



ENERGY STAR® Program Requirements for Computers

Version 5.0
DRAFT 3

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ENERGY STAR[®] Program Requirements for Computers

Partner Commitments

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52 **Commitments**

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

- 56
- 57 • comply with current ENERGY STAR Eligibility Criteria, defining the performance criteria that must be
58 met for use of the ENERGY STAR certification mark on computers and specifying the testing criteria
59 for computers. EPA may, at its discretion, conduct tests on products that are referred to as ENERGY
60 STAR qualified. These products may be obtained on the open market, or voluntarily supplied by
61 Partner at EPA's request;
 - 62
 - 63 • comply with current ENERGY STAR Identity Guidelines, describing how the ENERGY STAR marks
64 and name may be used. Partner is responsible for adhering to these guidelines and for ensuring that
65 its authorized representatives, such as advertising agencies, dealers, and distributors, are also in
66 compliance;
 - 67
 - 68 • work with resellers of Partner's products to help ensure that these products remain in compliance with
69 ENERGY STAR requirements. Any party within the distribution channel of an ENERGY STAR
70 qualified computer product that alters the power profile of a product after its date of manufacture
71 through hardware or software modifications must ensure that the product continues to meet the
72 ENERGY STAR requirements before delivering this product to the end customer. If the product no
73 longer meets the requirements, it may not bear the ENERGY STAR mark;
 - 74
 - 75 • qualify at least one ENERGY STAR computer model within one year of activating the computers
76 portion of the agreement. When Partner qualifies the product, it must meet the specification (e.g., Tier
77 1 or 2) in effect at that time;
 - 78
 - 79 • provide clear and consistent labeling of ENERGY STAR qualified computers. The ENERGY STAR
80 mark must be clearly displayed:

- 81 1. On the top or front of the product. Labeling on the top or front of the product may be permanent or
82 temporary. All temporary labeling must be affixed to the top or front of the product with an
83 adhesive or cling-type application;

84 Electronic Labeling Option: Manufacturers have the option of using an alternative electronic
85 labeling approach in place of this product labeling requirement, as long it meets the following
86 requirements:

- 87 – The ENERGY STAR mark in cyan, black, or white (as described in "The ENERGY STAR
88 Identity Guidelines" available at www.energystar.gov/logos) appears at system start-up. The
89 electronic mark must display for a minimum of 5 seconds;
- 90
- 91 – The ENERGY STAR mark must be at least 10% of the screen by area, may not be smaller
92 than 76 pixels x 78 pixels, and must be legible.
- 93

94 EPA will consider alternative proposals regarding approach, duration, or size for electronic
95 labeling on a case-by-case basis.

- 96
97 2. In product literature (i.e., user manuals, spec sheets, etc.);
98 3. On product packaging for products sold at retail; and
99 4. On the manufacturer's Internet site where information about ENERGY STAR qualified models is
100 displayed:
- 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;

- 105
106 • agree to complete steps to educate users of their products about the benefits of power management
107 by including the following information, in addition to that described in the User Information
108 Requirements found in the ENERGY STAR Eligibility Criteria (Section 3.C), with each computer (i.e.,
109 in the user manual or on a box insert):
110
- 111 1. Energy saving potential;
 - 112 2. Financial saving potential;
 - 113 3. Environmental benefits;
 - 114 4. Information on ENERGY STAR and a link to www.energystar.gov; and
 - 115 5. ENERGY STAR logo (used in accordance with "The ENERGY STAR Identity Guidelines"
116 available at www.energystar.gov/logos).

117 In addition, a link should be made available to www.energystar.gov/powermanagement from computer
118 product pages, product specifications, and related content pages.

119
120 At the manufacturer's request, EPA will supply suggested facts and figures related to the above
121 criteria, template elements, or a complete template suitable for use in user guides or box inserts.

- 122
- 123 • provide to EPA, on an annual basis, an updated list of ENERGY STAR qualified computer models.
124 Once the Partner submits its first list of ENERGY STAR qualified computer models, the Partner will be
125 listed as an ENERGY STAR Partner. Partner must provide annual updates in order to remain on the
126 list of participating product manufacturers;
127
 - 128 • provide to EPA, on an annual basis, unit shipment data or other market indicators to assist in
129 determining the market penetration of ENERGY STAR. Specifically, Partner must submit the total
130 number of ENERGY STAR qualified computers shipped (in units by model) or an equivalent
131 measurement as agreed to in advance by EPA and Partner. Partner is also encouraged to provide
132 ENERGY STAR qualified unit shipment data segmented by meaningful product characteristics (e.g.,
133 capacity, size, speed, or other as relevant), total unit shipments for each model in its product line, and
134 percent of total unit shipments that qualify as ENERGY STAR. The data for each calendar year
135 should be submitted to EPA, preferably in electronic format, no later than the following March and may
136 be provided directly from the Partner or through a third party. The data will be used by EPA only for
137 program evaluation purposes and will be closely controlled. Any information used will be masked by
138 EPA so as to protect the confidentiality of the Partner;
139
 - 140 • notify EPA of a change in the designated responsible party or contacts for computers within 30 days.
141
142

143 **Performance for Special Distinction**

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

- 147
- 148 • consider energy efficiency improvements in company facilities and pursue the ENERGY STAR mark
- 149 for buildings;
- 150
- 151 • purchase ENERGY STAR qualified products. Revise the company purchasing or procurement
- 152 specifications to include ENERGY STAR. Provide procurement officials' contact information to EPA
- 153 for periodic updates and coordination. Circulate general ENERGY STAR qualified product information
- 154 to employees for use when purchasing products for their homes;
- 155
- 156 • ensure the power management feature is enabled on all ENERGY STAR qualified displays and
- 157 computers in use in company facilities, particularly upon installation and after service is performed;
- 158
- 159 • provide general information about the ENERGY STAR program to employees whose jobs are relevant
- 160 to the development, marketing, sales, and service of current ENERGY STAR qualified product
- 161 models;
- 162
- 163 • provide a simple plan to EPA outlining specific measures Partner plans to undertake beyond the
- 164 program requirements listed above. By doing so, EPA may be able to coordinate, communicate,
- 165 and/or promote Partner's activities, provide an EPA representative, or include news about the event in
- 166 the ENERGY STAR newsletter, on the ENERGY STAR Web pages, etc. The plan may be as simple
- 167 as providing a list of planned activities or planned milestones that Partner would like EPA to be aware
- 168 of. For example, activities may include: (1) increase the availability of ENERGY STAR qualified
- 169 products by converting the entire product line within two years to meet ENERGY STAR guidelines; (2)
- 170 demonstrate the economic and environmental benefits of energy efficiency through special in-store
- 171 displays twice a year; (3) provide information to users (via the Web site and user's manual) about
- 172 energy-saving features and operating characteristics of ENERGY STAR qualified products: and (4)
- 173 build awareness of the ENERGY STAR Partnership and brand identity by collaborating with EPA on
- 174 one print advertorial and one live press event;
- 175
- 176 • provide quarterly, written updates to EPA as to the efforts undertaken by Partner to increase
- 177 availability of ENERGY STAR qualified products, and to promote awareness of ENERGY STAR and
- 178 its message;
- 179
- 180 • join EPA's SmartWay Transport Partnership to improve the environmental performance of the
- 181 company's shipping operations. SmartWay Transport works with freight carriers, shippers, and other
- 182 stakeholders in the goods movement industry to reduce fuel consumption, greenhouse gases, and air
- 183 pollution. For more information on SmartWay, visit www.epa.gov/smartway;
- 184
- 185 • join EPA's Climate Leaders Partnership to inventory and reduce greenhouse gas emissions.
- 186 Through participation, companies create a credible record of their accomplishments and receive EPA
- 187 recognition as corporate environmental leaders. For more information on Climate Leaders, visit
- 188 www.epa.gov/climateleaders;
- 189
- 190 • join EPA's Green Power partnership. EPA's Green Power Partnership encourages organizations to
- 191 buy green power as a way to reduce the environmental impacts associated with traditional fossil fuel-
- 192 based electricity use. The partnership includes a diverse set of organizations including Fortune 500
- 193 companies, small and medium businesses, government institutions as well as a growing number of
- 194 colleges and universities, visit <http://www.epa.gov/grnpower>.
- 195



ENERGY STAR® Program Requirements for Computers

Eligibility Criteria (Version 5.0)

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202 Below is the Version 5.0 product specification for ENERGY STAR qualified computers. A product must
203 meet all of the identified criteria to earn the ENERGY STAR.
204

205 **1) Definitions:** Below are the definitions of the relevant terms in this document.
206

