

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460



OFFICE OF
AIR AND RADIATION

**Summary of Rationale for Version 5.0 ENERGY STAR® Displays Specification
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I. Introduction and Background

The Version 4.1 ENERGY STAR Monitors specification entered effect on January 1, 2006. Upon launching the Version 5.0 specification revision process on October 29, 2007, there were 40 Monitors Program Partners with 1188 qualified models. These ENERGY STAR qualified products represented about 95% of the LCD monitor market.

The Version 5.0 ENERGY STAR Displays specification program requirements were finalized on March 30, 2009. The requirements will go into effect on October 30, 2009 for displays under 30 inches viewable diagonal screen size ("small displays"), and on January 30, 2010 for displays between 30 and 60 inches viewable diagonal screen size, inclusive ("large displays").

This decision memorandum summarizes important details about the specification development process. The document is divided into the following sections:

- Summary of Key Specification Requirements
- Key Specification Development Milestones
- Summary of Stakeholder Input
- EPA's Rationale for Specification

II. Summary of Key Specification Requirements

Qualifying Products

- The Version 5.0 Displays specification opens ENERGY STAR eligibility to a wider range of products than did the Version 4.1 Monitors specification. EPA replaced the term "monitor" with "display" and created a broader product definition to allow products such as professional displays and digital photo frames to qualify for ENERGY STAR.
- Qualifying products include commercially-available displays with a display screen and associated electronics, often encased in a single housing, that as their primary function display visual information from (i) a computer, workstation or server via one or more inputs, such as VGA, DVI, HDMI, or IEEE 1394, or (ii) a USB flash drive, a memory card, or wireless Internet connection.
- To qualify, the Display must:
 - Have a viewable diagonal screen size of less than or equal to (\leq) 60 inches;

- Be powered by a separate AC wall outlet, a battery unit that is sold with an AC adapter, or a data or network connection; and,
- Have at least one mechanism enabled by default that allows the display to automatically enter Sleep or Off Mode.
- If the display has an integrated television tuner, it may qualify for ENERGY STAR under this specification as long as it is primarily marketed and sold to consumers as a display or as a dual-function display and television. However, under Tier 2 of this specification only those displays without tuners may qualify. If a display with an integrated television tuner is marketed as a television, it may qualify under the TV specification.
- Products ineligible for ENERGY STAR qualification under this specification include:
 - Any display with a television tuner that is marketed and sold exclusively as a television;
 - TVs, TV monitors, component TVs, and TV combination products, e.g., a TV/DVD combination unit.
 - “Television monitor” products, or equipment intended to display a video signal from an external tuner or other video source are covered by the Version 3.0 TV specification, not the Version 4.1 Monitors specification. These products will not be covered under future TV specifications.

Energy Efficiency Criteria

- The Version 5.0 specification is technology-neutral, i.e., all products, regardless of underlying technology, must meet the same requirements in order to qualify.
- EPA will publish On, Sleep, and Off Mode power consumption data for qualifying products on the ENERGY STAR Web site.
- Products must meet On, Sleep, and Off Mode power consumption requirements in order to earn the ENERGY STAR under the Version 5.0 requirements.
 - *On Mode*: For small displays, power consumption limits are based on both viewable screen area and resolution, and for large displays, on viewable screen area alone. In general, larger, high resolution displays will have higher maximum On Mode power consumption allowances than smaller, low resolution displays. Tier 1 On Mode requirements are based on the following equations (Tier 2 requirements remain under development as of this writing):

Tier 1 On Mode Power Consumption Requirements

Display Category	Maximum On Mode Power Consumption (W)
Diagonal Screen Size < 30 inches Screen Resolution ≤ 1.1 MP	$P_O = 6*(MP) + 0.05*(A) + 3$
Diagonal Screen Size < 30 inches Screen Resolution > 1.1 MP	$P_O = 9*(MP) + 0.05*(A) + 3$
Diagonal Screen Size 30 - 60 inches All Screen Resolutions	$P_O = 0.27*(A) + 8$

MP = Display Resolution (megapixels)

A = Viewable Screen Area (square inches)

EXAMPLE: The maximum On Mode 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: $((9 \times 1.296) + (0.05 \times 162)) + 3 = 22.8$ watts when rounded to the nearest tenth of a watt.

