings that are configured through hardware settings if the manufacturer has control over such features.	Yes	Yes	Yes	Yes	Yes	Yes

3.4 User Information Requirements

3.4.1 Products shall be shipped with informational materials to notify customers of the following:

- i. A description of power management settings that have been enabled by default,
- ii. A description of the timing settings for various power management features, and
- iii. Instructions for properly waking the product from Sleep Mode.

3.4.2 Products shall be shipped with one or more of the following:

- i. A list of default power management settings.
- ii. A note stating that default power management settings have been selected for compliance with ENERGY STAR (within 15 min of user inactivity for the display, within 30 min for the computer, if applicable per Table 2), and are recommended by the ENERGY STAR program for optimal energy savings.
- iii. Information about ENERGY STAR and the benefits of power management, to be located at or near the beginning of the hard copy or electronic user manual, or in a package or box insert.

3.5 Requirements for Desktop, Integrated Desktop, and Notebook Computers

3.5.1 Categories for TEC Criteria: Desktops, Integrated Desktops shall be evaluated in the categories described in Table 3, and Notebook Computers shall be evaluated in the categories described in Table 4.

- i. For the purposes of determining TEC levels, desktops and integrated desktops must qualify under Categories A, B, C, or D as defined in Table 3.

Table 3: Categorization of Desktop and Integrated Desktop Computers

Category A	All desktop computers that do not meet the definition of Category B, Category C, or Category D below will be considered under Category A for ENERGY STAR qualification.
Category B	To qualify under Category B, desktops <u>must</u> have: <ul style="list-style-type: none"> ▪ Equal to 2 Physical Cores; and ▪ Greater than or equal to 2 gigabytes (GB) of System Memory.
Category C	To qualify under Category C, desktops <u>must</u> have: <ul style="list-style-type: none"> ▪ Greater than 2 Physical Cores. In addition to the requirement above, models qualifying under Category C must be configured with a minimum of 1 of the following 2 characteristics: <ul style="list-style-type: none"> ▪ Greater than or equal to 2 gigabytes (GB) of System Memory; and/or ▪ A Discrete GPU.
Category D	To qualify under Category D, desktops <u>must</u> have: <ul style="list-style-type: none"> ▪ Greater than or equal to 4 Physical Cores. In addition to the requirement above, models qualifying under Category D must be configured with a minimum of 1 of the following 2 characteristics: <ul style="list-style-type: none"> ▪ Greater than or equal to 4 gigabytes (GB) of System Memory; and/or ▪ A Discrete GPU with a Frame Buffer Width greater than 128-bit.

- ii. For the purposes of determining TEC levels, notebooks must qualify under Categories A, B, or C as defined in Table 4:

Table 4: Categorization of Notebook Computers

Category A	All notebook computers that do not meet the definition of Category B or Category C below will be considered under Category A for ENERGY STAR qualification.
Category B	To qualify under Category B, notebooks <u>must</u> have: <ul style="list-style-type: none"> ▪ A Discrete GPU.
Category C	To qualify under Category C, notebooks <u>must</u> have: <ul style="list-style-type: none"> ▪ Greater than or equal to 2 Physical Cores; ▪ Greater than or equal to 2 gigabytes (GB) of System Memory; and ▪ A Discrete GPU with a Frame Buffer Width greater than 128-bit.

- 3.5.2 Calculated Typical Energy Consumption (E_{TEC}) per Equation 1 shall be less than or equal to the maximum TEC requirement (E_{TEC_MAX}), as calculated per Equation 2, subject to the following requirements:
- i. The Additional Internal Storage adder ($TEC_{STORAGE}$) shall be applied if there are one or more internal storage devices present in the product, in which case it shall only be applied once.
 - ii. For a product to qualify for the Full Network Connectivity weightings, the following criteria shall be satisfied:
 - Products shall meet a non-proprietary Full Network Connectivity standard that has been approved by the EPA and the European Union as meeting the goals of ENERGY STAR. Such approval must be in place prior to submittal of product data for qualification.
 - Products shall have the applied level of functionality enabled and configured by default upon shipment. If Full Network Connectivity features are not enabled by default, the system shall be tested and reported with Conventional TEC weightings.