207 A. Computer: A device which performs logical operations and processes data. Computers are
208 composed of, at a minimum: (1) a central processing unit (CPU) to perform operations; (2) user
209 input devices such as a keyboard, mouse, digitizer or game controller; and (3) a computer display
210 screen to output information. For the purposes of this specification, computers include both
211 stationary and portable units, including desktop computers, gaming consoles, integrated desktop
212 computers, notebook computers, small-scale servers, thin clients, and workstations. Although
213 computers must be capable of using input devices and computer displays, as noted in numbers 2
214 and 3 above, computer systems do not need to include these devices on shipment to meet this
215 definition.
216

217 **Components**

218 B. Computer Display: A display screen and its associated electronics encased in a single housing, or
219 within the computer housing (e.g., notebook or integrated desktop computer), that is capable of
220 displaying output information from a computer via one or more inputs, such as a VGA, DVI, and/or
221 IEEE 1394. Examples of computer display technologies are the cathode-ray tube (CRT) and
222 liquid crystal display (LCD).
223
224

225 **Note:** EPA is actively revising the ENERGY STAR Displays specification (previously “Monitors”) and is scheduled
226 to finalize that specification in early 2009. Due to the earlier finalization date of the Computers specification, and to
227 avoid inconsistency with the definition of “Display” to be included in the revised ENERGY STAR Displays
228 specification, EPA has used the more specific term “Computer Display” where requirements impact computer
229 display behavior (e.g. power management, test procedure, etc.). The definition of “Display” in the ENERGY STAR
230 Displays specification is more general, comprising additional products not necessarily used with computers.
231

232 The Computer Display definition is derived from applicable portions of the ENERGY STAR Displays definition.
233
234

235 C. Discrete Graphics Processing Unit (GPU): A graphics display device with a local memory
236 controller interface and a local, graphics-specific memory.
237

238 **Note:** The definition above has been added to the specification based on a stakeholder comment and to
239 compliment the Draft 2 definition for Integrated GPU. EPA encourages stakeholders to comment on the
240 applicability of this definition and any suggested revisions.
241

242 D. External Power Supply: A component contained in a separate physical enclosure external to the
243 computer casing and designed to convert line voltage ac input from the mains to lower dc
244 voltage(s) for the purpose of powering the computer. An external power supply must connect to
245 the computer via a removable or hard-wired male/female electrical connection, cable, cord or
246 other wiring.
247

248 E. Integrated Graphics Processing Unit (GPU): A graphics processing unit (GPU) connected directly
249 to an internal peripheral controller device or to internal peripheral devices (storage, network, etc.).

250 A discrete GPU does not comply with the definition of an integrated GPU.
251

- 252 F. Internal Power Supply: A component internal to the computer casing and designed to convert ac
253 voltage from the mains to dc voltage(s) for the purpose of powering the computer components.
254 For the purposes of this specification, an internal power supply must be contained within the
255 computer casing but be separate from the main computer board. The power supply must connect
256 to the mains through a single cable with no intermediate circuitry between the power supply and
257 the mains power. In addition, all power connections from the power supply to the computer
258 components, with the exception of a DC connection to a computer display in an Integrated
259 Desktop Computer, must be internal to the computer casing (i.e., no external cables running from
260 the power supply to the computer or individual components). Internal dc-to-dc converters used to
261 convert a single dc voltage from an external power supply into multiple voltages for use by the
262 computer are not considered internal power supplies.
263

264 Computer Types

- 265
- 266 G. Desktop Computer: A computer where the main unit is intended to be located in a permanent
267 location, often on a desk or on the floor. Desktops are not designed for portability and utilize an
268 external computer display, keyboard, and mouse. Desktops are designed for a broad range of
269 home and office applications.
270
- 271 H. Small-Scale Server: A computer that typically uses desktop components in a desktop form factor,
272 but is designed explicitly to be a storage host for other computers. A computer must have the
273 following characteristics to be considered a Small-Scale Server:
274
- 275 • Designed in a pedestal, tower, or other form factor similar to those of desktop computers such
276 that all data processing, storage, and network interfacing is contained within one box/product;
 - 277 • Intended to be operational 24 hours/day and 7 days/week, and unscheduled downtime is
278 extremely low (on the order of hours/year);
 - 279 • Capable of operating in a simultaneous multi-user environment serving several users through
280 networked client units; and
 - 281 • Designed for an industry accepted operating system for home or low-end server applications
282 (e.g., Windows Home Server, Mac OS X Server, Linux, UNIX and Solaris).
283

284
285 Small-Scale Servers are designed to perform functions such as providing network infrastructure
286 services (e.g., archiving) and hosting data/media. These products are not designed to process
287 information for other systems or run web servers as a primary function.
288

289 This specification does not cover Enterprise Server computers as defined in the ENERGY STAR
290 Version 1.0 Enterprise Server specification. Small-Scale Servers covered by this specification are
291 limited to computers marketed for non-datacenter operation (e.g. homes, small offices).
292

293 **Note:** EPA received comments that certain products in desktop form factors could fit both the Draft 2 Enterprise
294 Server definition and the one above. To clarify, the last clause of the definition is intended to make clear that
295 products falling under the scope of the Enterprise Server specification are not covered by this V5.0 Computer
296 specification. An additional clarification has been added to the definition, stating that Small-Scale Servers must be
297 marketed for use outside the datacenter. Also changed was the characteristic requirement on operating systems to
298 account for small-scale servers shipped without pre-installed operating systems.
299

- 300 I. Game Console: A standalone computer-like device whose primary use is to play video games.
301 Game consoles use a hardware architecture based in part on typical computer components (e.g.,
302 processors, system memory, video architecture, optical and/or hard drives, etc.). The primary
303 input for game consoles are special hand held controllers rather than the mouse and keyboard
304 used by more conventional computer types. Game consoles are also equipped with audio visual
305 outputs for use with televisions as the primary display, rather than (or in addition to) an external or

306 integrated display. These devices do not typically use a conventional PC operating system, but
307 often perform a variety of multimedia functions such as: DVD/CD playback, digital picture viewing,
308 and digital music playback.
309

310 J. Integrated Desktop Computer: A desktop system in which the computer and computer display
311 function as a single unit which receives its ac power through a single cable. Integrated desktop
312 computers come in one of two possible forms: (1) a system where the computer display and
313 computer are physically combined into a single unit; or (2) a system packaged as a single system
314 where the computer display is separate but is connected to the main chassis by a dc power cord
315 and both the computer and computer display are powered from a single power supply. As a
316 subset of desktop computers, integrated desktop computers are typically designed to provide
317 similar functionality as desktop systems.
318

319 K. Thin Client: An independently-powered computer that relies on a connection to remote computing
320 resources to obtain primary functionality. Main computing (e.g., program execution, data storage,
321 interaction with other Internet resources, etc.) takes place using the remote computing resources.
322 Thin Clients covered by this specification are limited to devices with no rotational storage media
323 integral to the computer. The main unit of a Thin Client covered by this specification must be
324 intended for location in a permanent location (e.g. on a desk) and not for portability.
325

326 L. Notebook Computer: A computer designed specifically for portability and to be operated for
327 extended periods of time either with or without a direct connection to an ac power source.
328 Notebooks must utilize an integrated computer display and be capable of operation off an
329 integrated battery or other portable power source. In addition, most notebooks use an external
330 power supply and have an integrated keyboard and pointing device. Notebook computers are
331 typically designed to provide similar functionality to desktops, including operation of software
332 similar in functionality as that used in desktops. For the purposes of this specification, docking
333 stations are considered accessories and therefore, the performance levels associated with
334 notebooks presented in Section 3, below, do not include them. Tablet PCs, which may use touch-
335 sensitive screens along with or instead of other input devices, are considered Notebook
336 Computers in this specification.
337

338 **Note:** Tablet PCs fall under the same requirements as other Notebook Computers, both as proposed in this draft
339 and in Version 4.0. To simplify specification terminology, "Notebook" now encompasses Tablet PCs in this
340 specification, and the final sentence in the Notebook Computer definition above is added to this end.
341

342
343 M. Workstation: A high-performance, single-user computer typically used for graphics, CAD, software
344 development, financial and scientific applications among other compute intensive tasks. To qualify
345 as a workstation, a computer must:
346

- 347 • Be marketed as a workstation;
- 348 • Have a mean time between failures (MTBF) of at least 15,000 hours based on either Bellcore
349 TR-NWT-000332, issue 6, 12/97 or field collected data; and
- 350 • Support error-correcting code (ECC) and/or buffered memory.