- *Sleep and Off Modes*: Sleep and Off Mode requirements are equivalent across product sizes and resolutions, and are as follows:

Tier 1 and 2 Sleep and Off Mode Power Consumption Requirements for all Displays

Mode	Tier 1	Tier 2
Maximum Sleep Mode Power Consumption (W)	≤ 2	≤ 1
Maximum Off Mode Power Consumption (W)	≤ 1	≤ 1

- Credit is given for products that offer an Automatic Brightness Control (ABC) feature and ship with ABC enabled by default. For these products, On Mode power consumption is averaged over both low and high ambient light conditions, assuming low ambient light conditions 20% of the time, and high ambient light conditions 80% of the time.
- Products that are sold with an external power supply (EPS) are required to use either (i) an ENERGY STAR qualified EPS, or (ii) an EPS that meets the ENERGY STAR no-load and active efficiency requirements in effect at the time that the display is manufactured.
- Manufacturers must qualify their products for ENERGY STAR with picture settings (brightness, contrast, etc.) set as shipped from the factory. Manufacturers who wish to offer high-brightness settings for use in a retail display environment must offer a “Forced Menu” to consumers upon initial start-up. The forced menu shall offer a choice of either “home” or “retail” modes, and an additional prompt shall be offered to users that select “retail” mode in order to confirm their selection.
- Products must be tested at the following luminance levels:
 - CRTs: 100 cd/m².
 - Small displays of 1.1 MP resolution or less: 175 cd/m².
 - Small displays of greater than 1.1 MP resolution: 200 cd/m².
 - Large displays: EPA has opted to not set a default luminance level for large displays under Tier 1. Instead, EPA will require Partners to test their products at default luminance and report these luminance levels to EPA. Under Tier 2, EPA may propose a default luminance level based on data collected between now and the Tier 2 effective date of October 30, 2011, in order to harmonize the specification with other ENERGY STAR specification levels (and possibly international levels).

Test Procedures

- The following test procedures are required for determining ENERGY STAR qualification of *small displays*:
 - On Mode power consumption shall be measured according to the Test Requirements section and Annex 1 of the Version 5.0 ENERGY STAR Displays specification.
 - Sleep and Off Mode power consumption shall be measured using IEC 62301, Ed. 1.0: *Household Electrical Appliances – Measurement of Standby Power*, accompanied by clarifications provided in the Test Requirements section and Annex 1 of the Version 5.0 ENERGY STAR Displays specification.
- The following test procedures are required for determining ENERGY STAR qualification of *large displays*:
 - On Mode power consumption shall be measured as ‘P_{o_broadcast}’, as described in section 11.6.1, “On mode (average) testing with dynamic broadcast-content video signal,” of IEC 62087, Ed 2.0: *Methods of Measurement for the Power Consumption of Audio, Video and Related Equipment*.
 - Sleep and Off Mode power consumption shall be measured using IEC 62301, Ed. 1.0: *Household Electrical Appliances – Measurement of Standby Power*, accompanied by clarifications provided in the Test Requirements section and Annex 2 of the Version 5.0 ENERGY STAR Displays specification.

Labeling Requirements

- Partners must include the ENERGY STAR mark on the top/front of the product, or use an alternative electronic labeling approach 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 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.
- The ENERGY STAR label must also be used in product literature, on product packaging, and on the Partner’s Web site where information about ENERGY STAR qualified products is displayed.

