ENERGY STAR® Program Requirements for Displays

Table of Contents

ENERGY STAR® Program Requirements for Displays

Partner Commitments

Commitment

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

- comply with current ENERGY STAR Eligibility Criteria, defining the performance criteria that must be met for use of the ENERGY STAR certification mark on displays and specifying the testing criteria for displays. EPA may, at its discretion, conduct tests on products that are referred to as ENERGY STAR qualified. These products may be obtained on the open market, or voluntarily supplied by Partner at EPA's request;

- comply with current ENERGY STAR Identity Guidelines, describing how the ENERGY STAR name and mark may be used. Partner is responsible for adhering to these guidelines and for ensuring that its authorized representatives, such as advertising agencies, dealers, and distributors, are also in compliance;

- qualify at least one ENERGY STAR qualified display model within six months of activating the display portion of the agreement. When Partner qualifies the product, it must meet the specification (e.g., Tier 1 or 2) in effect at that time;

- provide clear and consistent labeling of ENERGY STAR qualified displays. The ENERGY STAR mark must be clearly displayed:

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

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

       – The ENERGY STAR mark in cyan, black, or white (as described in "The ENERGY STAR Identity Guidelines" available at www.energystar.gov/logos) appears at system start-up. The electronic mark must display for a minimum of 5 seconds;

       – The ENERGY STAR mark must be at least 10% of the screen by area, may not be smaller than 76 pixels x 78 pixels, and must be legible.

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

    2. In product literature (i.e., user manuals, spec sheets, etc.);
    3. On product packaging for products sold at retail; and
    4. On the Partner's Internet site where information about ENERGY STAR qualified models is 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;

Note: EPA has removed the 'labeling through advertising' option under this Draft 2 Version 5.0 specification because, to EPA's knowledge, no Partners have elected to use this option as a substitute for placing either a permanent, temporary, or electronic label on their products since the Version 4.0 specification took effect in January 2005. Additionally, EPA has removed language indicating that the labeling requirements were deferred until July 1, 2006.

In this Draft 2 Version 5.0 specification, in order to increase harmonization between specifications, EPA has replaced the product labeling language in the Version 4.1 Monitors specification with the language in Version 5.0 of the ENERGY STAR Computers specification. As a result, the language here confirms EPA will consider alternative proposals regarding approach, duration, or size for electronic labeling on a case-by-case basis.

- include information on the importance of power management in either the product manual or as a box insert for displays intended for use with computers. This information should include a reference to the energy saving and environmental benefits of power management for both the display and computer. In addition, a link should be made available to www.energystar.gov/powermanagement from computer product pages, product specifications, and related content pages. At the Partner's request, EPA will supply suggested facts and figures related to the above criteria, template elements, or a complete template suitable for use in user guides or box inserts.

- provide to EPA, on an annual basis, an updated list of ENERGY STAR qualifying display models. Once the Partner submits its first list of ENERGY STAR qualified display models, the Partner will be listed as an ENERGY STAR Partner. Partner must provide annual updates in order to remain on the list of participating product Partners;

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

- notify EPA of a change in the designated responsible party or contacts for displays within 30 days.

Performance for Special Distinction

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

- consider energy efficiency improvements in company facilities and pursue the ENERGY STAR label for buildings;

- purchase ENERGY STAR qualified products. Revise the company purchasing or procurement specifications to include ENERGY STAR. Provide procurement officials' contact information to EPA for periodic updates and coordination. Circulate general ENERGY STAR qualified product information to employees for use when purchasing products for their homes;

- ensure the power management feature is enabled on all ENERGY STAR qualified displays in use in company facilities, particularly upon installation and after service is performed;

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

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

- provide a simple plan to EPA outlining specific measures Partner plans to undertake beyond the program requirements listed above. By doing so, EPA may be able to coordinate, communicate, and/or promote Partner's activities, provide an EPA representative, or include news about the event in the ENERGY STAR newsletter, on the ENERGY STAR Web pages, etc. The plan may be as simple as providing a list of planned activities or planned milestones that Partner would like EPA to be aware of. For example, activities may include: (1) increase the availability of ENERGY STAR qualified products by converting the entire product line within two years to meet ENERGY STAR guidelines; (2) demonstrate the economic and environmental benefits of energy efficiency through special in-store displays twice a year; (3) provide information to users (via the Web site and user's manual) about energy-saving features and operating characteristics of ENERGY STAR qualified products, and (4) build awareness of the ENERGY STAR Partnership and brand identity by collaborating with EPA on one print advertorial and one live press event;

- provide quarterly, written updates to EPA as to the efforts undertaken by Partner to increase availability of ENERGY STAR qualified products, and to promote awareness of ENERGY STAR and its message.

Note: EPA proposes the following additions to the "Performance for Special Distinction" section of the Partner Commitments for Display Partners:

- Join EPA's SmartWay Transport Partnership to improve the environmental performance of the company's shipping operations. SmartWay Transport works with freight carriers, shippers, and other stakeholders in the goods movement industry to reduce fuel consumption, greenhouse gases, and air pollution. For more information on SmartWay, visit www.epa.gov/smartway;

- Join EPA's Climate Leaders Partnership to inventory and reduce greenhouse gas emissions. Through participation, companies create a credible record of their accomplishments and receive EPA recognition as corporate environmental leaders. For more information on Climate Leaders, visit www.epa.gov/climateleaders;

- Join EPA's Green Power partnership. EPA's Green Power Partnership encourages organizations to buy green power as a way to reduce the environmental impacts associated with traditional fossil fuel-based electricity use. The partnership includes a diverse set of organizations including Fortune 500 companies, small and medium businesses, government institutions as well as a growing number of colleges and universities, visit http://www.epa.gov/grnpower/.

