ENERGY STAR® Program Requirements for Single Voltage External Ac-Dc and Ac-Ac Power Supplies

DRAFT 3 Eligibility Criteria

Below is the **DRAFT 3** product specification for ENERGY STAR qualified single voltage external ac-dc and ac-ac power supplies. A product must meet all of the identified criteria if it is to be qualified as ENERGY STAR by its external power supply manufacturer.

1) **Definitions**: The goal of this ENERGY STAR external power supply specification is to recognize those models with an efficient ac-dc or ac-ac conversion process. EPA is not currently attempting to address the efficiency of the battery charging and monitoring circuitry. Consistent with this goal and the test methodology, as described in Section 4, EPA has prepared the following detailed definitions of single voltage external ac-dc and ac-ac power supplies and other related terms as relevant to ENERGY STAR. The power supply definitions intentionally exclude models with more sophisticated battery charging functionality, as they are beyond the current scope of this initiative.

   A. Single Voltage External Ac-Dc Power Supply: For the purposes of this specification, a single voltage external ac-dc power supply: a) is designed to convert line voltage ac input into lower voltage dc output; b) is able to convert to only one dc output voltage at a time; c) is sold with, or intended to be used with, a separate end-use product that constitutes the primary load; d) is contained in a separate physical enclosure[1] from the end-use product; e) is connected to the end-use product via a removable or hard-wired male/female electrical connection, cable, cord or other wiring; f) does not have batteries or battery packs that physically attach directly (including those that are removable) to the power supply unit; g) does not have a battery chemistry or type selector switch AND an indicator light or state of charge meter; and h) has nameplate output power less than or equal to 250 watts.

> ***Note**: To complement the definition above, EPA has attached a flowchart (based on ac-dc models but also applicable to ac-ac models) to graphically depict the proposed scope of the specification and test methodology. The following is a summary of the key substantive changes made to the ac-dc definition from Draft 2 to Draft 3:*
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> - *Revised part "d" and added a footnote to differentiate between the "physical enclosure" of the end-use product and the retail packaging;*
> - *Clarified in part "e" that an external power supply may be connected to the end-use product via a male/female electrical connection;*
> - *Added language to part "f" to better distinguish batteries that connect directly and immediately to the charger, such as a AA charger, which are excluded from this specification;*
> - *Removed the requirement for "only two output wires," in response to stakeholder feedback. The revised Test Method requires manufacturers to measure the positive and negative wires and to put the others aside for testing purposes; and*
> - *Expanded the scope of the definition from products with nameplate output power less than or equal to 180 watts to 250 watts, to keep pace with market trends.*
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> *Stakeholders are encouraged to provide additional suggestions if they feel any part of the definition continues to be vague and/or could be better communicated.*

[1] "Physical enclosure" refers to the housing of the products themselves, not their retail packaging.

***Note**: During the Draft 2 comment period, EPA received some stakeholder feedback regarding the external power supply definition that it would like to share with all interested parties in order to solicit additional viewpoints. Specific comments, including product data where applicable or feasible, on the following issues would be appreciated.*

- *EPA has received some stakeholder feedback that the external power supply definition we are currently proposing could inadvertently encourage end-use product manufacturers, that use linear power supplies, to put a resistor in the end-use product to regulate current and transfer the losses to the end-use product. This would potentially allow the power supply to meet the specification, but not reduce overall energy consumption for the system (end-use product and external power supply). EPA is seeking additional input on the extent to which stakeholders believe this is a likely scenario versus the likelihood that a manufacturer might change to a higher efficiency power supply (e.g., switch-mode design) or simply choose not to redesign the product (based on a cost/benefit analysis or other considerations) given that ENERGY STAR is a voluntary labeling program.*

- *One commenter questioned the validity of the current test procedure for external power supplies that charge batteries because of the possibility that the operating point of the charger with the battery in the system could be outside of the regime tested by the test method. This is especially an issue for external power supplies with low voltage regulation. In such a charger, the voltage supplied with a battery in place could fall outside of the range of voltage tested under the test method. EPA acknowledges that this is the case for some external power supplies. However, it is EPA's opinion at this juncture that this will not be an issue for most power supplies, particularly those with a relatively high degree of voltage regulation. EPA invites further industry comment on this issue.*