III. Key Specification Development Milestones

EPA officially announced its intention to revise the Version 4.1 ENERGY STAR Monitors specification with a memorandum and accompanying discussion guide on October 29, 2007. The development of the Version 5.0 ENERGY STAR program requirements for displays took slightly over one-and-a-half years and included the following key events:

- October 29, 2007: EPA released a memorandum and accompanying discussion guide to all stakeholders, officially launching the Version 5.0 specification development process. Stakeholders were invited to comment on these documents by November 23, 2007.
- November 27, 2007: EPA hosted an online stakeholder meeting to discuss comments on the discussion guide, including widening the scope of the specification and harmonizing the Displays and TV specifications.
- December 19, 2007: EPA released a first request for On, Sleep, and Off Mode test data on non-qualified computer monitor models, professional display models, and digital photo frame models to assist EPA in determining revised performance levels.
- March 11, 2008: After identifying a significant difference in the On Mode power consumption of ENERGY STAR qualified computer monitors at the prescribed luminance level and the default, as-shipped luminance level, EPA requested a second round of product testing at minimum, factory-default, and maximum luminance settings.
- July 24, 2008: EPA released the Draft 1 Version 5.0 ENERGY STAR Displays specification and accompanying files. Key updates included the addition of a general “display” definition; proposed Tier 1 On Mode requirements taking into account both screen resolution and viewable screen area; proposed Tier 1 and 2 Sleep and Off Mode requirements; and the proposal to test products at their default, as-shipped luminance levels. Stakeholders were invited to comment by August 27, 2008.
- September 25, 2008: EPA hosted a stakeholder meeting in Washington, DC to discuss proposed changes for Draft 2; the European Union perspective; the data analysis process; luminance; and Tier 2 opportunities.
- October 22, 2008: EPA released the Draft 2 Version 5.0 ENERGY STAR Displays specification and accompanying files. Key updates included new proposed Tier 1 On, Sleep and Off Mode requirements; a proposal to test products at fixed luminance levels; consideration for products that ship with Automatic Brightness Control enabled; new labeling language; proposed laboratory accreditation requirements; modified definitions of Sleep and Off Mode; a new required minimum crest factor of the power meter to be used in testing; the addition of a paragraph on Greenhouse Gas Emissions under the Future Specification Revisions section; a request for input from stakeholders on ways to address high global warming potential gases; a new section titled, “Power Management Requirements,” to replace

the “Sleep Mode Exception” section; and, a methodology for measuring the power consumption of products powered by a standard low voltage dc supply. Stakeholders were invited to comment by November 12, 2008.

- December 2, 2008: EPA hosted an online stakeholder meeting to discuss luminance settings; proposed test method clarifications; revised laboratory accreditation language; convergence impacts; and meeting customer demand for multi-attribute environmental impacts.
- December 15, 2008: EPA released the Draft Final Version 5.0 ENERGY STAR Displays specification and accompanying files. This update replaced the laboratory accreditation language in Draft 2 with facility quality control recommendations; moved test methods into separate annexes to the specification; and noted that listing products via the Online Product Submittal (OPS) tool would satisfy the requirement to provide EPA with an updated list of ENERGY STAR qualified models. EPA also released a data gathering tool with a request for On, Sleep, and Off Mode test data on large displays, and estimates of energy savings associated with the Draft Final specification. Stakeholders were invited to comment by January 5, 2009.
- January 30, 2009: EPA released the Final Version 5.0 ENERGY STAR Displays specification for small displays, and a final Annex 1: Test Procedures for Displays with screen area less than 30 inches diagonal.
- February 12, 2009: EPA distributed to stakeholders revised draft On Mode power consumption requirements for large displays.
- February 18, 2009: EPA hosted an online stakeholder meeting to discuss the data received in response to the December 15, 2008 request; new On, Sleep and Off Mode criteria based on that data; luminance issues; and, a comparison to the On Mode power requirement for TVs.
- March 12, 2009: EPA released a memorandum to clarify newly proposed Sleep and Off Mode and luminance reporting requirements; announce a maximum viewable diagonal screen size of 60 inches; propose a new maximum On Mode power consumption requirement for large displays; and extend the effective date for large displays to January 30, 2010 to coincide with the EU standby standard’s implementation date. Stakeholders were invited to comment by March 26, 2009.
- March 30, 2009: EPA released the Final Version 5.0 ENERGY STAR Displays specification for all eligible display sizes, and final versions of the specifications’ Annex 1 and Annex 2.