ENERGY STAR® Program Requirements for Displays

Eligibility Criteria (Version 5.0)

DRAFT 2

Below is the Draft 2 (Version 5.0) product specification for ENERGY STAR qualified displays. A product must meet all of the identified criteria if it is to be labeled as ENERGY STAR by the Partner.

1) **Definitions**: Below is a brief description of an Electronic Display and other terms as relevant to ENERGY STAR.

   A. Electronic Display (also referred to as "Display"): A commercially-available, electronic product with a display screen and its associated electronics encased in a single housing that, as it's primary function, displays visual information from (i) a computer, workstation or server via one or more inputs, such as VGA, DVI, HDMI, and/or IEEE 1394, or (ii) a USB flash drive, a memory card, or wireless Internet connection to obtain primary functionality. Common display technologies include liquid crystal display (LCD), light emitting diode (LED), cathode-ray tube (CRT), or other device. To qualify, the display must be capable of being powered by a separate AC wall outlet, a battery unit that is sold with an AC adapter, or from a data or network connection. Displays with a tuner may qualify as ENERGY STAR under this specification as long as they are marketed and sold to consumers as displays (i.e., focusing on electronic display as the primary function) or as dual-function displays and televisions. However, products with a tuner and computer connectivity that are marketed and sold as televisions are not included in this specification.

> **Note:** EPA has broadened the scope of the 'computer monitor' definition provided under the Version 4.1 Monitor specification to now apply to a wider category of electronic display devices. It is EPA's intent that when finalized, this Version 5.0 Displays specification will cover a variety of electronic displays, including digital photo frames, computer monitors, and professional signage. As such, EPA has modified all references to 'computer monitors' in the Version 4.1 specification to now read 'displays' in this Draft 2 Version 5.0 document. However, while broadening the scope, EPA wants to ensure that the intent of the ENERGY STAR Displays program is maintained by allowing only products for which we have relevant power consumption test data to qualify. These product types include digital photo frames, computer monitors, and professional signage. For stakeholder reference, the smallest product in EPA's current displays dataset has a viewable diagonal screen size of 7 inches and the largest has a viewable diagonal screen size of 84 inches. **As such, EPA is considering including minimum and maximum viewable diagonal screen sizes for eligible products to the above definition and seeks stakeholder input on the appropriate size constraints.**
>
> Consistent with the Version 4.1 Monitor specification, products with a tuner may continue to qualify under this proposed Version 5.0 set of requirements as long as they are marketed and sold as displays or as dual function displays and televisions. However, it is EPA's intent that under Tier 2, only those products without tuners will be able to qualify under the proposed Version 5.0 displays specification. All displays products with tuners will have to qualify under Tier 2 of the Version 3.0 ENERGY STAR TV specification.
>
> During the comment period on Draft 1 of this specification, EPA received a comment recommending the removal of the requirement that the display screen and its associated electronics be encased in a single housing. EPA notes this terminology is taken from the Version 4.1 of this specification, and that it would be interested in receiving further information on why this may be a constraint.

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

Note: EPA has included a definition for external power supplies in this Draft 2 specification because of the inclusion of external power supply requirements under Section 3, Energy Efficiency Specifications for Qualifying Products.

C. On Mode: The product is connected to a power source and produces an image.

D. Sleep Mode: The reduced power state the display enters after receiving instructions from a content source (e.g. computer, game console, or set-top box), or via other functions (e.g. timers or sensors). A blank screen and reduction in power consumption characterize this mode. The display returns to On Mode with full operational capability upon sensing a signal from a source or function that can initiate that can initiate the reduced power state.

Note: EPA has modified the definition of Sleep Mode in order to reflect the fact that the specification now encompasses a greater variety of displays than only computer monitors.

E. Off Mode: The reduced power state the display is in when it is connected to a power source, produces no images, and is waiting to be switched to On Mode by a direct signal from a user (e.g., user pushes power switch). It is engaged by a power switch. If there is more than one such switch, the tester shall use the most readily available switch.

Note: EPA has clarified the definition of Off Mode to respond to confusion concerning hard off and soft off modes. Recognizing a display may have more than one off switch, EPA specifies here that the tester is to engage the Off Mode via the switch the user is most likely to use by virtue of its ease of access relative to other off switches the display may have.

2) **Qualifying Products**: In order to qualify as ENERGY STAR, a display model must meet the definition in Section 1.A and the specification requirements provided in Section 3, below. As explained in Section 1, this specification does not cover products with computer capability that are marketed and sold as televisions.

3) **Energy-Efficiency Criteria:** Only those products listed in Section 2 that meet the following criteria may qualify as ENERGY STAR. Effective dates for Tiers 1 and 2 are provided in Section 6 of this specification.

A. On Mode Requirements

1. Tier 1: To qualify as ENERGY STAR, display models must not exceed the maximum On Mode power consumption (P) found from the equations provided in Table 1, based on the unit's resolution and viewable screen area. The maximum On Mode power consumption is expressed in watts and rounded up to one decimal place. In the following equations, MP is the number of megapixels in decimal form (e.g., 1,920,000 pixels = 1.92 megapixels), and A is the viewable screen area of the product rounded to the nearest whole number, found by multiplying the viewable display width by the viewable display height.