351 In addition, a workstation must meet three of the following six optional characteristics:

- 352 • Have supplemental power support for high-end graphics (i.e., PCI-E 6-pin 12V supplemental
353 power feed);
- 354 • System is wired for greater than x4 PCI-E on the motherboard in addition to the graphics
355 slot(s) and/or PCI-X support;
- 356 • Does not support Uniform Memory Access (UMA) graphics;
- 357 • Includes 5 or more PCI, PCIe or PCI-X slots;

- 358
- 359
- 360
- Capable of multi-processor support for two or more processors (must support physically separate processor packages/sockets, i.e., not met with support for a single multi core processor); and/or
- 361
- 362
- Be qualified by at least 2 Independent Software Vendor (ISV) product certifications; these certifications can be in process, but must be completed within 3 months of qualification.

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Operational Modes

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N. 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 systems where ACPI standards are applicable, Off Mode correlates to ACPI System Level S5 state.

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O. 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 network connections or user interface devices with a latency of ≤ 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.

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P. Idle State: The state in which the operating system and other software have completed loading, a user profile has been created, the machine is not asleep, and activity is limited to those basic applications that the system starts by default.

384

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Q. Active State: The 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. This 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.

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R. Typical Energy Consumption (TEC): A method of testing and comparing the energy performance of computers, which focuses on the typical electricity consumed by a product while in normal operation during a representative period of time. The key criterion of the TEC approach for computers is a value for typical annual electricity use, measured in kilowatt-hours (kWh), using measurements of average operational mode power levels scaled by an assumed typical usage model (duty cycle).

396

Networking and Power Management

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S. Network Interface: The components (hardware and software) whose primary function is to make the computer capable of communicating over one or more network technologies. Network Interface refers to IEEE 802.3 (Ethernet) or IEEE 802.11 (Wi-Fi).

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T. Wake Event: A user, scheduled, or external event or stimulus that causes the computer to transition from Sleep or Off to active mode 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.

409

410

411

U. Wake On LAN (WOL): Functionality which allows a computer to wake from Sleep or Off when directed by a network request.

412

V. Full Network Connectivity: The ability of the computer to maintain network presence while in sleep

and intelligently wake when further processing is required. Maintaining network presence may include obtaining and/or defending an assigned interface or network address, responding to requests from other nodes on the network, or sending periodic network presence messages to the network all while in the sleep state. In this fashion, presence of the computer, its network services and applications, is maintained even though the computer is in sleep. (Note: More information on this can be found at: <http://efficientnetworks.lbl.gov/enet-proxying.html>)

Marketing and Shipment Channels

- W. Enterprise Channels: Sales channels normally used by large and medium-sized business, government organizations, educational institutions, or other organizations purchasing computers used in managed client/server environments.
- X. Model Number: A unique marketing name that applies to a specific configuration that is either pre-defined, or a configuration that is selected by the customer.
- Y. Model Name: A marketing name that includes reference to both the PC model family number, a short description of the product, or branding references.
- Z. 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.

Note: Stakeholders requested definitions for Model Name, Model Number, and Product Family in Version 5.0 to support labeling and marketing requirements in the specification. EPA has included initial proposals for these three terms above, and encourages stakeholder comments to help solidify these definitions such that the terms are meeting the needs of industry.

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 5.0 Specification	Products Not Covered by Version 5.0 Specification
<ul style="list-style-type: none"> • Desktop Computers • Integrated Desktop Computers • Notebook Computers • Workstations • Game Consoles • Small-Scale Servers • Thin Clients 	<ul style="list-style-type: none"> • Computer Servers (as defined in Version 1.0 computer server specification) • Handhelds, PDAs, and Smartphones

In order to conduct testing in support of qualification for ENERGY STAR, the computer must be tested in a laboratory that is accredited by an accreditation body that is a signatory, in good standing, to a mutual recognition arrangement of a laboratory accreditation cooperation (i.e. ILAC, APLAC, etc.) that verifies, by evaluation and peer assessment, that its signatory members are in full compliance with ISO/IEC 17011 and that their accredited laboratories comply with ISO/IEC 17025.

Laboratories must be specifically qualified to carry out tests to determine whether computers meet the Computer Key Product Criteria as outlined in the ENERGY STAR Program Requirements for Computers.

Note: The text above reflects the laboratory requirements section of the draft Verification Testing procedures manual to be applied to all laboratories used to acquire ENERGY STAR test data in accordance with verification requirements. EPA is proposing applying this definition to laboratory requirements associated with product qualification. It is EPA's intention to apply this definition to all relevant product specifications.

459 **3) Energy Efficiency and Power Management Criteria:** Computers must meet the requirements below
460 to qualify as ENERGY STAR. The Version 5.0 effective date is covered in Section 5 of this
461 specification.

462
463 **(A) Power Supply Efficiency Requirements -** Requirements are applicable to all product categories
464 covered by the ENERGY STAR Computer Specification:
465

466 **Computers Using an Internal Power Supply:** 85% minimum efficiency at 50% of rated output and
467 82% minimum efficiency at 20% and 100% of rated output, with Power Factor \geq 0.9 at 100% of rated
468 output.

469
470 **Computers Using an External Power Supply:** Must be ENERGY STAR qualified or meet the no-
471 load and active mode efficiency levels provided in the ENERGY STAR Program Requirements for
472 Single Voltage External Ac-Ac and Ac-Dc Power Supplies, Version 2.0. The ENERGY STAR
473 specification and qualified product list can be found at www.energystar.gov/powersupplies. Note: This
474 performance requirement also applies to multiple voltage output external power supplies as tested in
475 accordance to the Internal Power Supply test method referenced in Section 4, below.
476

477 **(B) Efficiency and Performance Requirements:**

478
479 **1) Desktop, Integrated Desktop, and Notebook Levels:**

480
481 **Desktop Categories for TEC Criteria:** For the purposes of determining TEC levels, desktops
482 and integrated desktops must qualify under Categories A, B, or C as defined below:
483

484 **Category A:** All desktop computers that do not meet the definition of either Category B or
485 Category C below will be considered under Category A for ENERGY STAR qualification.

486
487 **Category B:** To qualify under Category B, desktops must have:

- 488
- Greater than or equal to 2 Cores.

489 In addition to the requirement above, models qualifying under Category B must be
490 configured with a minimum of 1 of the following 2 characteristics:

- 491
- Greater than 2 gigabytes (GB) of system memory; and/or
 - A Discrete GPU.

492
493
494 **Category C:** To qualify under Category C, desktops must have:

- 495
- Greater than 2 Cores; and
 - Greater than 2 gigabytes (GB) of system memory; and
 - A Discrete GPU.

498 Note: EPA received comments from stakeholders on the Draft 2 three-tier proposal for desktop categorization both at
499 the September 26 meeting and in comments since Draft 2 release. Among the suggestions, the Information Technology
500 Industry Council (ITI) membership provided an alternative proposal with different hardware characteristics determining
501 the three categories. EPA closely evaluated this proposal in development of the Draft 3 requirements. EPA supports
502 the industry's desire to ensure that a binning system accurately describes entry-level products, midrange, and high-end
503 performance systems. The proposal above was developed to balance bins based on the previously-mentioned
504 characteristics with the need to create meaningful delineations for the life of the Version 5.0 specification.
505

506 The option provided in Category B represents a balance between integrated graphics (which rely on shared system
507 memory for graphics capability) with lower-end discrete graphics cards. Category C, again reflecting presence of
508 Discrete GPU, represents performance systems both in the near-term and through the life of the specification, when
higher core count processors and 64-bit operating systems allowing for utilization of increasing amounts of system
memory become increasingly mainstream. All proposed characteristics were supported by characteristics present in the
stakeholder-supplied dataset used for level setting.

Notebook Categories for TEC Criteria: For the purposes of determining TEC levels, notebooks must qualify under Categories A or B as defined below:

Category A: All notebook computers that do not meet the definition of Category B below will be considered under Category A for ENERGY STAR qualification.

Category B: To qualify under Category B, notebooks must have:

- A Discrete GPU.

Note: Draft 2 proposed a similar two-tier structure for notebooks, but with notebooks with low end discrete GPUs (characterized by a Frame Buffer Width 64-bit or less), falling into the entry-level Category A. As for desktops, ITI members provided an alternative proposal for categorization. Under this proposal, all notebooks with discrete GPUs fell under a higher end category B which industry communicated continuing to reflect the market. The approach above takes this consideration into account.

In the Draft 2 comments, stakeholders also suggested that “Netbooks,” an emerging category of notebook computer typically characterized by low-cost and a smaller form factor, be addressed in a separate category from those categories proposed in Draft 2. EPA agrees with stakeholders that these products could carry a distinct set of capabilities, but did not feel confident that with the limited dataset available at this time and uncertainty surrounding the definition of a Netbook, fair requirements could be set for Version 5.0. EPA intends to follow this product category as this market continues to mature. In this Draft 3 Specification, Netbooks identified by stakeholders in the dataset were excluded for level-setting purposes; these products represented 11 out of 191 non-duplicate systems in the notebook dataset.