- *One stakeholder has suggested that this definition covers external power supplies that spend significant time operating above the No-Load condition and below the 25 percent load condition and therefore, averaging the Active measurements across four loads (25%, 50%, 75%, 100%) and measuring No-Load is not a true representation of their overall efficiency. EPA is interested in obtaining additional stakeholder input either supporting or refuting this position as well as its relevance/significance to the current specification and program objectives. (As background, five loading conditions were chosen (0%, 25%, 50%, 75%, and 100%) during the development of the Test Method in an effort to balance EPA's need for partial load efficiency data with manufacturers' need to reduce the testing burden. Charting input and output power at each load condition is believed to provide a reasonable estimate of expected power usage at points between those five load conditions. EPA notes, however, that the actual operating point of external power supplies varies with end load served and usage patterns and that the percent of nameplate load varies among devices. As such, the Test Method does not attempt to replicate the usage patterns of any one power supply, but rather allows for like comparisons of the efficiency of power supplies under the same, repeatable test conditions.)*

- *Linear power supply transformers have built-in impedance to regulate current in the case of a battery fault. This is a safety consideration that limits active power efficiency in linear power supplies. One commenter expressed concern that for some products included under this definition, the ENERGY STAR specification for power supplies would encourage manufacturers to abandon this safety precaution. To prevent this, EPA is proposing, in this draft, to require that ENERGY STAR qualified power supplies must meet all applicable UL standards (see Section 4.A). EPA is seeking comment on the extent to which this change addresses the safety concern raised.*

B. Single Voltage External Ac-Ac Power Supply: For the purpose of this specification, a single voltage external ac-ac power supply: a) is designed to convert line voltage ac input into lower voltage ac output; b) is able to convert to only one ac output voltage at a time; c) is sold with, or intended to be used with, a separate end-use product that constitutes the primary load; d) is contained in a separate physical enclosure[1] from the end-use product; e) is connected to the end-use product via a removable or hard-wired male/female electrical connection, cable, cord or other wiring; f) does not have batteries or battery packs that physically attach directly (including those

that are removable) to the power supply unit; g) does not have a battery chemistry or type selector switch AND an indicator light or state of charge meter; and h) has nameplate output power less than or equal to 250 watts.

***Note**: In this Draft 3, EPA has included ac-ac power supplies for the following reasons:*

- *As external power supplies, ac-ac units have some functional similarities to ac-dc units and are found in some of the same high-volume products, such as cordless phones.*
- *Test data indicates that a range of efficiencies currently exist in the market, allowing EPA to differentiate the better performers through ENERGY STAR;*
- *Including ac-ac power supplies provides designers with flexibility and doesn't inadvertently favor one type of power supply over the other;*
- *Other regions of the world, such as the European Union, are including ac-ac power supplies in their external power supply specifications; and*
- *Only minor changes to the Test Method were needed to incorporate ac-ac models.*

C. Active Mode: The condition in which the input of a power supply is connected to line voltage ac and the output is connected to a dc or an ac load drawing a fraction of the power supply's nameplate power output greater than zero.

D. No-Load Mode: The condition in which the input of a power supply is connected to an ac source consistent with the power supply's nameplate ac voltage, but the output is not connected to a product or any other load.

2) **Qualifying Products**: In order to qualify as ENERGY STAR, an external power supply model must meet the definition in Section 1.A or 1.B and the specification requirements provided in Section 3, below. Some products that use the power supply's dc or ac output to charge different types of batteries at varying rates in varying operating modes are eligible based on the definitions in Sections 1.A and 1.B.

3) **Energy-Efficiency Specifications for Qualifying Products**: Only those products listed in Section 2 that meet the following criteria for both Active and No-Load Modes may qualify as ENERGY STAR.