Table 1. Tier 1 On Mode Power Consumption Requirements for Displays

Display Category	Maximum On Mode Power Consumption
Less than 30" viewable diagonal screen size and less than or equal to 1.1 MP resolution	P = 6*(MP) + 0.05*(A) + 3
Less than 30" viewable diagonal screen size and greater than 1.1 MP resolution	P = 9*(MP) + 0.05*(A) + 3
Greater than or equal to 30" viewable diagonal screen size	P = 35*(MP) + 0.12*(A) + 4

For example, the maximum power consumption for a display with 1440 x 900 resolution, or 1,296,000 pixels, a 19 inch viewable diagonal screen size and a viewable screen area of 162 square inches, would be: ((9 x 1.296) + (0.05 x 162)) + 3 = 22.8 watts when rounded to one decimal place. Under these metrics, maximum allowed power consumption for displays with various resolutions and screen sizes is provided below in Table 2.

Table 2. Sample Tier 1 On Mode Maximum Power Levels

Viewable Diagonal Screen Size (Inches)	Resolution	Total Megapixels	Viewable Screen Size in Inches	Screen Area in Square Inches	Maximum On Mode Power Use (Watts)
7	800 x 480	0.384	5.9 x 3.5	21	6.4
15	1024 x 768	0.786	12 x 9	108	13.1
19	1440 x 900	1.296	16.07 x 10.05	162	22.8
46	1366 x 768	1.049	40.1 x 22.5	902	149
54	1920 x 1080	2.074	47 x 26.4	1,241	225.5

Note: EPA established the On Mode power requirements in Table 1, above, using the prescribed luminance levels in Table 4, below. For units to be tested at 175 cd/m^2, EPA used manufacturer submitted data corresponding to the On Mode power testing results under the luminance setting prescribed in Version 4.1 of the ENERGY STAR Monitors specification (175 cd/m^2). This applies to all models of less than 30 inches viewable diagonal screen size and less than 1.1 megapixel. For models with greater than or equal to 1.1 MP resolution or of greater than or equal to 30" viewable diagonal screen size, EPA used the manufacturer's four submitted data points (175 cd/m^2, minimum luminance, default luminance, and maximum luminance) to determine a luminance to On Mode power relationship. EPA used this relationship on a model-by-model basis to adjust the On Mode power consumption to the appropriate prescribed luminance level. EPA checked the accuracy of the estimated relationship by calculating On Mode power at the current ENERGY STAR prescribed setting and then checking this estimate against manufacturer-submitted On Mode power data. EPA found high levels of consistency with a +2% difference in predicted vs. actual On Mode power consumption across the entire dataset, meaning that overall, there was a greater tendency to overestimate as opposed to underestimate industry power levels. The plasma displays in EPA's dataset currently have luminance settings significantly lower than the proposed 350 nits (see Table 4, below); therefore, EPA would like to receive additional data on plasma displays to further review this effect.

In conducting a statistical analysis on the data submitted by manufacturers, EPA found that both screen resolution and screen size play a role in determining a display's On Mode power consumption. For standard LCD displays, EPA found that On Mode power consumption (at default luminance setting) was most strongly correlated to resolution. However, for displays of the same resolution, screen size was clearly an important variable for determining On Mode power consumption. For very small screen models, EPA found On Mode power consumption to be most strongly correlated to resolution. For very large screen models, EPA found On Mode power consumption to be most strongly correlated to screen area. EPA determined it was feasible to integrate both variables into a single equation for determining On Mode performance levels. Market research also indicates that both screen area and resolution are key variables consumers look for when purchasing display products. This approach allows us to address the power consumption of models with the same resolution but different viewable screen sizes and conversely, the power consumption of models with the same viewable screen size but different resolutions. The approach also creates more consistency with the Version 3.0 ENERGY STAR TV specification, which will facilitate addressing convergence under Tier 2 for both televisions and displays. Including both resolution and screen area as independent variables explained over 70% of the variance in On Mode power consumption for LCD displays.

Continued on next page…

Note continued:

As a result of including both screen size and resolution, On Mode requirements proposed under this Draft 2 Version 5.0 specification indicate reduced power consumption allowances for low resolution, smaller screen sizes and increased power consumption allowances for higher resolution and/or larger screen sizes. Sample Tier 1 maximum on mode power consumption levels are provided in Table 2 for a variety of display resolutions/sizes.

Per EPA's preliminary analysis of monitor unit shipment data collected for calendar year 2007, market penetration of ENERGY STAR qualified monitors is estimated to be at over 90%. Based on EPA's current dataset, approximately 23% of display models would be able to meet the Tier 1 On Mode requirements proposed in this Draft 2 Version 5.0 displays specification.

2. Tier 2: To qualify as ENERGY STAR, display models must not exceed the following maximum On Mode consumption equations: TBD.

To qualify a display as ENERGY STAR, it must be tested according to the protocol outlined in Section 4, Test Method.

Note: EPA has left Tier 2 requirements under this Draft 2 Version 5.0 displays specification as TBD. However, it is EPA's intent to engage in dialogue with industry during the Tier 2 development process to discuss potential Tier 2 requirements that contribute to EPA's goal of pursuing convergence with the ENERGY STAR TV specification, and take into account energy-saving features for displays, such as (i) modulating backlights, (ii) automatic brightness control, (iii) polarizing films, (iv) timers/occupancy sensors, etc. Approximately **24%** of EPA's current displays dataset incorporates automatic brightness control, and it is anticipated that this feature, along with the others listed here, will only increase in prevalence over the next several years.