While it is EPA’s belief that most Netbooks will fall under Category A for 5.0 qualification based on characterizations of current products containing integrated GPUs, Netbooks will be evaluated under the appropriate category based on their features.

TEC (Desktop and Notebook product categories): The following tables indicate the required TEC levels for the 5.0 Specification. Table 1 below lists TEC requirements for Version 5.0, while Table 2 gives weightings for each operational mode by product type. TEC will be determined using the formula below:

$$E_{\text{annual}} = (8760/1000) * (P_{\text{off}} * T_{\text{off}} + P_{\text{sleep}} * T_{\text{sleep}} + P_{\text{idle}} * T_{\text{idle}})$$

where all P_x are power values in watts, all T_x are Time values in % of year, and the TEC E_{annual} is in units of kWh.

Table 1: Annual Energy Consumption

	Desktops and Integrated Computers (kWh)	Notebook Computers (kWh)
TEC (kWh)	Category A: ≤ 153 Category B: ≤ 175 Category C: ≤ 243	Category A: ≤ 36.5 Category B: ≤ 50.7
Capability Adjustments		
Memory	1 kWh (per GB over 2)	0.4 kWh (per GB over 4)
Premium Graphics (<i>for Discrete GPUs with specified Frame Buffer Widths</i>)	28 kWh (FB Width > 128-bit)	3 kWh (64-bit < FB Width ≤ 128-bit)
		13 kWh (FB Width > 128-bit)
Additional Storage	25 kWh	1 kWh

(see note on next page)

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Note: The TEC levels reflect both the categorization presented in Draft 3 and maintenance of a near-25% compliance level of tested systems in the dataset. Additionally, the capability adjustments were refined based on additional data made available to EPA after Draft 2. Further details on the analysis used to develop these numbers is provided in a companion document, "ENERGY STAR Notes on Draft 3 Data.doc," distributed with this specification. Below are two specific notes on capability adjustments.

Memory Adder – Notebooks: Category B of EPA’s dataset contained a high percentage of notebooks with over 4GB of memory – nearly 70% of models. Since the TEC base level reflected characteristics of these systems, the adder for memory is implemented for amounts greater than 4GB.

TV Tuner- Desktops: Stakeholders suggested that TV Tuners be considered for an additional capability adjustment to those above. While data was provided in support of this proposal, EPA was unsure if the limited number of models reflected the market as a whole and how many manufacturers of TV Tuners were considered in the data. EPA continues to believe that TV Tuners, which are not required to be exercised during testing for ENERGY STAR, should not consume power during the test in excess of what is expected for other discrete GPUs in Categories B and C. However, EPA will consider including a capability adjustment for TV tuner, applicable only to Category C Desktops, if EPA through additional assessment concludes that current technology makes unavoidable an additional power draw in the ENERGY STAR idle test and that data supporting any proposed level is based on a representative sample of the TV Tuner market.

Table 2: Operational Mode Weighting

	Desktop		Notebook	
	Conventional	Proxying*	Conventional	Proxying*
Toff	55%	40%	60%	45%
Tsleep	5%	30%	10%	35%
Tidle	40%	30%	30%	25%

Note: Proxying refers to a computer that maintains Full Network Connectivity as defined in Section 1 of this specification. For a system to qualify under the proxying weightings above, it must meet a non-proprietary proxying standard that has been approved by the EPA as meeting the goals of ENERGY STAR. Such approval must be in place prior to submittal of product data for qualification. See Section (C), Qualifying Computers with Power Management Capabilities, for further information and testing requirements.

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Note: The weightings above for conventional desktops and notebooks are maintained from Draft 3. EPA has reduced the difference between the idle weighting for proxying systems in both the Desktop and Notebook cases in response to concerns about enablement rates amongst capable systems in the early stages of the technology’s availability. In addition, notes have been added to clarify that a non-proprietary proxying standard must a) be finalized, and b) be approved by EPA before any products can be submitted using the weightings present above. EPA will continue to monitor the Ecma TC32-TG21 standards development process, an effort to create such a standard.

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Note: EPA received stakeholder comments on the TEC weightings proposed in Draft 2 and maintained above for conventional systems. Stakeholders were concerned that the weighting above might lead to misleading results about a computer’s efficiency. EPA maintains the TEC usage mode weightings based on the following factors:

- Supporting Data: as mentioned during development and refinement of Draft 2, the weightings above reflect both the program’s internal usage mode information (developed and maintained by Lawrence Berkeley National Lab), and a industry study that reflects activity patterns for a substantial number of computers;
- Relative Rankings – To ensure that these weightings did not result in a skewing of relative efficiency (i.e. a system’s TEC varied greatly in comparison to other systems if weightings were reallocated), EPA presented a review at the September 26 stakeholder meeting of the impact of shifted TEC weighting to the edges of what is realistic. This review is present in the final three slides of the EPA presentation, available on the ENERGY STAR Computer Specification Development site. EPA found that even with significant reallocation of idle amounts on either side of EPA’s proposal, there was minimal difference in the relative ranking of efficiency of systems in EPA’s dataset.

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As is the case with the Version 4.0 program, EPA intends to publish modal power levels for qualified systems on the qualified product list, allowing extreme usage scenarios (a computer always left on, for example). However, EPA continues to support the validity of the weightings presented above and believes they provide a foundation for comparison of computers’ relative energy use and efficiency.

3) Game Console Levels:

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Note: In response to the Draft 2 proposal in Table 5 for Game Consoles, EPA received concerns that the proposed Tier 1 requirements, to be effective with this 5.0 specification, offered very limited savings. EPA had hoped that Tier 1 requirements would encourage near-term efficiencies and also make energy efficiency a design priority for this product area in the coming years. It does appear, however, that the proposed near-term opportunities offer only marginal savings, not in line with the ENERGY STAR intention to deliver savings.

As such, EPA is proposing a set of requirements that combines those proposed previously under two distinct Tiers. This new single Tier has a proposed effective date of July 1, 2010. It is EPA's hope that this approach will give game console manufacturers design lead time, while also ensuring ENERGY STAR qualified game consoles will offer consumers significant energy savings. EPA requests stakeholder comment on the proposed requirements and timeline for Game Consoles.

Table 5: Game Console Requirements – Effective July 1, 2010

Operational Mode Requirements	
Off Mode: ≤ 1 W Sleep or Auto-Off: ≤ 5 W	
Power Management and Efficient Operation Requirements	
Sleep or Auto-Off	<ul style="list-style-type: none"> ▪ The console shall power down to a sleep mode after 1 hour of inactivity; and ▪ Provide Game Developers the tools/features allowing APD within games or programs designed for the console; and ▪ Automatically APD when games are in an inactive or paused game state; and ▪ Provide for Full Network Connectivity in sleep.
TV/Display Sleep	<ul style="list-style-type: none"> ▪ The console shall have the ability to drop Component, Composite, DVI outputs (using in-place standards where applicable) when the system is inactive for 15 minutes. Ability to do this in HDMI should be implemented once a HDMI standard for doing so exists; and ▪ Provide visual feedback on the console's integrated display or LEDs calling attention to the consoles continued active state while outputs are dropped.
Power Scaling	<ul style="list-style-type: none"> ▪ Set Top Box (STB) and DVD/Blu Ray/Movie Playback functions must come within 10% of the requirements in place for the ENERGY STAR STB Specification Version 2.0, Tier 2 (finalized on April 23, 2008). Game consoles must be tested using the test procedure in the Set Top Box specification to evaluate their ability to meet the requirement.
Efficient Networking	<ul style="list-style-type: none"> • Implement IEEE 802.3az and Full Network Connectivity in Sleep for Ethernet and Wi-Fi. • Wireless Access Point functions must use less than 10W.

Note: EPA received further comment requesting that ENERGY STAR include an On Mode cap set at the maximum power consumption of current boxes. This cap could be revisited later and adders could be provided should significant new features that are tied to greater consumption become available.