Equation 1: TEC Calculation (E_{TEC}) for Desktop, Integrated Desktop, and Notebook Computers

$$E_{TEC} = (8760 / 1000) * \{(P_{OFF} * T_{OFF}) + (P_{SLEEP} * T_{SLEEP}) + (P_{IDLE} * T_{IDLE})\}$$

Where:

- P_{OFF} = Measured power consumption in Off Mode (W)
- P_{SLEEP} = Measured power consumption in Sleep Mode (W)
- P_{IDLE} = Measured power consumption in Idle Mode (W)
- T_{OFF} , T_{SLEEP} , and T_{IDLE} are mode weightings as specified in Table 5 (for Desktops and Integrated Desktops) or Table 6 (for Notebooks).

Equation 2: E_{TEC_MAX} Calculation for Desktop, Integrated Desktop,

$$E_{TEC_MAX} = TEC_{BASE} + TEC_{MEMORY} + TEC_{GRAPHICS} + TEC_{STORAGE}$$

Where:

- TEC_{BASE} , TEC_{MEMORY} , $TEC_{GRAPHICS}$, and $TEC_{STORAGE}$ are adders as specified in Table 7 (for Desktops and Integrated Desktops) or Table 8 (for Notebooks).

Table 5: Mode Weightings for Desktop and Integrated Desktop Computers

Mode Weighting	Conventional	Full Network Connectivity			
		Base Capability	Remote Wake	Service Discovery/Name Services	Full Proxying
T_{off}	55%	50%	47%	43%	40%
T_{sleep}	5%	14%	20%	25%	30%
T_{idle}	40%	36%	33%	32%	30%

Table 6: Mode Weightings for Notebook Computers

Mode Weighting	Conventional	Full Network Connectivity			
		Base Capability	Remote Wake	Service Discovery / Name Services	Full Proxying
T _{off}	60%	54%	49%	48%	45%
T _{sleep}	10%	18%	24%	26%	30%
T _{idle}	30%	28%	27%	26%	25%

Table 7: Maximum TEC Allowances for Desktop and Integrated Desktop Computers

Product Category	TEC _{BASE} (kWh)	TEC _{MEMORY} (kWh) <i>Where: m = System Memory (GB)</i>	TEC _{GRAPHICS} (kWh)	TEC _{STORAGE} (kWh) <i>(Applies once if system has more than one Additional Internal Storage element.)</i>
A	148.0	1.0 <i>(per GB > 2.0)</i>	35.0 <i>(GPU Frame Buffer Width ≤ 128-bit)</i>	25.0
			50.0 <i>(GPU Frame Buffer Width > 128-bit)</i>	
B	175.0	1.0 <i>(per GB > 2.0)</i>	35.0 <i>(GPU Frame Buffer Width ≤ 128-bit)</i>	25.0
			50.0 <i>(GPU Frame Buffer Width > 128-bit)</i>	
C	209.0	1.0 <i>(per GB > 2.0)</i>	50.0 <i>(GPU Frame Buffer Width > 128-bit)</i>	25.0
D	234.0	1.0 <i>(per GB > 4.0)</i>	50.0 <i>(GPU Frame Buffer Width > 128-bit)</i>	25.0

Table 8: Maximum TEC Allowances for Notebook Computers

Product Category	TEC _{BASE} (kWh)	TEC _{MEMORY} (kWh) Where: <i>m</i> = System Memory (GB)	TEC _{GRAPHICS} (kWh)	TEC _{STORAGE} (kWh) (Applies <u>once</u> if system has more than one Additional Internal Storage element.)
A	40.0	0.4 (per GB > 4.0)	-	3.0
B	53.0	0.4 (per GB > 4.0)	3.0 (GPU Frame Buffer Width > 64-bit)	3.0
C	88.5	0.4 (per GB > 4.0)	-	3.0

3.6 Requirements for Workstations

3.6.1 Weighted power consumption (P_{TEC}) as calculated per Equation 3 shall be less than or equal to the maximum weighted power consumption requirement (P_{TEC_MAX}) as calculated per Equation 4.