For those products that already incorporate automatic brightness control, it is EPA's intent under Tier 1 of this proposed Version 5.0 specification to request manufacturers to submit On Mode power consumption data under both low and average ambient light conditions. EPA will subsequently use this data as part of the development process for determining Tier 2 levels.

EPA developed the proposed requirements for Tier 1 of this Draft 2 Version 5.0 specification to allow display models with added functionality such as built-in speakers or USB ports to qualify. Similarly, when developing Tier 2 requirements EPA is committed to recognizing full-featured products.

EPA is beginning review of other energy and safety related impacts associated with this product category for discussion with stakeholders for possible inclusion in Tier 2 of this specification. EPA is interested in receiving input on means to address this interest in a way that aligns with ENERGY STAR's guiding principles, and fully expects to engage stakeholder input during this process.

3. Displays with Automatic Brightness Control: EPA has noted a substantial increase in the default luminance settings of displays, and a near 1:1 relationship between increasing luminance and increasing power consumption. Hence, while EPA recognizes the benefit in offering the consumer full-featured products, higher luminance settings tend to offset power consumption reductions achieved through improved component efficiency. The use of displays in conditions where ambient light tends to vary offers an opportunity to offset this effect by matching delivered luminance to "needed" luminance through the implementation of Automatic Brightness Control (ABC). In addition to offering significant energy savings, this feature can also improve the user viewing experience. As such, EPA is recognizing products shipped with ABC enabled by default both as a means to deliver energy savings and to advance harmonization with the ENERGY STAR TV specification.

To account for the power savings achieved through ABC, where the feature is activated by default when shipped, On Mode power consumption shall be determined as follows: $P_{a1} = 0.8* P_o + 0.2*P_{abc}$, where P_{a1} is the average On Mode power consumption in watts and rounded to the nearest whole number, taking into consideration that the display will be in low ambient light level conditions 20% of the time; P_o is the On Mode power consumption in watts and rounded to the nearest whole number when tested with a minimum ambient light level of 300 lux entering directly into the sensor; and P_{abc} is the On Mode power consumption in watts and rounded to the nearest whole number when tested with an ambient light level of 0 lux entering directly into the sensor. (See Section 4.J. Test Method, below, for further information on how to test displays with Automatic Brightness Control to determine ENERGY STAR qualification.) When determining ENERGY STAR qualification, products that ship with automatic brightness control enabled should compare their On Mode power consumption (P_{a1}), found using the equation above, to the maximum On Mode power consumption allowed (P), determined using the equations in Table 1, above.

Note: Recognizing the growing use of Automatic Brightness Control in Displays, and bringing this specification further in line with the TV specification, EPA has incorporated from the TV specification 3.0 the procedure for determining an alternative power consumption value for products that ship with automatic brightness control enabled. EPA intends for this power consumption value to be compared to the model's power consumption limit as determined by the appropriate equation in Table 1 in order to determine ENERGY STAR qualification.

B. Display Products Using an External Power Supply: To qualify, the external power supply must be ENERGY STAR qualified or meet the no-load and active mode efficiency levels provided in the ENERGY STAR Program Requirements for Single Voltage Ac-Ac and Ac-Dc External Power Supplies. The ENERGY STAR specification and qualified product list can be found at www.energystar.gov/powersupplies.

Note: EPA has incorporated external power supply requirements for displays in this Draft 2 Version 5.0 ENERGY STAR displays specification. The inclusion of external power supply requirements is consistent with EPA's approach to other electronics product specifications developed/revised since the launch of the ENERGY STAR specification for single voltage ac-ac and ac-dc external power supplies, e.g., computers, set-top boxes, and televisions, whereby products must meet their respective energy-efficiency requirements and when coupled with external power supplies, those power supplies must also meet ENERGY STAR requirements.

C. Sleep and Off Modes

1. Tiers 1 and 2: Maximum power consumption levels for Sleep and Off Modes are provided in Tables 3a and 3b below. Displays capable of multiple Sleep Modes (i.e., Sleep and Deep Sleep) shall meet the Sleep Mode requirement below in all such modes. For example, a display of greater than or equal to 30" viewable diagonal screen size tested at 5 watts in Sleep and 4 watts in Deep Sleep would not qualify because one of the Sleep Modes exceeded 4 watts.

Table 3a. Tier 1 Energy-Efficiency Criteria for Sleep and Off Modes

Product Type	Sleep Mode (W)	Off Mode (W)
Less than 30" viewable diagonal screen size	≤ 2	≤ 1
Greater than or equal to 30" viewable diagonal screen size	≤ 4	≤ 2

Table 3b. Tier 2 Energy-Efficiency Criteria for Sleep and Off Modes

Product Type	Sleep Mode (W)	Off Mode (W)
All displays	≤ 1	≤ 1

Note: Under this Draft 2 Version 5.0 specification, EPA has replaced the Tier 1 Sleep and Off Mode requirements that were present in Draft 1 and applied to all displays regardless of screen area or resolution, with Tier 1 Sleep and Off Mode requirements that vary depending on screen area and resolution (Table 3a). EPA suggests this modification in order to address the pass rate of large screen area products that are typically employed as professional displays, which under Draft 1 was significantly below EPA's goal of 25%..Tier 2 (Table 3b) under this Draft 2 specification remains unchanged from Draft 1. Hence, consistent with Draft 1, EPA is proposing to lower the Sleep Mode requirement under Tier 2 to ≤ 1 watt. This proposal would allow consistency between Tier 2 displays criteria and other ENERGY STAR specifications, such as the TV specification.