Note that the above list only includes reference to stakeholder group meetings and major communications attended and organized by EPA. Several additional one-on-one meetings were held with manufacturers, trade associations, and other stakeholders during the test procedure and specification development processes.

IV. Summary of Stakeholder Input

EPA received substantial feedback from stakeholders during the development of the new Version 5.0 specification. Written stakeholder comments were posted to the ENERGY STAR Web site throughout the specification development process. Provided below is a summary of key comments and EPA responses. More detailed comments and responses are provided in note boxes included within the draft specifications available in the ENERGY STAR Product Development Archives located at: www.energystar.gov/productdevelopment.

Definitions

- Comment: Stakeholders explained that televisions and displays were becoming increasingly similar and suggested EPA develop a comprehensive specification for both product categories instead of a planned revision to the Displays specification in 2011.

EPA Response: EPA has been working towards unifying the Televisions and Displays specifications since the inception of the Displays specification revision process, and intends to begin planning for product convergence by first harmonizing definitions and test procedures.

- Comment: Stakeholders expressed concern about whether displays with tuners would be able to qualify under the Displays specification. One stakeholder explained that in Japan, these products cannot apply for ENERGY STAR under the Televisions specification, and products with tuners would not be eligible to qualify there under Tier 2 of the Version 5.0 Displays specification. The stakeholder proposed that products with tuners be allowed to qualify as Displays even under Tier 2.

EPA Response: Products with tuners will be able to qualify under the Version 5.0 Displays specification as long as they are marketed and sold as displays or as dual function displays and televisions. It is EPA's intent that under Tier 2, only products without tuners will be able to qualify as displays, while products with tuners will have to qualify under the ENERGY STAR Televisions program.

- Comment: Several stakeholders requested that the single housing requirement be removed from the displays definition since it is possible to put the power supply in a box, the video circuits in a second box, and the display head in a third.

EPA Response: Based on stakeholder feedback, EPA removed the single-housing requirement by revising the displays definition to read "often encased in a single housing."

- Comment: Stakeholders expressed confusion about the Sleep Mode and Off Mode definitions from the Version 4.1 Monitors specification as they would be applied to the wider variety of products included in the Version 5.0 Displays specification.

EPA Response: EPA modified the Sleep Mode definition by adding that the product may enter Sleep Mode via a signal from a connected device or an internal function such as a timer or occupancy sensor. This modification was made to reflect the fact that the Version 5.0 specification now encompasses a greater variety of displays than only computer monitors. Also, recognizing a display may have more than one off switch, EPA clarified the Off Mode definition such that Off Mode is engaged via the on/off switch the user is most likely to use by virtue of its ease of access relative to other switches on the display.

Energy Efficiency Criteria

- Comment: Several stakeholders did not understand the argument that the best correlation for power consumption was a combination of screen area and resolution.

EPA Response: Screen area is a weak predictor of power consumption for small displays and digital picture frames. The Displays specification covers a variety of display technologies (CRT, LCD, plasma), and the data received from stakeholders support the inclusion of both screen area and resolution in determining power consumption levels. Ultimately, EPA developed three separate equations to accommodate the effects of screen area and resolution for displays with different screen sizes.

- Comment: Several stakeholders expressed opposition to power consumption requirements being based in part on screen resolution, since the majority of the displays use essentially the same format.

EPA Response: The product test data received from stakeholders demonstrated that screen resolution was a more important factor than screen area in determining On Mode power consumption of small displays.

- Comment: Several stakeholders expressed concern regarding the On Mode Requirements, stating that the revised Displays specification could prevent certain high performance displays from qualifying for the ENERGY STAR program. These displays utilize super in-plane switching (IPS) and similar technologies that are favored by professionals and tend to consume significantly more power than twisted nematic (TN) or vertical alignment (VA) displays.