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4) Small-Scale Server Levels:

Table 6: Small-Scale Server Efficiency Requirements

Small-Scale Server Operational Mode Power Requirements	
Off: ≤ 2.0 W	
Idle State: Category A: ≤ 50.0 W Category B: ≤ 65.0 W Category C: ≤ 95.0 W	
Capability	Additional Power Allowance
Wake On LAN (WOL) (Applies only if computer is shipped with WOL enabled)	+ 0.7 W for Off
<p>For the purposes of determining Idle state levels, Small-Scale Servers must qualify under Categories A, B, or C as defined below:</p> <p>Category A: All Small-Scale Servers that do not meet the definition of either Category B or Category C below will be considered under Category A for ENERGY STAR qualification.</p> <p>Category B: To qualify under Category B Small-Scale Servers must have:</p> <ul style="list-style-type: none"> • Multi-core processor(s) or greater than 1 discrete processor; and • Minimum of 1 gigabyte of system memory. <p>Category C: To qualify under Category C Small-Scale Servers must have:</p> <ul style="list-style-type: none"> • Multi-core processor(s) or greater than 1 discrete processor; and • A GPU with greater than 128 megabytes of dedicated, non-shared memory. <p>In addition to the requirements above, models qualifying under Category C must be configured with a minimum of 2 of the following 3 characteristics:</p> <ul style="list-style-type: none"> • Minimum of 2 gigabytes of system memory; • TV tuner and/or video capture capability with high definition support; and/or • Minimum of 2 hard disk drives. 	

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Note: As noted in Draft 2, the dataset provided to EPA was not sufficiently robust to create new levels for the Small-Scale Server product category. However, a stakeholder commented that the definition for Category C does not apply to Small-Scale Servers not designed for computer display output. EPA reviewed both the limited stakeholder data submitted earlier this year and the Small-Scale Servers qualified under Version 4.0. In all cases, systems met the characteristics for category B or below. With this in mind, EPA intends to remove Category C for Small-Scale Servers in the Draft Final Version 5.0 specification and encourages stakeholder comment if there are concerns with this proposal.

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5) Thin Client Levels

Thin Client Categories for Idle Criteria: For the purposes of determining Idle levels, Thin Clients must qualify under Categories A or B as defined below:

Category A: All Thin Clients that do not meet the definition of Category B, below, will be considered under Category A for ENERGY STAR qualification.

Category B: To qualify under Category B, Thin Clients must:

- Support local multimedia encode/decode.

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Table 7 : Thin Client Efficiency Requirements

Thin Client Operational Mode Power Requirements	
Off Mode:	≤ 2 W
Sleep Mode (if applicable):	≤ 2 W
Idle State:	
Category A:	≤ 12.0 W
Category B:	≤ 15.0 W
Capability	Additional Power Allowance
Wake On LAN (WOL) <i>(Applies only if computer is shipped with WOL enabled)</i>	+ 0.7 W for Sleep + 0.7 W for Off

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659 **Note:** Stakeholders requested a multi-category approach for thin clients. EPA’s initial data collection efforts did not
660 yield enough data points to support such an approach. Shortly before release of this Draft 3, thin client
661 manufacturers presented EPA and the EC with some additional data and proposals on possible category
662 delimiters. After evaluation of the data, the levels above were set with local media encoding/decoding splitting the
663 categories. While data yielded a small delta between Idle limits, it is EPA’s belief that such a structure in this first
664 set of requirements for Thin Clients provides a foundation for Thin Clients in the ENERGY STAR Computer
665 Program and provides significant client energy savings based on data received to date.

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(C) Power Management Requirements: Products must meet the power management requirements detailed in Table 5, below, and be tested as shipped.

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Table 8: Power Management Requirements

Specification Requirement		Applicable to	
Shipment Requirements			
Sleep Mode	Shipped with a Sleep mode which is set to activate within 30 minutes (1 hr for Game Consoles) of user inactivity. <i>(Note: Thin Clients and Game Consoles may transition to a full off mode within the timeframe above in lieu of sleep provided such functionality is capable of meeting the desired ≤ 5 second latency listed in definition O, above. Game Consoles need not take latency into consideration)</i>	Desktop Computers	√
		Integrated Desktop Computers	√
		Notebook Computers	√
		Workstations	√
		Game Consoles	√
		Small-Scale Servers	
		Thin Clients	√
Display Sleep Mode	Shipped with the display’s Sleep mode set to activate within 15 minutes of user inactivity.	Desktop Computers	√
		Integrated Desktop Computers	√
		Notebook Computers	√
		Workstations	√
		Game Consoles	√
		Small-Scale Servers (if computer display is present)	√
		Thin Clients	√
Network Requirements for Power Management			
Wake on LAN (WOL)	Computers with Ethernet capability shall have the ability to enable and disable WOL for Sleep mode.	Desktop Computers	√
		Integrated Desktop Computers	√
		Notebook Computers	√

		Workstations	√
		Game Consoles	
		Small-Scale Servers	√
		Thin Clients (<i>Only applies if software updates from the centrally managed network are conducted while the unit is in sleep or off mode. Thin Clients whose standard framework for upgrading client software does not require, off-hours scheduling are exempt from the requirement.</i>)	√
		<i>Applies to computers shipped through Enterprise Channels, only:</i>	
		Desktop Computers	√
		Integrated Desktop Computers	√
		Notebook Computers	√
		Workstations	√
		Game Consoles	
Wake Management	<p>Computers with Ethernet capability must meet one of the following requirements:</p> <ul style="list-style-type: none"> ▪ be shipped with Wake On LAN (WOL) enabled from the Sleep mode when operating on ac power (i.e. notebooks may automatically disable WOL when disconnected from the mains); or ▪ provide control to enable WOL that is sufficiently-accessible from both the client operating system user interface and over the network if computer is shipped to enterprise without WOL enabled. 	Small-Scale Servers	√
		Thin Clients (<i>Only applies if software updates from the centrally managed network are conducted while the unit is in sleep or off mode. Thin Clients whose standard framework for upgrading client software does not require, off-hours scheduling are exempt from the requirement.</i>)	√
		<i>Applies to computers shipped through Enterprise Channels, only:</i>	
		Desktop Computers	√
		Integrated Desktop Computers	√
		Notebook Computers	√
		Workstations	√
		Game Consoles	
		Small-Scale Servers	√
Thin Clients	√		
Manufacturers shall ensure, where the manufacturer has control (i.e., configured through hardware settings rather than software settings), that these settings can be managed centrally, as the client wishes, with tools provided by the manufacturer.			

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For all computers with WOL enabled, any directed packet filters shall be enabled and set to an industry standard default configuration. Until one (or more) standards are agreed upon, partners are asked to provide their direct packet filter configurations to EPA for publication on the Website to stimulate discussion and development of standard configurations.

Qualifying Computers with Power Management Capabilities: The following requirements should be followed when determining whether models should be qualified with or without WOL:

Off: Computers shall be tested and reported as shipped for Off. Models that will be shipped with

682 WOL enabled for Off shall be tested with WOL enabled. Likewise, products shipped with WOL
683 disabled for Off shall be tested with WOL disabled.

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685 **Sleep:** Computers shall be tested and reported as shipped for Sleep. Models sold through
686 enterprise channels, as defined in Section 1, definition V, shall be tested, qualified, and shipped
687 with WOL enabled based on the requirements in Table 8. Products going directly to consumers
688 through normal retail channels only are not required to be shipped with WOL enabled from Sleep,
689 and may be tested, qualified, and shipped with WOL either enabled or disabled.

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691 **Proxying:** Desktop, Integrated Desktop, and Notebook Computers shall be tested and reported
692 for Idle, Sleep, and Off with proxying features enabled or disabled as shipped. For a system to
693 qualify using TEC weightings for proxying, it must meet a proxying standard that has been
694 approved by the EPA as meeting the goals of ENERGY STAR. Such approval must be in place
695 prior to submittal of product data for qualification.

696 **Note:** The language above has been added to clarify that systems submitted for qualification under the proxying
697 requirements must be tested with such features enabled. As noted elsewhere in this draft, a proxying standard
698 must be finalized and be approved by EPA before computers may attempt to qualify against the proxying
699 requirements.

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702 **Customer Software and Management Service Pre-Provisioning:**

703 The Partner will remain responsible for testing products and qualifying them as they ship them. If
704 the product meets and is qualified as ENERGY STAR at this point, it can be labeled as such.

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706 If the Partner is hired by a customer to load a custom image, the Partner must take the following
707 steps:

- 708 ▪ The Partner must let the customer know that their product may not meet ENERGY STAR
709 with the custom image loaded (*a sample letter is available for use from the ENERGY
710 STAR website that can be shared with customers*).
- 711 ▪ The Partner must encourage their customer to test the product for ENERGY STAR
712 compliance.
- 713 ▪ The Partner must encourage their customer, should the product no longer meet ENERGY
714 STAR, to make use of EPA's free technical assistance that can assist with Power
715 Management performance. Please see tools as well as contact information at:
716 www.energystar.gov/fedofficeenergy.