A. Active Mode

1. Tier 1: To be eligible for ENERGY STAR qualification, an external power supply model must meet or exceed a minimum average efficiency for Active Mode, which varies based on the model's nameplate output power. Table 1 below outlines the proposed equations for determining minimum average efficiency where P_{no} stands for nameplate output power and Ln refers to the natural logarithm. Efficiency shall be expressed in decimal form and rounded to the hundredths place.

Table 1: Proposed Energy-Efficiency Criteria for Active Mode

Nameplate Output Power (P_{no})	Minimum Average Efficiency in Active Mode (expressed as a decimal) [2]
0 to ≤ 1 watt	≥ 0.49 * P_{no}
> 1 to ≤ 49 watts	≥ [0.09 * Ln (P_{no})] + 0.49
> 49 watts	≥ 0.84

Examples to Illustrate the Proposed Active Mode Approach: Average Active Mode efficiency and ENERGY STAR qualification would be determined as follows:

[2] (a) "Ln" refers to the natural logarithm. The algebraic order of operations requires that the natural logarithm calculation be performed first and then multiplied by 0.09, with the resulting output added to 0.49. (b) An efficiency of 0.84 in decimal form corresponds to the more familiar value of 84% when expressed as a percentage.

- Calculate the model's single average Active Mode efficiency value by testing at 100%, 75%, 50%, and 25% of rated current output and then computing the simple arithmetic average of these four values, as specified in the Test Method.
- Based on the model's nameplate output power, select the appropriate equation from Table 1 and calculate the minimum average efficiency.
- Compare the model's actual average efficiency to the minimum average efficiency required by ENERGY STAR. If actual average efficiency is greater than or equal to the minimum average efficiency, the model has satisfied ENERGY STAR's Active Mode requirement.

To provide an example using the proposed criteria in Table 1, the minimum average efficiencies required of three sample power supplies are provided in Table 2 below. As shown in the last column, power supplies 1, 2, and 3 would meet the ENERGY STAR Active Mode requirement if they had average efficiencies of at least 25%, 76%, and 84%, respectively. Therefore, if Power Supply 1 in Table 2 had an actual average efficiency of 30%, it would satisfy the Active Mode requirement because it surpassed the ENERGY STAR minimum average efficiency of 25%.

Table 2: Examples of Minimum Average Efficiency in Active Mode

Sample	Nameplate Output Power (P_{no})	Average Efficiency in Active Mode (expressed as a decimal)
Power Supply 1	0.5 watts	0.49 * 0.5 = 0.25
Power Supply 2	20 watts	[0.09 * Ln (20)] + 0.49 = 0.759616 or 0.76
Power Supply 3	75 watts	0.84

***Note**: Please note the following regarding Active Mode as presented in this Draft 3 specification:*

- *The Tier 1 Active Mode specification has been modified to require slightly less stringent minimum average efficiencies.*
- *The proposed specification represents the top 34.7% of models in Active Mode from EPA's data set, which includes 17 new data points since Draft 2 was released.*
- *The Tier 1 specifications for both Active and No-Load represent the top 21.6% of models in the data set.*

During the Draft 2 comment period, EPA received a few inquiries regarding the number of measurements conducted at 115 V versus 230 V. Despite concerns from one stakeholder that the 230 V data might be limited, we believe the data represents a balance between 115 V and 230 V measurements: the largest number of units was tested at 230 V, the next largest group was tested at 115 V, and the smallest number of units was tested at both voltages.

As indicated in some of the stakeholder feedback, EPA agrees that cord length and output voltage are important design considerations that may impact the power supply's energy efficiency. In fact, cord length was discussed in some detail during the development of the Test Method. For a summary of the test method comments and responses, please visit http://www.efficientpowersupplies.org/methods.asp and click on the second bullet "Summary of Comments Received on the External Power Supply Test Method." To date, however, EPA has not seen compelling evidence that the specification should be changed to accommodate these design choices. Each manufacturer needs to weigh the pros and cons of various design options in order to maximize efficiency in combination with product functionality. As a voluntary program committed to recognizing the more efficient products on the market, ENERGY STAR does not expect all external power supplies to meet the specification and strives to reward approximately the top 25 percent.