EPA Response: The Displays specification accommodates customer preference for higher resolution, larger screen displays by defining On Mode power requirements as a function of these attributes. EPA determined that the specified On Mode power equation would allow for a selection of qualified products in the 24-29 inch range to qualify under the Version 5.0 criteria. While we recognize that the “high performance,” larger screen products of concern to the manufacturer do not currently meet the Version 5.0 power requirements, EPA did not have sufficient information at the time the specification was developed to conclude that these products' enhanced features warranted an additional energy allowance beyond that permitted by their screen size and resolution. While EPA takes a technology-neutral approach to specification development, when we revise this specification in the future we will consider other variables in addition to screen size and resolution if they significantly affect power consumption.

- Comment: A stakeholder commented that the specification set the maximum viewable diagonal screen size at 84 inches, but that no maximum screen size should be specified because the screen sizes of professional signage were increasing every year.

EPA Response: EPA solicited data to support the inclusion or exclusion of an upper limit on screen size, and did not receive power consumption data that would suggest products above the 84-inch diagonal would qualify under the proposed power consumption levels.

Test Methodology

- Comment: Several stakeholders expressed concern that EPA's proposal to test products at as-shipped luminance would prevent fair comparisons between products.

EPA Response: EPA agreed with stakeholder comments and included fixed luminance levels in the specification from Draft 2 onward. While previous versions of the specification specified one luminance level for all products regardless of screen size or resolution, the levels in Version 5.0 vary by screen size and resolution, in line with actual usage.

- Comment: One stakeholder commented that the average picture level (APL) of the image proposed by EPA for use during On Mode power testing was too high to accurately reflect how large displays were used.

EPA Response: EPA agreed with the comment and replaced the VESA FPD Standard 2.0 image with a dynamic broadcast-content video signal as described in IEC 62087, to be used for testing large displays. Adopting the IEC 62087 test procedure also served the purpose of harmonizing the Displays specification with the TV specification. Under Tier 2, it is EPA's intention that all Display products, regardless of size, be tested according to the IEC 62087 test

procedure.

- Comment: One stakeholder stated that the IEC 62087 test method for large displays was flawed because (1) use of only the static test pattern from the test method did not provide meaningful luminance measurements; and, (2) the use of static test patterns of more than 35% APL was risky for plasma display panels since doing so would likely trigger power supply protection, rendering power measurement impossible.

EPA Response: EPA collected On Mode power consumption data from the three different test patterns (static, broadcast, and internet signals) described in IEC 62087. Based on the data submitted by stakeholders, EPA determined the IEC 62087 test method provided the most appropriate measurements of On Mode power consumption for large displays.

- Comment: One stakeholder requested that the IEC 62087 test loop methodology be adopted without modification for large LCD displays in order to ensure consistent testing, and that manufacturers be asked to declare the peak luminance of their products and the ratio of peak luminance to as-shipped and other pre-set mode luminance.

EPA Response: To maintain consistency with the ENERGY STAR Televisions specification, EPA decided not to set a default luminance boundary for displays under Tier 1. Instead, large displays are to be tested at default (as-shipped) luminance, and the actual test luminance value shall be reported to EPA along with the power consumption data. Under Tier 2, EPA may propose a default luminance boundary based on data collected between now and the Tier 2 effective date of October 30, 2011, in order to harmonize the specification with other ENERGY STAR specification levels (and possibly international levels).

- Comment: One stakeholder expressed concern about the burdens of testing PC displays with many combinations of interfaces and operating modes. The stakeholder suggested that testing should only be required for widely used interfaces such as VGA and DVI.

EPA Response: Consistent with the previous version of the specification, the Version 5.0 specification requires power consumption to be measured using an analog interface, except in those cases where one is not provided, in which case a digital interface must be used.

Effective Date

- Comment: Several stakeholders argued that the October effective date for Version 5.0 would be difficult and costly to achieve due to product development schedules. Several alternate dates were proposed, including January 1, 2010 and April 1, 2010.

EPA Response: Revisions to ENERGY STAR specifications typically become effective nine months after being finalized to allow manufacturers adequate time to prepare for the new requirements. Hence, the effective date for small displays remains October 30, 2009. EPA extended the Version 5.0 effective date for large displays by three months, to January 30, 2010, to coincide with the implementation date for the European Union Standby requirements scheduled to take effect on January 7, 2010.