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718 Although EPA believes that Partners in partnership with EPA can help ensure their products
719 continue to be leadership products when it comes to efficiency once deployed. EPA is committed
720 to helping to reduce the likelihood that custom images will disrupt a product's ability to meet
721 ENERGY STAR requirements. For example, EPA is engaging in federal desktop core
722 configuration discussions with the intention of facilitating the development of a core configuration
723 for Federal Agencies that supports energy efficiency. In April 2008, EPA also launched the
724 ENERGY STAR Low Carbon IT Campaign in an effort to get more businesses and organizations
725 to implement power management. More information on the campaign can be found at:
726 www.energystar.gov/lowcarbonit.

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728 **User Information Requirement:** In order to ensure that purchasers/users are properly informed on
729 the benefits of power management, the manufacturer will include with each computer, one of the
730 following:

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

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736 Either option must at least include the following information:

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- Notice that the computer has been shipped enabled for power management and what the time settings are; and
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- How to properly wake the computer from Sleep mode.
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743 **(D) Voluntary Requirements**

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

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

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- In performing these tests, partner agrees to use the test procedures provided in Table 6, below.
- The test results must be reported to EPA or the European Commission, as appropriate.

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Additional testing and reporting requirements are provided below.

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761 A. Number of Units Required for TEC or Idle Testing: Manufacturers may initially test a single unit for
762 qualification. If the initial unit tested is less than or equal to the applicable requirement for TEC or
763 Idle but falls within 10% of that level, one additional unit of the same model with an identical
764 configuration must also be tested. Manufacturers shall report test values for both units. To qualify
765 as ENERGY STAR, both units must meet the maximum TEC or Idle level for that product and that
766 product category.

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768 **Note:** This additional testing is only required for TEC qualification (*Desktops, Integrated Desktops,*
769 *Notebooks, Workstations*) and Idle qualification (*Small-Scale Servers, Thin Clients*) – only one unit
770 is required to be tested for Sleep and Standby if such requirements apply. The following
771 examples further illustrate this approach:

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1. Category A Desktops must meet a TEC level of 153 kWh or less, making 137.7 kWh the 10% threshold for additional testing.

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- If the first unit is measured at 136 kWh, no more testing is needed and the model qualifies (134 kWh is 12% more efficient than the specification and is therefore “outside” the 10% threshold).

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- If the first unit is measured at 137.7 kWh, no more testing is needed and the model qualifies (137.7 kWh is exactly 10% more efficient than the specification).

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- If the first unit is measured at 140 kWh, then an additional unit must be tested to determine qualification (140 kWh is only 8% more efficient than the specification and is “within” the 10% threshold).

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- If the two units are then tested at 140 and 154 kWh, the model does not qualify as ENERGY STAR—even though the average is 147 kWh — because one of the values exceeds the ENERGY STAR specification.

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- If the two units are then tested at 140 and 152 kWh, the model does qualify as ENERGY STAR because both values meet the ENERGY STAR specification of 153 kWh.

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2. A Category A Small-Scale Server must meet an Idle level of 50 watts or less, making 45 Watts the 10% threshold for additional testing. The following scenarios could then occur when testing a model for qualification:

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- If the first unit is measured at 44 watts, no more testing is needed and the model qualifies (44 watts is 12% more efficient than the specification and is therefore “outside” the 10% threshold).
 - If the first unit is measured at 45 watts, no more testing is needed and the model qualifies (45 watts is exactly 10% more efficient than the specification).
 - If the first unit is measured at 47 watts, then an additional unit must be tested to determine qualification (47 Watts is only 6% more efficient than the specification and is “within” the 10% threshold).
 - If the two units are then tested at 47 and 51 watts, the model does not qualify as ENERGY STAR—even though the average is 49 watts— because one of the values (51) exceeds the ENERGY STAR specification.
 - If the two units are then tested at 47 and 49 watts, the model does qualify as ENERGY STAR because both values meet the ENERGY STAR specification of 50 watts.

Note: The section above is modified from Version 4.0 and is included to show thresholds for multiple unit testing in Version 5.0. This Draft 3, representing a second review of levels for most product categories in the specification, provided a more meaningful opportunity to reintroduce this section.

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- B. 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.

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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).

Table 9: Test Procedures

Product Category	Specification Requirement	Test Protocol	Source
All Computers	Power Supply Efficiency	<p>IPS: Internal Power Supply Efficiency Protocol</p> <p>EPS: ENERGY STAR Test Method for External Power Supplies</p> <p><i>Note: Should any information/procedures in addition to those described by the Internal Power Supply Efficiency Protocol be required in order to test an Internal Power Supply, partners must make available to EPA upon request the test setup used to acquire IPS data used in a product submittal.</i></p>	<p>IPS: www.efficientpowersupplies.org</p> <p>EPS: www.energystar.gov/powersupplies</p>
Desktop, Integrated, and Notebook Computers	Annual Energy Consumption	ENERGY STAR Computer Test Method (Version 5.0), Section III	Appendix A
Workstations	Standby (Off Mode), Sleep Mode, Idle State and Maximum Power	ENERGY STAR Computer Test Method (Version 5.0), Section III-IV	
Game Consoles	Off Mode, and Sleep/Auto-Off	ENERGY STAR Computer Test Method (Version 5.0), Section V	
Small-Scale Servers	Off Mode and Idle State	ENERGY STAR Computer Test Method (Version 5.0), Section III	
Thin Clients	Off Mode, Sleep Mode, and Idle State	ENERGY STAR Computer Test Method (Version 5.0), Section III	

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Note: The current Energy Star specification for Imaging Products allows products powered by low-voltage direct current (e.g. USB, Power over Ethernet--PoE) to qualify if meeting the specification requirements. While initially introduced for USB scanners, PoE opens up a much wider range of products that could be powered by dc, including notebooks.

To allow for product data submittal, the Imaging Specification includes a provision in the Power Measurement Method for manufacturers to test and report the effective ac consumption of these products. To create a similar channel for computers powered by low-voltage DC, this approach could be included in the test procedures in Appendix A, or the measured DC consumption could be divided by 0.80 to reflect an implicit 80% efficient power conversion. A product that could be powered through ac or standard dc would continue to be tested only on its ac supply.

EPA seeks comment on whether such a provision would be valued by manufacturers in Version 5.0, or whether such technology is better addressed in future versions of the program as markets and product availability matures.

C. Qualifying Families of Products: 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 model 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 desktop systems which meet the definition for multiple desktop categories (as defined in section 3.A.2) 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.

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).

Note: The final paragraph above has been revised to allow for marketing identifiers, used consistently with configurations on the ENERGY STAR Qualified Product list and all product sales and marketing materials, to be used to designate compliant configurations.

5) Effective Date: The date that manufacturers may begin to qualify products as ENERGY STAR will be defined as the *effective date* of the agreement. The ENERGY STAR Version 5.0 Computers

887 Specification effective date is July 1, 2009. All products (except for Game Consoles), including
888 models originally qualified under Version 4.0, with a **date of manufacture** on or after **July 1, 2009**
889 must meet the Version 5.0 requirements in order to qualify for ENERGY STAR. Game Consoles with a
890 **date of manufacture** on or after **July 1, 2010** must meet the Version 5.0 requirements in order to
891 qualify for ENERGY STAR. Any previously executed agreement on the subject of ENERGY STAR
892 qualified computers shall be terminated effective June 30, 2009.

893 **Note:** The effective date language above reflects the July 1, 2010 staggered effective date for Game Consoles. All
894 other product types remain under a July 1, 2009 effective date as planned.
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897 **6) Future Specification Revisions:** EPA reserves the right to revise the specification should
898 technological and/or market changes affect its usefulness to consumers or industry or its impact on
899 the environment. In keeping with current policy, revisions to the specification will be discussed with
900 stakeholders. In the event of a specification revision, please note that ENERGY STAR qualification is
901 not automatically granted for the life of a product model. To qualify as ENERGY STAR, a product
902 model must meet the ENERGY STAR specification in effect on the model's date of manufacture.

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**APPENDIX A:
ENERGY STAR Test Procedure for Determining the
Power Use of Computers/Game Consoles in Off, Sleep, and Idle**

Note: Based on feedback received during EEcoMark development, there has been a request to test all computers with displays on, thereby streamlining test setup among the products in the computer program. EPA sees the benefits to this proposal, but cannot accommodate this revision at this time due to inconsistency with the data collection procedures used in acquiring data for Version 5.0. Additionally, various industry representatives expressed concerns with this proposal when it was raised at the stakeholder meeting. As part of this discussion, some agreement formed around an alternative of requiring that computer displays to be off for testing, but forcing graphics cards to remain on and active during the test. This alternative would require coordination with OS and graphics card manufacturers to implement.