Equation 3: P_{TEC} Calculation for Workstations

$$P_{TEC} = (P_{OFF} * T_{OFF}) + (P_{SLEEP} * T_{SLEEP}) + (P_{IDLE} * T_{IDLE})$$

Where:

- P_{OFF} = Measured power consumption in Off Mode (W)
- P_{SLEEP} = Measured power consumption in Sleep Mode (W)
- P_{IDLE} = Measured power consumption in Idle Mode (W)
- T_{OFF} , T_{SLEEP} , and T_{IDLE} are mode weightings as specified in Table 9

Table 9: Mode Weightings for Workstations

T _{OFF}	T _{SLEEP}	T _{IDLE}
0.35	0.10	0.55

Equation 4: P_{TEC_MAX} Calculation for Workstations

$$P_{TEC_MAX} \leq 0.28 * \{P_{MAX} + (N_{HDD} * 5)\}$$

Where:

- P_{MAX} = Measured maximum power consumption (W)
- N_{HDD} = Number of installed hard disk drives (HDD) or solid state drives (SSD)

3.6.2 Desktop Workstations: Products marketed as workstations may qualify for ENERGY STAR under the Desktop requirements in Section 3.5, instead of the Workstation requirements in Section 3.6.1, at the Partner’s option. EPA will identify Workstations qualified as Desktops as “Desktops” in all ENERGY STAR marketing materials, on qualified product lists, etc.

3.7 Requirements for Small-scale Servers

3.7.1 Measured Off Mode power (P_{OFF}) shall be less than or equal to the maximum Off Mode power consumption requirement (P_{OFF_MAX}) listed in Table 10, as calculated per Equation 5, subject to the following requirements:

- i. Products shall be evaluated using the highest letter category to which they apply.
- ii. The Off Mode Wake-On-LAN (WOL) adder (P_{OFF_WOL}) shall only be applied to products that offer WOL that is enabled by default upon shipment.

Equation 5: Calculation of P_{OFF_MAX} for Small-scale Servers

$$P_{OFF_MAX} = P_{OFF_BASE} + P_{OFF_WOL}$$

3.7.2 Measured Idle State power (P_{IDLE}) shall be less than or equal to the maximum Idle State power consumption requirement (P_{IDLE_MAX}) specified in Table 10.

Table 10: Classification & Power Consumption Requirements for Small-scale Servers

Small-scale Server Classification		Operational Mode Requirements		
Product Category	Category Description	P_{OFF_BASE} (watts)	P_{OFF_WOL} (watts)	P_{IDLE_MAX} (watts)
A	All Small-Scale Servers that do not meet the definition of Category B will be considered under Category A for ENERGY STAR qualification.	2.0	0.7	50.0
B	To qualify under Category B Small-Scale Servers must have: <ul style="list-style-type: none"> • Processor(s) with greater than 1 physical core or greater than 1 discrete processor; and • Minimum of 1 gigabyte of system memory. 	2.0	0.7	65.0

3.8 Requirements for Thin Clients

3.8.1 Measured Off Mode power (P_{OFF}) shall be less than or equal to the maximum Off Mode power consumption requirement (P_{OFF_MAX}) in Table 11, as calculated per Equation 6, subject to the following requirements.

- i. Products shall be evaluated using the highest letter category to which they apply.
- ii. The Off Mode Wake-On-LAN (WOL) adder (P_{OFF_WOL}) shall only be applied to products that offer WOL that is enabled by default upon shipment.

Equation 6: Calculation of P_{OFF_MAX} for Thin Clients

$$P_{OFF_MAX} = P_{OFF_BASE} + P_{OFF_WOL}$$

3.8.2 For products that offer a Sleep Mode, measured Sleep Mode power (P_{SLEEP}) shall be less than or equal to the maximum Sleep Mode power consumption requirement (P_{SLEEP_MAX}) in Table 11, as calculated per Equation 7, subject to the following requirement.