2. Tier 2: To continually recognize the most efficient models on the market and reflect forthcoming improvements in technology, EPA plans to implement a Tier 2 Active Mode specification on July 1, 2006. Approximately one year before the Tier 2 effective date, EPA will: 1) collect efficiency data (based on the ENERGY STAR Test Methodology) on a wide range of external power supplies (varying in terms of size, efficiency, manufacturer, and other parameters) sold in markets throughout the world; 2) analyze the data to identify the top 25

percent in terms of energy efficiency; 3) release the proposed Tier 2 specification for stakeholder review and comment (focusing on the technical elements of Tier 2 and not on all programmatic details); and 4) finalize the specification by late 2005 so partners have adequate time to transition to the new levels.

> ***Note**: Regarding Tier 2 Active Mode, please note the following:*
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> - *EPA has moved up the Tier 2 effective date from early 2007 to mid 2006. See Notes box below for Tier 2 No-Load Mode for more details.*
> - *As suggested by one stakeholder, EPA agrees that power factor correction (PFC) data should be collected during the ENERGY STAR product qualification process and then later analyzed when determining Tier 2 performance levels (for both Active and No-Load).*

B. No-Load Mode

1. Tier 1: The second half of the ENERGY STAR specification is the no-load power requirement, which specifies the maximum ac power that may be used by a qualifying external power supply in the no-load condition. Proposed maximum power consumption levels for No-Load Mode are provided in Table 3, below.

Table 3: Proposed Energy Consumption Criteria for No Load

Nameplate Output Power (P_{no})	Maximum Power in No-Load
0 to < 10 watts	≤ 0.5 watts
≥ 10 to ≤ 250 watts	≤ 0.75 watts

> ***Note**: In this Draft 3 version, the maximum power allowed in No-Load Mode has not changed and remains consistent with Draft 2. However, minor changes were made to the nameplate output power segmentations. The proposed specification represents the top 37.4% of models in No-Load Mode from EPA's data set.*
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> *Several stakeholders commented that the Tier 1 No-Load specification should remain at the Draft 1 version's 0.3 watts for the less than 10-watt external power supply market. However, EPA has decided to continue with the less stringent 0.5-watt specification. There are more compelling lifetime energy savings opportunities available from further improvements in Active Mode energy consumption, which is why the proposed specification is comparatively more stringent for Active Mode.*

2. Tier 2: To continually recognize the most efficient models on the market and reflect forthcoming improvements in technology, EPA plans to implement a Tier 2 No-Load Mode specification on July 1, 2006. While subject to change based on analysis of new data, EPA believes that 0.3 watts (nameplate output power less than 10 watts) and 0.5 watts (nameplate output power from 10 to 250 watts) represent reasonable Tier 2 targets for manufacturers. Approximately one year before the Tier 2 effective date, EPA will: 1) collect efficiency data (based on the ENERGY STAR Test Methodology) on a wide range of external power supplies (varying in terms of size, efficiency, manufacturer, and other parameters) sold in markets throughout the world; 2) analyze the data to identify the top 25 percent in terms of energy efficiency; 3) release the proposed Tier 2 specification for stakeholder review and comment (focusing on the technical elements of Tier 2 and not on all programmatic details); and 4) finalize the specification by late 2005 so partners have adequate time to transition to the new levels.

> ***Note**: In recognition of stakeholder support for a 0.3-watt specification and given EPA's interest in harmonizing with other international specifications, EPA is strongly considering a Tier 2 No-Load level of less than or equal to 0.3 watts for the less than 10-watt external power supply category and less than or equal to 0.5 watts for the 10-watt and greater products.*
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> *While EPA does not plan to implement the 0.3-watt specification immediately under Tier 1, it has moved up the Tier 2 effective date by approximately six months so that it takes effect more quickly.*

4) **Test Methodology**

The specifics for testing the energy efficiency of an external power supply model are outlined in a separate document titled "Test Method for Calculating the Energy Efficiency of Single-Voltage External Ac-Dc and Ac-Ac Power Supplies (August 13, 2004)," which is available on the ENERGY STAR Web site. The test results produced by this procedure shall be used to determine if a model qualifies as ENERGY STAR. In addition, below are five ENERGY STAR-specific testing requirements.