V. EPA Rationale for Specification

EPA uses a consistent set of criteria in the development and revision of specifications for ENERGY STAR qualified products. These criteria help ensure that the ENERGY STAR mark

will continue to be a trustworthy symbol for consumers to rely upon as they look for energy efficient products for their homes or businesses. The criteria include:

- Significant energy savings and environmental protection potential on a national basis;
- Efficiency level is technically feasible while product performance is maintained or enhanced;
- Labeled products will be cost-effective to the buyer;
- Efficiency can be achieved with several technology options, at least one of which is non-proprietary (i.e., not exclusive to proprietary technology);
- Product differentiation and testing are feasible; and,
- Labeling would be effective and recognizable in the market.

Below, EPA addresses the Version 5.0 Displays specification relative to each of these criteria:

- Expected Energy Savings and Environmental Benefits: On average, ENERGY STAR qualified displays will be approximately 20% more efficient than conventional models. Disaggregated savings associated with the Displays specification will be as follows: Office monitors, 21%; home monitors, 22%; digital picture frames, 27%; and professional displays, 29%, for a weighted average of 23%.

In terms of product lifetime savings, by 2015, if all new shipments were ENERGY STAR qualified units, the program would save 11.5 billion kWh and reduce 17.6 billion pounds of CO² emissions, annually.

- Product Performance Measured and Verified with Testing: EPA participated in the development of Section 11 of IEC 62087, Ed. 2.0: *Methods of Measurement for the Power Consumption of Audio, Video and Related Equipment*; and IEC 62301, Ed. 1.0: *Household Electrical Appliances – Measurement of Standby Power*. EPA adopted these industry-accepted test procedures for measuring On Mode power consumption for displays. Both procedures were developed under the strict guidelines of the IEC and subject to multiple rounds of international stakeholder review, comment, and vote prior to finalization.
- Technical Feasibility/Impact on Product Performance/Functionality: EPA believes the energy efficiency requirements in the Version 5.0 ENERGY STAR specification are technically feasible to achieve without causing an adverse impact on product performance. At the time that the Version 5.0 specification was finalized, 23% of the models in the EPA dataset were able to meet the Tier 1 requirements. These models covered the full range of available screen sizes and display technologies, i.e., CRTs, LCDs, and plasmas.
- Cost-Effectiveness: Based on the costs of the products in EPA's dataset, Version 5.0 ENERGY STAR performance requirements for displays are attainable without increased cost to the end-user. EPA arrived at this conclusion after comparing displays of similar resolution and screen area, and finding there was little if any difference in the price of the products.
- Several Technology Options, including some with Non-proprietary Technology: The Version 5.0 ENERGY STAR Displays specification is intended to be performance-based and technology-neutral. The requirements are designed to identify the most energy-efficient products on the market without regard to the underlying display technology. As such, CRT,

LCD, and plasma displays were included in the 23% of models from EPA's final data set that could meet the Version 5.0 specification at the time that the requirements were finalized. Many of the leading display manufacturers were involved in the development of the Version 5.0 specification, and over 60% of the manufacturers in the data set had at least one model that could qualify under the new requirements.

- Product Differentiation and Labeling: EPA believes that the ENERGY STAR label serves as an objective basis for consumers to identify the most energy efficient displays on the market. Under the previous Version 4.1 requirements, market penetration of ENERGY STAR qualified monitors was over 90%. At the time of finalizing the Version 5.0 specification, the specification's pass rate was estimated to be 23%, based on available performance data. This reestablishes the ENERGY STAR mark's ability to help consumers identify the most energy efficient displays on the market.

In addition, several of EPA's key ENERGY STAR retail Partners, including Amazon.com, Best Buy, Costco, Office Depot, OfficeMax, Sears, Staples, and Walmart carry and promote ENERGY STAR qualified displays, increasing brand awareness and contributing to the program's success.