- i. The Sleep Mode Wake-On-LAN (WOL) adder (P_{SLEEP_WOL}) shall only be applied to products that offer WOL that is enabled by default upon shipment.

Equation 7: Calculation of P_{SLEEP_MAX} for Thin Clients

$$P_{SLEEP_MAX} = P_{SLEEP_BASE} + P_{SLEEP_WOL}$$

3.8.3 Measured Idle State power (P_{IDLE}) shall be less than or equal to the maximum Idle State power consumption requirement (P_{IDLE_MAX}) specified in Table 11.

Table 11: Classification & Power Consumption Requirements for Thin Clients

Thin Client Classification		Operational Mode Requirements				
Product Category	Category Description	P_{OFF_BASE} (watts)	P_{OFF_WOL} (watts)	P_{SLEEP_BASE} (watts)	P_{SLEEP_WOL} (watts)	P_{IDLE_MAX} (watts)
A	All Thin Clients that do not meet the definition of Category B, below, will be considered under Category A for ENERGY STAR qualification.	2.0	0.7	2.0	0.7	12.0
B	To qualify under Category B, Thin Clients must support local multimedia encode/decode.	2.0	0.7	2.0	0.7	15.0

4 TESTING

4.1 Test Methods

4.1.1 When testing Computer products, the test methods identified in Table 12 shall be used to determine ENERGY STAR qualification.

Table 12: Test Methods for ENERGY STAR Qualification

Product Type or Component	Test Method
All	ENERGY STAR Test Method for Computers, Rev. Aug-2010

4.2 Number of Units Required for Testing

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

- i. For qualification of an individual product configuration, the unique configuration that is intended to be marketed and labeled as ENERGY STAR is considered the Representative Model.
- ii. For qualification of a product family of all product types, with the exception of Workstations, product configurations that represent the worst-case power consumption for each product category within the family are considered Representative Models.
- iii. For qualification of a product family of Workstations under the Workstation or Desktop product type, the product configuration that represents the worst-case power consumption with a single GPU within the family is considered the Representative Model. Note: Workstations that meet ENERGY STAR requirements with a single graphics device may also qualify a configuration with more than one graphics device, provided the additional hardware configuration is identical with the exception of the additional graphics device(s). The use of multiple graphics includes, but is not limited to, driving multiple displays and ganging for high performance, multi-GPU configurations (e.g. ATI Crossfire, NVIDIA SLI). In such cases, and until such time as SPECviewperf® supports multiple graphics threads, manufacturers may submit the test data for the workstation with the single graphics device for both configurations without retesting the system.

4.2.2 A single unit of each Representative Model shall be selected for testing. If the initial unit tested is less than or equal to the applicable requirement for TEC or Idle but falls within 10% of that level, one additional unit of the same model with an identical configuration must also be tested.

4.2.3 Test values shall be reported test for both units. To qualify as ENERGY STAR when testing of an additional unit is required, both units must meet the maximum TEC or Idle level for that product and that product category. All tested units shall meet ENERGY STAR qualification requirements.

4.2.4 The requirements detailed in 4.2.2 and 4.2.3 are required only for TEC qualification (Desktops, Integrated Desktops, Notebooks, Workstations) and Idle qualification (Small-Scale Servers, Thin Clients). For product categories subject to power limits in Off Mode or Sleep Mode, only one unit is required to be tested for these modes to evaluate qualification.

4.3 Qualifying Families of Products

4.3.1 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. If a product model is offered in the market in multiple configurations or styles, as a product “family” or series, the partner may report and qualify the product under a single model number, as long as all of the models within that family or series meet either of the following requirements:

- Computers that are built on the same platform and are identical in every respect except for housing and color may be qualified through submission of test data for a single, representative model.
- If a product model is offered in the market in multiple configurations, the partner may report and qualify the product under a single unique model identifier number that represents the highest power configuration available in the family, rather than reporting each and every individual model in the family; there must not be higher consuming configurations of the same product model than the representative configuration. In this case, the highest configuration would consist of: the highest power processor, the maximum memory configuration, the highest power GPU, etc. For systems which meet the definition for multiple categories (as defined in section 3.B) depending on the specific configuration, manufacturers will have to submit the highest power configuration for each category under which they would like the system to qualify. For example, a system that could be configured either as a Category A or a Category B desktop would require a submittal of the highest power configuration for both categories in order to qualify as ENERGY STAR. If a product could be configured to meet all three categories, it would then have to submit data for the highest power configuration in all categories. Manufacturers will be held accountable for any efficiency claims made about all other models in the family, including those not tested or for which data was not reported.