2. Power Management Requirements: Displays must have at least one mechanism enabled by default that allows the display to automatically enter Sleep or Off Mode. For instance, any data or network connection must support powering down the display according to standard mechanisms, such as Display Power Management Signaling, while displays generating their own content must have a sensor or timer enabled by default to automatically engage Sleep or Off Mode.

Note: In this Draft 2 specification, EPA has substituted the section titled "Sleep Mode Exception" in the Version 4.1 Monitor specification with the section above, "Power Management Requirements," to clarify EPA's approach to the management of Sleep and Off modes under this specification, noting that displays must have at least one mechanism enabled by default that allows the display to automatically enter Sleep or Off Mode. EPA notes that over 50% of the digital picture frames (DPFs) in its dataset were reported as having a Sleep Mode, and would like to receive further information from DPF Partners regarding whether their DPF products have a Sleep Mode, and how these products engage this mode.

4) **Test Method**

Product Testing Set-up, Method, and Documentation: EPA utilizes, where possible, widely-accepted industry practices for measuring product performance and power use under normal or typical operating conditions. The testing and measurement methods below reference published specifications from the Video Electronics Standards Association (VESA) Display Metrology Committee and the International Electrotechnical Commission (IEC), and supplement those guidelines where necessary with methods developed in cooperation with the display industry.

Partners are required to perform tests and self-certify those product models that meet the ENERGY STAR guidelines. In order to conduct testing in support of qualification for ENERGY STAR, the display 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 displays meet key product criteria for displays as outlined in this document. A laboratory's Scope of Accreditation must reflect its specific competence to carry out the test procedures as outlined in the ENERGY STAR Program Requirements for Displays.

Note: EPA is proposing applying the accreditation requirements above to laboratories associated with product qualification. It is EPA's intention to apply these requirements to all relevant product specifications.

Families of display models that are built on the same chassis and are identical in every respect but housing and color may be qualified through submission of test data for a single, representative model. Likewise, 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.

Power shall be measured from the outlet or power source to the product under test. The average true power consumption of the display shall be measured during On Mode, Sleep Mode, and Off Mode. When performing measurements to self-certify a product model, the product being tested must initially be in the same condition (e.g., configuration and settings) as when shipped to the customer, unless adjustments need to be made pursuant to instructions below. If a product's electrical power comes from Mains, USB, IEEE1394, Power-over-Ethernet, telephone system, or any other means or combinations of means, the net AC electrical power consumed by the product (taking into account ac-to-dc conversion losses) must be used for qualification.

To ensure a consistent means for measuring the power consumption of electronics products, the following protocol must be followed, which has three main components:

- Product Testing Set-up and Conditions
- Product Testing Method
- Product Testing Documentation

This protocol ensures that outside factors do not adversely affect the test results and that the test results can be consistently reproduced. Partners may elect to use an in-house or independent laboratory to provide the test results.

Product Testing Set-up and Conditions

A. 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%)
		Note: For products rated for > 1.5 kW maximum power, the voltage range is ± 4%
Total Harmonic Distortion (THD) (Voltage):	< 2% THD (< 5% for products which are rated for > 1.5 kW maximum power)	
Ambient Temperature:	23°C ± 5°C	
Relative Humidity:	10 – 80 %	

(Reference IEC 62301 Ed 1.0: Household Electrical Appliances – Measurement of Standby Power, Sections 4.2, 4.3)

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

Note: EPA has updated the Test Conditions in Draft 2 to be consistent with language related to qualifying products capable of operating at multiple voltage/frequency combinations in other recently developed/revised ENERGY STAR specifications, e.g., computers, set-top boxes, and TVs. The test conditions are based on IEC 62301, Ed 1.0. The intent of this language is identical to that of the text included in the Version 4.1 specification under the heading, "**Supply Voltage**," whereby models must be tested at the voltage/frequency combination for each region where the manufacturer intends to sell the model as ENERGY STAR qualified.

C. Dark Room Conditions: When performing light measurements, the display shall be located in a dark room condition. The display screen illuminance measurement (E) when in Off Mode must be 1.0 Lux or less. Measurements should be made at a point perpendicular to the center of the screen using a Light Measuring Device (LMD) with the display in Off Mode (Reference VESA FPDM Standard 2.0, Section 301-2F).

D. Color Controls and Peripherals: All color controls (hue, saturation, gamma, etc.) shall be placed at their factory default settings. No external devices shall be connected to any included Universal Serial Bus (USB) hubs or ports. Any built-in speakers, TV tuners, etc. may be placed in their minimum power configuration, as adjustable by the user, to minimize power use not associated with the display itself. Circuit removal or other actions not under user control may not be taken to minimize power use.

E. Power Measurement Test Conditions: For LCDs and other fixed pixel technologies, pixel format shall be set to the native level. LCD refresh rate shall be set to 60 Hz, unless a different refresh rate is specifically recommended by the Partner, in which case that rate shall be used. CRT pixel format shall be set at the preferred pixel format with the highest resolution that is intended to be driven at a 75 Hz refresh rate. A VESA Discrete Monitor Timing (DMT) or newer industry standard pixel format timing must be used for the test. The CRT display must be capable of meeting all its Partner-stated quality specifications in the tested format.