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Additionally, stakeholders requested a 2 minute rolling average to be used instead of an average of the total 15 minute measurement period. EPA feels this is not feasible unless a tool for automating this rolling average test was available to ENERGY STAR's smaller OEM partners who may not have the resources to develop such a test.

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The following protocol should be followed when measuring power consumption levels of computers/game consoles for compliance with the Off, Sleep, and Idle levels provided in the ENERGY STAR Version 5.0 Computer Specification. Partners must measure a representative sample of the configuration as shipped to the customer. However, the Partner does not need to consider power consumption changes that may result from component additions, BIOS and/or software settings made by the computer user after sale of product. *This procedure is intended to be followed in order and the mode being tested is labeled where appropriate.*

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I. Definitions

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Unless otherwise specified, all terms used in this document are consistent with the definitions contained in the Version 5.0 ENERGY STAR Eligibility Criteria for Computers.

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UUT

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

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UPS

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

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II. Testing Requirements

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Approved Meter

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Approved meters will include the following attributes¹:

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- Power resolution of 1 mW or better;
 - An available current crest factor of 3 or more at its rated range value; and
 - Lower bound on the current range of 10mA or less.

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The following attributes in addition to those above are suggested:

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- Frequency response of at least 3 kHz; and
 - Calibration with a standard that is traceable to the U.S. National Institute of Standards and Technology (NIST).

¹ Characteristics of approved meters taken from IEC 62301 Ed 1.0: Measurement of Standby Power

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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.

Accuracy

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

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

All power figures should be in watts and rounded to the second decimal place. For loads greater than or equal to 10 W, three significant figures shall be reported.

Test Conditions

Supply Voltage:	North America/Taiwan:	115 (± 1%) Volts AC, 60 Hz (± 1%)
	Europe/Australia/New Zealand:	230 (± 1%) Volts AC, 50 Hz (± 1%)
	Japan:	100 (± 1%) Volts AC, 50 Hz (± 1%)/60 Hz (± 1%)
		<i>Note:</i> For products rated for > 1.5 kW maximum power, the voltage range is ± 4%
Total Harmonic Distortion (THD) (Voltage):	< 2% THD (< 5% for products which are rated for > 1.5 kW maximum power)	
Ambient Temperature:	23°C ± 5°C	
Relative Humidity:	10 – 80 %	

(Reference IEC 62301: Household Electrical Appliances – Measurement of Standby Power, Sections 3.2, 3.3)

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Test Configuration

Power consumption of a computer shall be measured and tested from an ac source to the UUT.

The UUT must be connected to an Ethernet network switch capable of the UUT's highest and lowest network speeds. The network connection must be live during all tests.

III. Test Procedure for Off, Sleep and Idle for All Computer Products

Measurement of ac power consumption of a computer should be conducted as follows:

UUT Preparation

1. Record the manufacturer and model name of the UUT.
2. Ensure that the UUT is connected to network resources as detailed below, and that the UUT maintains this live connection for the duration of testing, disregarding brief lapses when transitioning between link speeds.

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- a. *Desktops, Integrated Desktops, and Notebooks* shall be connected to a live Ethernet (IEEE 802.3) network switch as specified in Section II., “Test Configuration,” above. The computer must maintain this live connection to the switch for the duration of testing, disregarding brief lapses when transitioning between link speeds. Computers without Ethernet capability must maintain a live wireless connection to a wireless router or network access point for the duration of testing.
 - b. *Small-Scale Servers* shall be connected to a live Ethernet (IEEE 802.3) network switch as specified in Section II., “Test Configuration,” above, and that the connection is live.
 - c. *Thin Clients* shall be connected to a live server via a live Ethernet (IEEE 802.3) network switch and shall run intended terminal/remote connection software.
3. 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.
 4. 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. For a valid test to take place the meter should remain in place until all Off, Sleep, and Idle power data is recorded.
 5. Record the ac voltage.
 6. Boot 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.

Note: In the comment period after Draft 2, EPA received specific instructions from a stakeholder on processes in a single OS that should be disabled to ensure the intended completion of one-time/periodic events. EPA continues to intend for this test procedure to be as platform-agnostic as possible and as such has not included the proposed text directly in the test procedure. EPA is open to discussing if stakeholders would like to collaborate on a companion “Testing FAQ” document created after specification finalization that could include such details.

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7. 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.²
 8. Record basic information about the video card or graphics chipset (if applicable) - video card/chipset name, resolution, amount of onboard memory, and bits per pixel.³
 9. Ensure that the UUT is configured as shipped including all accessories, power management settings, WOL enabling and software shipped by default. UUT should also be configured using the following requirements for all tests:
 - a. *Desktop* systems shipped without accessories should be configured with a standard mouse, keyboard and external computer display.
 - b. *Notebooks* should include all accessories shipped with the system, and need not include a separate keyboard or mouse when equipped with an integrated pointing device or digitizer.
 - c. *Notebooks* should have the battery pack(s) removed for all tests. For systems where operation without a battery pack is not a supported configuration, the test may be performed with fully charged battery pack(s) installed, making sure to report this configuration in the test results.
 - d. *Small-Scale Servers* and *Thin Clients* shipped without accessories should be configured with a standard mouse, keyboard and external computer display (if server has display output functionality).

² On Windows-based machines, much of this information can be found by selecting the following window: Start / Programs / Accessories / System Tools / System Information.

³ On Windows-based machines, this can be found by selecting the following window: Start / Programs / Accessories / System Tools / Components / Display.

- 1045 e. Power to wireless radios should be turned off for all tests. This applies to wireless
1046 network adapters (e.g., 802.11) or device-to-device wireless protocols.
1047
- 1048 10. The following guidelines should be followed to configure power settings for computer displays
1049 (adjusting no other power management settings):
1050 a. For computers with external computer displays (most desktops): use the computer
1051 display power management settings to prevent the display from powering down to ensure
1052 it stays on for the full length of the Idle test as described below.
1053 b. For computers with integrated computer displays (notebooks and integrated systems):
1054 use the power management settings to set the display to power down after 1 minute.
1055

Note: Based on Stakeholder feedback with respect to testing with monitors on, the test procedure in this draft is representative of the calls for data that were released over the summer, which did not include this provision. However, EPA believes there is merit to this proposal and intends to discuss this topic at the September 26 stakeholder meeting. EPA's proposal is as follows:

1. All computers are tested for Idle *with displays active, not power managed*. This is consistent for external displays, but a modification for integrated; and
2. A capability adjustment, based on the ENERGY STAR Displays/Monitors requirements in effect at the time of test and percentage of time in Idle, is subtracted from the TEC level of compliance to adjust for the additional TEC amount.

EPA welcomes comments during the comment period of this document and in advance of the meeting to allow for a more productive discussion of potential approaches.

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- 1069 11. Shut down the UUT.
1070

1071 **Off Mode Testing**

- 1072 12. With the UUT shut down and in Off, set the meter to begin accumulating true power values at an
1073 interval of 1 reading per second. Accumulate power values for 5 additional minutes and record
1074 the average (arithmetic mean) value observed during that 5 minute period.⁴
1075

1076 **Idle Mode Testing**

- 1077 13. Switch on the computer and begin recording elapsed time, starting either when the computer is
1078 initially switched on, or immediately after completing any log in activity necessary to fully boot the
1079 system. Once logged in with the operating system fully loaded and ready, close any open
1080 windows so that the standard operational desktop screen or equivalent ready screen is displayed.
1081 Between 5 and 15 minutes after the initial boot or log in, set the meter to begin accumulating true
1082 power values at an interval of 1 reading per second. Accumulate power values for 5 additional
1083 minutes and record the average (arithmetic mean) value observed during that 5 minute period.
1084

1085 **Sleep Mode Testing**

- 1086 14. After completing the Idle measurements, place the computer in Sleep mode. Reset the meter (if
1087 necessary) and begin accumulating true power values at an interval of 1 reading per second.
1088 Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value
1089 observed during that 5 minute period.
- 1090 15. If testing both WOL enabled and WOL disabled for Sleep, wake the computer and change the
1091 WOL from Sleep setting through the operating system settings or by other means. Place the
1092 computer back in Sleep mode and repeat step 15, recording Sleep power necessary for this
1093 alternate configuration.
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1095 **Reporting Test Results**

⁴ 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.

1096 16. The test results must be reported to EPA or the European Commission, as appropriate, taking
1097 care to ensure that all required information has been included.
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1099 IV. Maximum Power Test for Workstations 1100

1101 **Note:** The maximum power test used in Version 4.0 has been again included in the test procedure to reflect the
1102 Workstation test approach.