4.3.2 All units/configurations associated with a product model designation, for which a Partner is seeking ENERGY STAR qualification, must meet the ENERGY STAR requirements. If a Partner wishes to qualify configurations of a model for which non-qualifying alternative 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).

4.4 International Market Qualification

4.4.1 Products shall be tested for qualification at the relevant input voltage/frequency combination for each market in which they will be sold and promoted as ENERGY STAR.

4.5 Customer Software and Management Service Pre-Provisioning

- 4.5.1 If a manufacturing Partner is hired by a customer to load a custom image to an ENERGY STAR qualified computer, the Partner shall take the following steps:
- i. Inform the customer that their product may not meet ENERGY STAR with the custom image. A sample notification letter is available on the ENERGY STAR Web site.
 - ii. Encourage the customer to test the product for ENERGY STAR compliance.
 - iii. Encourage the customer, should the product no longer meet ENERGY STAR, to make use of EPA's free technical assistance that can assist with Power Management performance, which can be found at www.energystar.gov/fedofficeenergy.

5 USER INTERFACE

5.1.1 Manufacturers are encouraged to design products in accordance with the user interface standard IEEE P1621: Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments. For details, see <http://eetd.LBL.gov/Controls>.

6 EFFECTIVE DATE

- 6.1.1 Effective Date: The Version 5.2 ENERGY STAR Computers specification shall take effect on the dates specified in Table 13. To qualify for ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on its date of manufacture. The date of manufacture is specific to each unit and is the date (e.g., month and year) on which a unit is considered to be completely assembled.
- 6.1.2 Future Specification Revisions: EPA reserves the right to change this 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 stakeholder discussions. In the event of a specification revision, please note that the ENERGY STAR qualification is not automatically granted for the life of a product model.

Table 13: Specification Effective Dates

Effective Date
July 1, 2009

APPENDIX A: Sample Calculations

- I. **Desktop, Integrated Desktop, Notebook Computers:** Below is a sample TEC calculation intended to show how levels for compliance are determined based on functional adders and operational mode measurements.

Following is a sample E_{TEC} evaluation for a Category A Notebook Computer with integrated GPU, 8 GB Memory, and 1 HDD.

- A) Measure values using the ENERGY STAR Computers Test Method:

- 5) Off Mode = 1.0 W
- 6) Sleep Mode = 1.7 W
- 7) Idle State = 10.0 W

- B) Calculate E_{TEC} from power measurements and weightings:

Toff	0.60
Tsleep	0.10
Tidle	0.30

- 1) $E_{TEC} = (8760/1000) * (P_{off} * T_{off} + P_{sleep} * T_{sleep} + P_{idle} * T_{idle})$
- 2) $E_{TEC} = (8760/1000) * (1.0 * 0.60 + 1.7 * 0.10 + 10.0 * 0.30)$

3) $E_{TEC} = 33.03$ kWh / year

- C) Determine which Capability Adjustments apply:

- 1) Discrete Graphics? *No, therefore does not apply for Premium Graphics adder.*
- 2) Memory: *8 GB installed, meets memory threshold, calculate $((8 - 4) * 0.4 \text{ kWh}) = 1.6 \text{ kWh}$*

- D) Calculate E_{TEC_MAX} by adding any capability adjustments to the Base TEC requirement:

Category A	40.0
Category B	53.0
Category C	88.5

- 1) $E_{TEC_MAX} = 40.0 \text{ kWh / year} + 1.6 \text{ kWh / year}$
- 2) $E_{TEC_MAX} = 41.6 \text{ kWh / year}$

- E) Compare E_{TEC} to the E_{TEC_MAX} to determine if the model qualifies:

- 1) $33.03 \text{ kWh / year} < 41.6 \text{ kWh / year}$

F) Therefore, the notebook meets ENERGY STAR requirements.