F. Power Measurement Protocols: Display power consumption shall be measured in watts with an imposed test pattern. Warm-up time shall be a minimum of a 20-minute period (Reference VESA FPDM Standard 2.0, Section 301-2D or 305-3 for warm-up test). A true RMS power meter with a crest factor of at least three shall be used to measure the power use of each randomly chosen unit at one or more, as appropriate, of the voltage/frequency combinations provided in Section 4.A (Reference VESA Standard: Display Specifications and Measurement Procedures, Version 1.0, Revision 1.0, Section 8.1.3). Measurements shall be taken after wattage values are stable over a three-minute period. Measurements are considered stable if the wattage reading does not vary more than 1% over the three-minute period (Reference IEC 4.3.1). (Testers shall ignore the input sync signal check cycle when metering the model in Sleep Mode and Off Mode.) Testers shall use calibrated measuring equipment capable of measurements accurate to one-tenth of a watt or better.

Note: To bring this specification further into alignment with the TV specification, EPA has changed the required minimum crest factor of the power meter from five to three, after IEC 62301 Ed 1.0: Household Electrical Appliances – Measurement of Standby Power.

Also, in light of the fact that the definition of “Electronic Display” in section 1.A. above, allows for the qualification of displays capable of being powered by a data or network connection, EPA has added the methodology above to measure the power consumption of products powered by a standard low voltage dc supply.

Products powered by a standard low voltage dc supply (e.g., USB, USB PlusPower, IEEE 1394, and Power Over Ethernet) shall utilize a suitable ac-powered source of the dc power. This ac-powered source’s energy consumption shall be measured and recorded as the power consumption of the display under test. For a display powered by USB, a powered hub serving only the display being tested shall be used. For a display powered by Power Over Ethernet or USB PlusPower, it is acceptable to measure the power distribution device with and without the display connected, and record the difference between the two readings as the display’s power consumption. The tester should confirm that this reasonably reflects the unit’s dc consumption plus some allowance for power supply and distribution inefficiency. Any product with both ac and standard low-voltage dc capability should be tested only at ac.

G. Number of Units Required for Testing: Borrowing from European Norm 50301 (Reference BSI 03-2001, BS EN 50301:2001, Methods of Measurement for the Power Consumption of Audio, Video, and Related Equipment, Annex A), EPA has established a test procedure where the number of units required for test depends on the test results for the first unit. If a tested display uses at least 15% less power (i.e., greater than or equal to 15%) than the ENERGY STAR specification in all three operating modes (On Mode, Sleep Mode, and Off Mode), then it only has to be tested once. However, if a tested display is within 15% of the ENERGY STAR specification in any of the three operating modes, then two more units must be tested, and their test results reported to EPA via the Online Product Submittal tool along with the average On, Sleep, and Off Mode values for that model based on the three units tested. None of the test values may exceed the ENERGY STAR specification for the model to be ENERGY STAR qualified.

The following example further illustrates this approach:

EXAMPLE: For simplicity, assume the specification is **100 watts or less and only applies to one operational mode. 85 watts would represent the 15% threshold…**

- If the first unit is measured at **80 watts**, **no more testing** is needed and the model qualifies (80 watts is at least 15% more efficient than the specification and is "outside" the 15% threshold).
- If the first unit is measured at **85 watts**, **no more testing** is needed and the model qualifies (85 watts is exactly 15% more efficient than the specification).
- If the first unit is measured at **90 watts**, then **two more units** must be tested to determine qualification (90 watts is only 10% more efficient than the specification and is "within" the 15% threshold).
- If three units are tested at **90, 98, and 105 watts**, the model **does not qualify** as ENERGY STAR—even though the average is 98 watts— because one of the values (105) exceeds the ENERGY STAR specification.

H. Luminance Test Patterns and Procedures: **For all fixed pixel displays (e.g., LCDs and others),** test pattern (VESA FPDM Standard 2.0, A112-2F, SET01K) shall be displayed that provides eight shades of gray from full black (0 volts) to full white (0.7 volts).[1] Input signal levels shall conform to VESA Video Signal Standard (VSIS), Version 1.0, Rev. 2.0, December 2002. With the brightness and contrast controls at maximum, the technician shall check that, at a minimum, the white and near white gray levels can be distinguished. If white and near white gray levels cannot be distinguished, then contrast shall be adjusted until they can be distinguished. The technician shall next display a test pattern (VESA FPDM Standard 2.0, A112-2H, L80) that provides a full white (0.7 volts) box that occupies 80% of the image. The technician shall then adjust the brightness control until the white area of the screen is set at the correct luminance setting as described in Table 4, below, measured according to VESA FPDM Standard 2.0, Section 302-1. The luminance value shall be reported to EPA with other required testing documentation.

For CRT displays, the technician shall initiate the AT01P (Alignment Target 01 Positive Mode) pattern (VESA FPDM Standard 2.0, A112-2F, AT01P) for screen size and use it to set the display to the Partner's recommended image size, which is typically slightly smaller than maximum viewable screen size. Then, test pattern (VESA FPDM Standard 2.0, A112-2F, SET01K) shall be

displayed that provides eight shades of gray from full black (0 volts) to full white (0.7 volts).[1] Input signal levels shall conform to VESA Video Signal Standard (VSIS), Version 1.0, Rev. 2.0, December 2002. The technician shall adjust (where feasible) the display brightness control downward from its maximum until the lowest black bar luminance level is just slightly visible

[1] Corresponding voltage values for digital only interface displays that correspond to the brightness of the image (0 to 0.7 volts) are:
0 volts (black) = a setting of 0
0.1 volts (darkest shade of gray analog) = 36 digital gray
0.7 volts (full white analog) = 255 digital gray
Please note that future digital interface specifications may widen this range, but in all cases, 0 volts shall correspond to black and the maximum value shall correspond to white, with 0.1 volts corresponding to one-seventh of the maximum value.