> ***Note**: For a copy of the revised test methodology, visit www.energystar.gov/powersupplies. The document will be posted to the site during the week of August 16, 2004.*

A. Safety Standards: ENERGY STAR qualified external power supplies shall comply with the following standards, where applicable:

- *UL 1012, Standard for Power Units Other Than Class 2, Edition 6, June 28, 1994*
- *UL 1310, Standard for Class 2 Power Units, Edition 4, July 28, 1994*

> ***Note**: Consistent with ENERGY STAR's Guiding Principles, Section 4.A. has been added to this Draft 3 to help ensure that product quality and safety are never compromised for energy efficiency. Participating manufacturers will be required to provide appropriate UL certifications when qualifying a model as ENERGY STAR. To read more about the key principles that guide EPA's specification development efforts, visit www.energystar.gov/productdevelopment.*

B. Number of Units Required for Test: Testing shall be conducted by the manufacturer or its authorized representative on three randomly chosen units of the same model. Manufacturers shall report Active and No-Load Mode values for all three units.

C. Models Capable of Operating at Multiple Voltage/Frequency Combinations: For switchmode power supplies capable of operating at multiple voltages and frequencies, testing shall be conducted at both 115 volts @ 60 Hz and 230 volts @ 50 Hz, with the least efficient set of test values used to determine if products qualify for the Active Mode and No-Load specifications.

> ***Note**: Draft 3 continues to require switchmode power supplies capable of operating at multiple voltages and frequencies to be tested at both 115 volts and 230 volts. By qualifying models under the least efficient set of test values, this approach ensures that models meet the ENERGY STAR performance levels in multiple markets and mitigates any potential variations in tested values across markets.*

D. Multiple Tap or Switch Selectable Models: Manufacturers shall test a multiple tap or switch selectable model at the highest and the lowest voltage outputs of the power supply. If the model meets or exceeds the ENERGY STAR requirements at both the highest and the lowest voltage outputs, then it qualifies as ENERGY STAR.

E. 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. ENERGY STAR qualifying product lists, including information about new models as well as notification of discontinued models, must be provided on a quarterly basis, or more frequently if desired by the manufacturer.

5) **Effective Date**: The date that manufacturers may begin to qualify and promote products as ENERGY STAR will be defined as the *effective date* of the agreement. The proposed ENERGY STAR single voltage external ac-dc and ac-ac power supplies effective date is November 1, 2004.

> ***Note**: The proposed effective date has been delayed by one month. EPA and the China Certification Center for Energy Conservation Products (CECP) will attend PowerChina 2004, the 10th China International Power Supply Exhibition in Beijing, China on September 27-29, 2004 to jointly announce the final external power supply specification. Interested external power supply and end-use product manufacturers are invited to attend; PowerChina 2004 information will be coming soon to the ENERGY STAR Web site.*
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> *As noted earlier in this document, EPA plans to implement a Tier 2 specification on July 1, 2006.*
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> *Finally, for existing ENERGY STAR end-use product categories (e.g., Telephony, Audio/DVD, Set-top Boxes, Imaging, Computers/Laptops, Monitors, and Water Coolers) the new external power supply specification will be phased in as an additional eligibility requirement, where appropriate, when those specifications are revised. **Thus, end-use product manufacturers will not need to meet the external power supply requirement for their respective products, (e.g., printers) beginning on November 1, 2004.** Rather, different transition times and effective dates will be determined for each applicable end-use product category and, as always, will be informed by stakeholder comments and discussions. Please note that the first product category to incorporate the external power supply specification will be Telephony (cordless phones, answering machines, and combination units).*

6) **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. In the event of a specification revision, please note that ENERGY STAR qualification is not automatically granted for the life of a product model. To qualify as ENERGY STAR, a product model must meet the ENERGY STAR specification in effect on the model's date of manufacture. The date of manufacture is specific to each unit and is the date on which a unit is considered to be completely assembled.