II. **Workstations:** Below is a sample P_{TEC} calculation for a Workstation with 2 hard drives.

A) Measure values using the ENERGY STAR Computers Test Method:

- 1) Off Mode = 2 W
- 2) Sleep Mode = 4W
- 3) Idle State = 80W
- 4) Max Power = 180W

B) Note number of Hard Drives installed:

- 5) Two hard drives installed during test.

C) Calculate P_{TEC} from power measurements and weightings using Equation 3:

Toff	0.35
Tsleep	0.10
Tidle	0.55

6) $P_{TEC} = (.35 * P_{off} + .10 * P_{sleep} + .55 * P_{idle})$

7) $P_{TEC} = (.35 * 2 + .10 * 4 + .55 * 80)$

8) $P_{TEC} = \mathbf{45.10 W}$

D) Calculate the P_{MAX} requirement using Equation 4:

9) $P_{MAX} = 0.28 * [P_{max} + (\# \text{ HDD} * 5)]$

10) $P_{MAX} = 0.28 * [180 + 2 * 5]$

11) $P_{MAX} = 53.2$

E) Compare P_{TEC} to the ENERGY STAR levels to determine if the model qualifies:

12) $45.10 < 53.2$

G) Therefore, the Workstation meets ENERGY STAR requirements.



ENERGY STAR[®] Program Requirements Product Specification for Computers

Test Method

1 OVERVIEW

The following test method shall be used for determining product compliance with requirements in the ENERGY STAR Eligibility Criteria for Computers.

2 APPLICABILITY

ENERGY STAR test requirements are dependent upon the feature set of the product under evaluation. The following guidelines shall be used to determine the applicability of each section of this document:

- Section 6 shall be conducted on all eligible computer products.
- Section 7 shall be conducted on Workstations.

3 DEFINITIONS

Unless otherwise specified, all terms used in this document are consistent with the definitions in the ENERGY STAR Eligibility Criteria for Computers.

4 TEST SETUP

- A) Input Power: Products intended to be powered from AC mains shall be connected to a voltage source appropriate for the intended market, as specified in Table 1 and Table 2.

**Table 1: Input Power Requirements for Products with
Nameplate Rated Power Less Than or Equal to 1500 W**

Market	Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
North America, Taiwan	115 Vac	+/- 1.0 %	2.0 %	60 Hz	+/- 1.0 %
Europe, Australia, New Zealand	230 Vac	+/- 1.0 %	2.0 %	50 Hz	+/- 1.0 %
Japan	100 Vac	+/- 1.0 %	2.0 %	50 Hz/60 Hz	+/- 1.0 %

Table 2: Input Power Requirements for Products with Nameplate Rated Power Greater Than 1500 W

Market	Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
North America, Taiwan	115 Vac	+/- 4.0 %	5.0 %	60 Hz	+/- 1.0 %
Europe, Australia, New Zealand	230 Vac	+/- 4.0 %	5.0 %	50 Hz	+/- 1.0 %
Japan	100 Vac	+/- 4.0 %	5.0 %	50 Hz/60 Hz	+/- 1.0 %

- B) Ambient Temperature: Ambient temperature shall be from 18° C to 28° C.
- C) Relative Humidity: Relative humidity shall be from 10% to 80%.
- D) Power Meter: Power meters shall possess the following attributes:
- 1) Crest Factor: Possesses an available current crest factor of 3 or more at its rated range value.
 - 2) Minimum Frequency Response: 3.0 kHz
 - 3) Minimum Resolution:
 - i) 0.01 W for measurement values less than 10 W;
 - ii) 0.1 W for measurement values from 10 W to 100 W; and
 - iii) 1.0 W for measurement values greater than 100 W.
- E) Measurement Accuracy:
- 1) Power measurements with a value greater than or equal to 0.5 W shall be made with an uncertainty of less than or equal to 2% at the 95% confidence level.
 - 2) Power measurements with a value less than 0.5 W shall be made with an uncertainty of less than or equal to 0.01 W at the 95% confidence level.