(VESA FPDM Standard 2.0, Section 301-3K). The technician shall then display a test pattern (VESA FPDM Standard 2.0, A112-2H, L80) that provides a full white (0.7 volts) box that occupies 80% of the image. The technician shall then adjust the contrast control until the white area of the screen is set at the correct luminance setting as described in Table 4, below, measured according to VESA FPDM Standard 2.0, Section 302-1. The luminance value shall be reported to EPA with other required testing documentation.

Table 4. Luminance Settings for Testing Displays

Product	Cd/m^2
All CRTs	100
Less than 30" viewable diagonal screen size and less than or equal to 1.1 MP resolution	175
Less than 30" viewable diagonal screen size and greater than 1.1 MP resolution	200
Greater than or equal to 30" viewable diagonal screen size	350

Note: While Draft 1 of this specification revision called for testing displays at default, as-shipped luminance settings, EPA has updated the luminance settings in this Draft 2 Version 5.0 specification to specify that manufacturers must test their displays at prescribed luminance settings to determine ENERGY STAR qualification. EPA has made this change to align the specification with luminance values that are closer to actual usage than the 175 candelas/square meter called for in the Version 4.1 specification.

Currently, the plasma displays in the dataset have luminance settings significantly lower than the proposed 350 nits. EPA would like to receive additional data on plasma displays to further improve Table 4.

I. Light Measurement Protocols: When light measurements, such as illuminance and luminance, need to be made, an LMD shall be used with the display located in dark room conditions. The LMD shall be used to take measurements at the center of and perpendicular to the display screen (Reference VESA FPDM Standard 2.0, Appendix A115). The screen surface area to be measured shall cover at least 500 pixels, unless this exceeds the equivalent of a rectangular area with sides of length equal to 10% of the visible screen height and width (in which case this latter limit applies). However, in no case may the illuminated area be smaller than the area the LMD is measuring (Reference VESA FPDM Standard 2.0, Section 301-2H).

Note: EPA has removed the Display Set-Up and Characterization section after determining that it represented only a small subset of the information the Online Product Submittal (OPS) tool for Displays requires Partners to submit when qualifying a product. Rather than reproduce the entire set of OPS fields here, which would differ from what is done in other ENERGY STAR specifications, EPA decided to remove this section and direct Partners to the OPS tool for Displays should they wish to consult the informational fields they will be required to complete when submitting a product for qualification.

Testing Method

J. Test Method: Following are the test steps for measuring the true power requirements of the test unit in On Mode, Sleep Mode, and Off Mode. Partners are required to test their displays using the analog interface, except in those cases where one is not provided (i.e., digital interface monitors, which for the purposes of this test method are defined as having only a digital interface). For digital interface displays, please see Footnote 1 on page 14 for voltage information, and follow the test method below using a digital signal generator.

On Mode

1. Connect the test sample to the outlet or power source and test equipment. For displays shipped with an external power supply, the external power supply (as opposed to a reference

power supply) must be used in the test.
2. Power on all test equipment and properly adjust power source voltage and frequency.
3. Check for normal operation of the test unit and leave all customer adjustments set to factory default settings.
4. Bring the test unit into On Mode either by using the remote control device or by using the ON/OFF switch on the test unit cabinet. Allow the unit under test to reach operating temperature (approximately 20 minutes).
5. Set the proper display mode. Refer to Section E, Power Measurement Test Conditions.
6. Provide dark room conditions. See Sections I, Light Measurement Protocols, and C, Dark Room Conditions.
7. Set size and luminance. Refer to Section H, Luminance Test Patterns and Procedures for CRT or Fixed Pixel displays. Once luminance is set, dark room conditions are no longer needed.

   (Note, if the test sample is equipped with Automatic Brightness Control, and this feature is enabled by default, then substitute points 6 and 7 above with the procedure for testing such models as described in Section 3.A.3, testing the sample at ambient light levels of 0 and 300 lux, and continuing with steps 8 through 13, below.)

8. Either verify that the wall outlet power is within specifications or adjust the AC power source output as described in Section A (e.g., 115V ± 1%, 60Hz ± 1%).
9. Set the power meter current range. The full-scale value selected multiplied by the crest factor rating (Ipeak/Irms) of the meter must be greater than the peak current reading from the oscilloscope.
10. Allow the readings on the power meter to stabilize and then take the true power reading in watts from the power meter. Measurements are considered stable once the wattage reading does not vary more than 1% over a three-minute period. See Section F, Power Measurement Protocols.
11. Power consumption shall be recorded, as well as total pixel format (horizontal x vertical pixels displayed), to calculate pixels/watt.
12. Record the test conditions and test data.

Note: In light of the addition of Automatic Brightness Control to Section 3.A.3. of this Draft 2 of Version 5.0 of the Displays specification, EPA has modified the On Mode Testing Method above to allow the tester to substitute steps 6 and 7 of this method, “Provide dark room conditions,” and ”Set size and luminance,” respectively, with the procedure for testing ABC models as described in Section 3.A.3.