1103 The maximum power for workstations is found by the simultaneous operation of two industry standard
1104 benchmarks: Linpack to stress the core system (e.g., processor, memory, etc.) and SPECviewperf[®]
1105 (latest available version for the UUT) to stress the system's GPU. Additional information on these
1106 benchmarks, including free downloads, can be found at the URLs found below:

1107

Linpack <http://www.netlib.org/linpack/>

SPECviewperf[®] <http://www.spec.org/benchmarks.html#gpc>

1108

1109 This test must be repeated three times on the same UUT, and all three measurements must fall within
1110 a $\pm 2\%$ tolerance relative to the average of the three measured maximum power values.

1111 Measurement of the maximum ac power consumption of a workstation should be conducted as
1112 follows:

1113 **UUT Preparation**

- 1114 1. Connect an approved meter capable of measuring true power to an ac line voltage source set to
1115 the appropriate voltage/frequency combination for the test. The meter should be able to store and
1116 output the maximum power measurement reached during the test or be capable of another
1117 method of determining maximum power.
- 1118 2. Plug the UUT into the measurement power outlet on the meter. No power strips or UPS units
1119 should be connected between the meter and the UUT.
- 1120 3. Record the ac voltage.
- 1121 4. Boot the computer and, if not already installed, install Linpack and SPECviewperf as indicated on
1122 the above Websites.
- 1123 5. Set Linpack with all the defaults for the given architecture of the UUT and set the appropriate
1124 array size "n" for maximizing power draw during the test.
- 1125 6. Ensure all guidelines set by the SPEC organization for running SPECviewperf are being met.
1126

1127 **Maximum Power Testing**

- 1128 7. Set the meter to begin accumulating true power values at an interval of 1 reading per second, and
1129 begin taking measurements. Run SPECviewperf and as many simultaneous instances of Linpack
1130 as needed to fully stress the system.
- 1131 8. Accumulate power values until SPECviewperf and all instances have completed running. Record
1132 the maximum power value attained during the test.
1133

1134 **Reporting Test Results**

- 1135 9. The test results must be reported to EPA or the European Commission, taking care to ensure that
1136 all required information has been included.
- 1137 10. Upon submittal of data, manufacturers must also include the following data:
 - 1138 a. Value of the n (the array size) used for Linpack,
 - 1139 b. Number of simultaneous copies of Linpack run during the test,
 - 1140 c. Version of SPECviewperf run for test,
 - 1141 d. All compiler optimizations used in compiling Linpack and SPECviewperf, and
 - 1142 e. A precompiled binary for end users to download and run of both SPECviewperf and
1143 Linpack. These can be distributed either through a centralized standards body such as
1144 SPEC, by the OEM or by a related third party.

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V. Test Procedure for All Modes for Game Consoles

Measurement of ac power consumption of a computer should be conducted as follows:

Note: The Maximum Power test for workstations present in V4.0 has been removed. This section has been added to provide an ordered test procedure for collecting ENERGY STAR compliance data for Game Consoles.

UUT Preparation

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, and total and available physical memory, etc.
3. Ensure that the UUT is connected to a TV(s) which support all of the output types supported by the UUT.
 - a. *For each output that supports APD, repeat step 10 of this procedure.*
4. 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.
5. 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. For a valid test to take place the meter should remain in place until all power data is recorded.
6. Record the ac voltage.
7. Turn on the console and wait until the operating system has fully loaded.
8. If necessary, run the initial system setup and allow all preliminary tasks and other one-time/periodic processes to complete.
9. Ensure that the UUT is configured as shipped including all accessories, power management settings and software shipped by default
10. For each applicable output, wait for 15 minutes and ensure the output drops after the prescribed time.
11. Place the system in a state without the game loaded.
12. Then wait one hour and verify the system goes into a low power state.
13. Bring the console back into its OS loaded state
14. Load a game and bring it to the games menu.
15. Begin game play and pause the game.
16. Wait one hour and verify the system goes into a low power state. (Applicable after Version 5.0)
17. Shut down the UUT.

Off Mode Testing

18. With the UUT shut down and in Off, set the meter to begin accumulating true power values at an interval of 1 reading per second. Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value observed during that 5 minute period.⁵

Sleep/APD Mode Testing

19. After completing the Off mode measurements, place the computer in it's Sleep/APD mode. Reset the meter (if necessary) and begin accumulating true power values at an interval of 1 reading per second. Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value observed during that 5 minute period.

VI. Continuing Verification

This testing procedure 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.

⁵ *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.*

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VII. Verification Testing Requirements

The following requirements outline a manufacturer-financed quality assurance system that allows for independent evaluation of ENERGY STAR qualified computers. These requirements will be effective with Version 5.0. EPA may request manufacturers to submit products for verification testing as described below. EPA reserves the right to modify these procedures based on experience gained in their implementation. The Procedures Manual for this program will be available on the ENERGY STAR Office Equipment Partner Resources page on the ENERGY STAR website.

Product Selection: EPA will select computers each year for verification testing. The manufacturer of each selected product will be required to commission third-party testing of the specified computer by a manufacturer-independent testing lab. The testing lab will procure one (1) sample of each computer model on the open market (if possible). EPA will make exceptions on a case-by-case basis for computers that are unreasonable to obtain on the open market (e.g., cost more than \$5000 or highly customized), by allowing the manufacturer to provide a model directly to the laboratory for testing. Specific testing details are outlined in the ENERGY STAR for Computers Verification Testing Guidelines and Procedures Manual.

Schedule Requirements: The manufacturer must retain a qualified third-party testing lab within fourteen (14) business days of EPA notification. The laboratory must complete all testing within 30 calendar days of notification of test start date to EPA.

If the sample fails to meet the performance requirements of the ENERGY STAR specification, the failure will be addressed under EPA's product failure and dispute protocol and if applicable, the procedure for delisting products.

**APPENDIX B:
Sample Calculations**

Note: The appendix B below has been added to address stakeholder requests for sample calculations in support of the TEC Product categories. As this is a new section in the specification and it is intended to aid stakeholders in evaluating products for ENERGY STAR, stakeholder comments are encouraged.

- 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.

Example: Notebook Computer, Category A

1. Measure values using the Appendix A test procedure.
Off = 1W
Sleep = 1.7W
Idle = 10W
2. Determine which Capability Adjustments apply.
Integrated Graphics? Does not apply for Premium Graphics.
*8GB Memory installed. Does meet memory adjustment level: 8yields a 1.6kWh adjustment (4 * 0.4kWh).*
3. Apply Weightings based on Table 2 to calculate TEC:

Table 2 (for conventional notebook):

Toff	60%
Tsleep	10%
Tidle	30%

$$\begin{aligned}
 E_{annual} &= (8760/1000) * (P_{off} * T_{off} + P_{sleep} * T_{sleep} + P_{idle} * T_{idle}) \\
 &= (8760/1000) * (P_{off} * .60 + P_{sleep} * .10 + P_{idle} * .30) \\
 &= (8760/1000) * (1 * .60 + 1.7 * .10 + 10 * .30) \\
 &= \mathbf{33.03 kWh}
 \end{aligned}$$

4. Determine "adjusted TEC" for evaluation by subtracting any capability adjustments (step 2) from the measured TEC (step 3).

$$33.03 \text{ kWh} - 1.6 \text{ kWh} = 31.43 \text{ kWh}$$
5. Compare the adjusted TEC to the ENERGY STAR levels to determine if the model qualifies.

Category A requirement: Category A: ≤ 36.5
Adjusted TEC: 31.43 kWh
31.43kWh < 36.5
Notebook meets ENERGY STAR requirements.

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

1. Measure values using the Appendix A test procedure.

1276 *Off* = 2 W
 1277 *Sleep* = 4W
 1278 *Idle* = 80W
 1279 *Max Power* = 180W

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2. Note number of Hard Drives installed.
 Two hard drives installed during test.
3. Apply Weightings based on Table 4 to calculate TEC:

Table 2 (for conventional notebook):

Toff	35%
Tsleep	10%
Tidle	55%

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$$\begin{aligned}
 P_{TEC} &= (.35 * P_{off} + .10 * P_{sleep} + .55 * P_{idle}) \\
 &= (.35 * 2 + .10 * 4 + .55 * 80) \\
 &= \mathbf{45.10\ W}
 \end{aligned}$$

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4. Calculate the TEC requirement.

$$\begin{aligned}
 P_{TEC} &= 0.28*[P_{max} + (\# \text{ HDD} * 5)] \\
 P_{TEC} &= 0.28*[180 + 2 * 5] \\
 P_{TEC} &= 53.2
 \end{aligned}$$

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5. Compare the adjusted TEC to the ENERGY STAR levels to determine if the model qualifies.

45.10 < 53.2
Workstation meets ENERGY STAR requirements.