5 TEST CONDUCT

- A) As-shipped Condition: Computers shall be tested with configuration and settings in their default “as-shipped” condition, unless otherwise specified in this document. Note that test procedure steps that require alternative configurations are marked with an asterisk (“*”).
- B) Test Procedure Order: Section 6 and/or 7 shall be followed in the order it is written.
- C) Measurement Location: Power consumption of a computer shall be measured and tested at the ac input to the unit under test (UUT).

D) Networking:

- i) Desktops, Integrated Desktops, Notebooks, Thin Clients, and Small-Scale Servers with Ethernet (IEEE 802.3) capability shall be connected to a live Ethernet network switch and any wireless radios shall be turned off. The computer shall maintain this live connection to the switch for the duration of testing, disregarding brief lapses when transitioning between link speeds.
- ii) Thin Clients shall run intended terminal/remote connection software during all tests.
- iii) Desktops, Integrated Desktops, and Notebook Computers without Ethernet capability shall maintain a live wireless connection to a wireless router or network access point, which supports the highest and lowest data speeds of the client radio, for the duration of testing.
- iv) The network connection shall be live during all tests.

E) State of Units for Test (Power Management Capabilities): The following requirements shall be followed when determining whether models should be qualified with or without WOL:

- 1) Off Mode: Computers shall be tested in their “as-shipped” condition for Off Mode. Models that will be shipped with WOL enabled for Off Mode shall be tested with WOL enabled.
- 2) Sleep Mode: Computers shall be tested their “as-shipped” condition for Sleep Mode.
 - i) Models sold through enterprise channels shall be tested, qualified, and shipped with WOL enabled/disabled as specified in Table 2 in the ENERGY STAR Eligibility Criteria for Computers.
 - ii) Products going directly to consumers through normal retail channels only are not required to be shipped with WOL enabled from Sleep, and may be tested, qualified, and shipped with WOL either enabled or disabled.
- 3) Full Network Connectivity (“Proxying”): Desktop, Integrated Desktop, and Notebook Computers shall be tested for Idle, Sleep, and Off with proxying features enabled or disabled as shipped.

6 TEST PROCEDURES FOR ALL PRODUCTS

6.1 UUT Preparation

- 1) Connect the power meter directly between the ac input voltage source and the UUT.
- 2) Record the ac voltage and frequency.
- 3) Boot the computer and wait until the operating system has fully loaded. If necessary, run the initial operating system setup and allow all preliminary file indexing and other one-time/periodic processes to complete.
- 4) Record basic information about the computer’s configuration – computer type, operating system name and version, processor type and speed, and total and available physical memory, etc.
- 5) Record basic information about the video card or graphics chipset (if applicable) - video card/chipset name, frame buffer width, resolution, amount of onboard memory, and bits per pixel.

- 6) * Ensure that the UUT is configured as shipped including all accessories, WOL enabling, and software shipped by default, except as specified below.
 - i) Desktop computers shipped without accessories shall be configured with a standard mouse, keyboard and external computer display.
 - ii) Integrated Desktop computers shipped without accessories shall be configured with a standard mouse and keyboard.
 - iii) Notebook computers without an integrated pointing device or digitizer shall be configured with a mouse.
 - iv) Notebook computers shall not be configured with a docking station.
 - v) If possible, the notebook computer battery pack(s) shall be removed for all tests. If removal is impossible, the battery shall be fully charged prior to the beginning the test and left in place for the duration of the test, and its presence reported.
 - vi) Small-Scale Servers and Thin Clients shipped without accessories shall be configured with a standard mouse, keyboard and external computer display (if server has display output functionality).
 - vii) Primary hard drives shall not be power managed (“spun-down”) during Idle testing unless containing non-volatile cache integral to the drive (e.g. “hybrid” hard drives or similar non-removable disk caching architectures). Any secondary internal hard drive(s) may be tested with hard drive power management enabled as shipped. If these additional drives are not power managed when shipped to customers, they shall be tested without such features implemented.
- 7) * The following guidelines shall be followed to configure power settings for computer displays (adjusting no other power management settings):
 - i) For computers with external computer displays: use the computer display power management settings to prevent the display from powering down to ensure it stays on for the full length of the Idle test as described below.
 - ii) For computers with integrated computer displays: use the power management settings to set the display to power down after 1 minute.
- 8) Shut down the UUT.