Sleep Mode (Power Switch On, No Video Signal)

1. At the conclusion of the On Mode test, initiate the display’s Sleep Mode. The method of adjustment shall be documented along with the sequence of events required to reach the Sleep Mode. Power on all test equipment and properly adjust operation range.
2. Allow the display to remain in Sleep Mode until stable power readings are measured. Measurements are considered stable once the wattage reading does not vary more than 1% over a three-minute period. Tester shall ignore the input sync signal check cycle when metering the unit in Sleep Mode.
3. Record the test conditions and test data. The measurement time shall be sufficiently long to measure the correct average value (i.e., not peak or instantaneous power). If the device has different Sleep Modes that can be manually selected, the measurement should be taken with the device in the most energy consumptive of those modes. If the modes are cycled through automatically, the measurement time should be long enough to obtain a true average that includes all modes.

Off Mode (Power Switch Off)

1. At the conclusion of the Sleep Mode test, initiate the display’s Off Mode using the power switch that is most easily accessed by the user. The method of adjustment shall be documented along with the sequence of events required to reach the Off Mode. Power on all test equipment and properly adjust operation range.
2. Allow the display to remain in Off Mode until stable power readings are measured.

Measurements are considered stable once the wattage reading does not vary more than 1% over a three-minute period. Tester shall ignore the input sync signal check cycle when metering the model in Off Mode.

3. Record the test conditions and test data. The measurement time shall be sufficiently long to measure the correct average value (i.e., not peak or instantaneous power).

Product Testing Documentation

K. Submittal of Qualified Product Data to EPA: Partners are required to self-certify those product models that meet the ENERGY STAR guidelines and report information to EPA through the Online Product Submittal tool. ENERGY STAR qualifying product data, including information about new as well as discontinued models, must be provided on an annual basis, or more frequently if desired by the Partner.

5) **User Interface**: Partners are strongly recommended to design products in accordance with the user interface standard IEEE P1621: Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments. The Power Management Controls project developed this standard to make power controls more consistent and intuitive across all electronic devices. For details, see http://eetd.LBL.gov/Controls.

6) **Effective Date**: The date that Partners may begin to qualify products as ENERGY STAR, under the Version 5.0 specification, will be defined as the effective date of the agreement. Any previously executed agreement on the subject of ENERGY STAR qualified displays shall be terminated effective October 20, 2009.

A. Qualifying Products Under Tier 1 of the Version 5.0 Specification: Tier 1 of the Version 5.0 specification shall commence on **October 21, 2009**. All products, including models originally qualified under Version 4.1, with a **date of manufacture** on or after **October 21, 2009**, must meet the new (Version 5.0) requirements in order to qualify for ENERGY STAR (including additional shipments of models originally qualified under Version 4.1). The **date of manufacture** is specific to each unit and is the date (e.g., month and year) of which a unit is considered to be completely assembled.

B. Qualifying Products Under Tier 2 of the Version 5.0 Specification: The second phase of this specification, Tier 2, shall commence on **October 21, 2011**. Specifications for Tier 2 shall apply to products with a date of manufacture on or after **October 21, 2011**. For example, a unit with a date of manufacture of October 21, 2011 must meet the Tier 2 specification in order to qualify as ENERGY STAR.

> **Note:** EPA anticipates finalizing the Version 5.0 ENERGY STAR displays specification in January 2009. The proposed effective date of October 21, 2009 would allow industry the typical nine months transition time prior to the revised specification taking effect. At the September 25, 2008 stakeholder meeting, in response to a stakeholder request EPA indicated it would investigate the impact of manufacturer design cycles on the effective date of the specification. EPA spoke with several manufacturers and other stakeholders with regards to this issue, and concluded there is no consistent design cycle for displays across manufacturers, and that instead, design cycles tend to vary across the calendar.
>
> EPA has subsequently allowed two years prior to Tier 2 requirements taking effect in October 2011.

C. Elimination of Grandfathering: EPA will not allow grandfathering under this Version 5.0 ENERGY STAR specification. **ENERGY STAR qualification under Version 4.1 is not automatically granted for the life of the product model.** Therefore, any product sold, marketed, or identified by the manufacturing partner as ENERGY STAR must meet the current specification in effect at the time of manufacture of the product.

7) **Future Specification Revisions**: EPA reserves the right to change the specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to the specification are arrived at through stakeholder discussions.

EPA will periodically assess the market in terms of energy efficiency and new technologies. As always, stakeholders will have an opportunity to share their data, submit proposals, and voice any concerns. EPA will strive to ensure that the Tier 1 and 2 specifications recognize the most energy-efficient models in the marketplace and reward those Partners who have made efforts to further improve energy efficiency.

Greenhouse Gas Emissions

EPA is interested in working with LCD industry stakeholders through the ENERGY STAR program to reduce the emission of high global warming potential gases associated with LCD production, specifically NF_3, SF_6, and CF_4. This area of concern presents an opportunity to significantly reduce emissions beyond product use-phase and to engage our partners in achieving significant, measurable greenhouse gas and energy reductions from the other phases of the product lifecycle.

Note: At the September 25, 2008 stakeholder meeting, EPA briefly presented its thoughts on how to address these GHGs, and agreed to craft a more detailed description of it rational and a proposed path forward (to include hosting a series of web meetings to discuss and work through the proposals). EPA is interested in receiving input from stakeholders on ways to address these high global warming potential gases. Initial thoughts include limiting the amount of emissions associated with LCD panels by either requiring the use of control technologies or by setting a limit on the amount of emissions per area of LCD panels produced. Manufacturers would then be responsible for working with their suppliers to track these emissions for LCD panels used in ENERGY STAR qualified displays. EPA will distribute an invitation to the first web meeting by early November 2008.