6.2 Off Mode Testing

- 1) With the UUT in Off Mode, set the meter to begin accumulating true power values at a frequency greater than or equal to 1 reading per second.
- 2) Accumulate power values for 5 minutes and record the average (arithmetic mean) value observed during that 5 minute period.¹

¹ 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.

6.3 Idle Mode Testing

- 1) Switch on the computer and begin recording elapsed time, starting either when the computer is initially switched on, or immediately after completing any log in activity necessary to fully boot the system.
- 2) 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.
- 3) Between 5 and 15 minutes after the initial boot or log in, set the meter to begin accumulating true power values at a frequency greater than or equal to 1 reading per second.
- 4) Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value observed during that 5 minute period.

6.4 Sleep Mode Testing

- 1) Place the computer in Sleep mode.
- 2) Reset the meter (if necessary) and begin accumulating true power values at a frequency greater than or equal to 1 reading per second.
- 3) Accumulate power values for 5 minutes and record the average (arithmetic mean) value observed during that 5 minute period.
- 4) If testing both WOL enabled and WOL disabled for Sleep, wake the computer and change the WOL from Sleep setting through the operating system settings or by other means. Repeat the Sleep mode test with the alternate configuration.

7 MAXIMUM POWER TEST FOR WORKSTATIONS

The maximum power for workstations is found by the simultaneous operation of two industry standard benchmarks: Linpack to stress the core system (e.g., processor, memory, etc.) and SPECviewperf® (latest available version for the UUT) to stress the system's GPU. This test shall be repeated three times on the same UUT, and all three measurements shall fall within a $\pm 2\%$ tolerance relative to the average of the three measured maximum power values.

Additional information on these benchmarks, including free downloads, can be found at the URLs found below:

Linpack	http://www.netlib.org/linpack/
SPECviewperf®	http://www.spec.org/benchmarks.html#gpc

7.1 UUT Preparation

- 1) Connect an approved meter capable of measuring true power to an ac line voltage source set to the appropriate voltage/frequency combination for the test. The meter should be able to store and output the maximum power measurement reached during the test or be capable of another method of determining maximum power.
- 2) Plug the UUT into the measurement power outlet on the meter. No power strips or UPS units should be connected between the meter and the UUT.
- 3) Record the ac voltage.

- 4) * Boot the computer and, if not already installed, install Linpack and SPECviewperf as indicated on the above Websites.
- 5) Set Linpack with all the defaults for the given architecture of the UUT and set the appropriate array size “n” for maximizing power draw during the test.
- 6) Ensure all guidelines set by the SPEC organization for running SPECviewperf have been met.

7.2 Maximum Power Testing

- 1) Set the meter to begin accumulating true power values at an interval of less than or equal to 1 reading per second, and begin taking measurements.
- 2) Run SPECviewperf and as many simultaneous instances of Linpack as needed to fully stress the system.
- 3) Accumulate power values until SPECviewperf and all instances have completed running. Record the maximum power value attained during the test.
- 4) The following data shall also be recorded:
 - i) Value of the n (the array size) used for Linpack,
 - ii) Number of simultaneous copies of Linpack run during the test,
 - iii) Version of SPECviewperf run for test,
 - iv) All compiler optimizations used in compiling Linpack and SPECviewperf, and
 - v) A precompiled binary for end users to download and run of both SPECviewperf and Linpack. These can be distributed either through a centralized standards body such as SPEC, by the OEM or by a related third party.