ENERGY STAR® Program Requirements for Products with Battery Charging Systems (BCSs)

FINAL Eligibility Criteria

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Eligibility Criteria

Below is the specification for ENERGY STAR qualified battery charging systems. Battery charging systems consist of the combination of a battery charger and battery as defined below. Covered systems may be either a battery charger with a detachable battery pack or a battery charger system functioning with a product or appliance that is powered by an integral battery. A battery charging system must meet all of the identified criteria if it is to be qualified as ENERGY STAR by its manufacturer.

While addressing a different set of product designs, this specification is intended to complement the existing ENERGY STAR external power supply specification. Manufacturers shall carefully examine their product designs and compare them to the detailed definitions (Section 1) and qualifying product descriptions (Section 2) for a battery charging system and external power supply (visit www.energystar.gov/powersupplies) to determine the appropriate specification for ENERGY STAR qualification. Manufacturers may only qualify individual models under the one specification (i.e., external power supply OR battery charging system) that best reflects the power supply and product design. Note that a qualified battery charging system may use an ENERGY STAR qualified external power supply, but this is not sufficient or necessary to qualify the battery charging system as ENERGY STAR.

> ***Note**: EPA decided to cover the majority of battery charging systems, such as those found in small household appliances and power tools, under a specification separate from external power supplies so that power consumption needs unique to battery charging systems, including battery maintenance, could be addressed. For some products, including cell phones and PDAs, the energy use profiles are such that EPA saw significant energy savings potential by focusing exclusively on the external power supply.*
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> *The external power supply specification applies to separable external power supplies designed to convert line voltage ac into lower voltage ac or dc output. See www.energystar.gov/powersupplies for the full definition. Product models meeting this definition shall be tested under the ENERGY STAR External Power Supply Test Method and, where appropriate, qualified as ENERGY STAR under the external power supply specification.*
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> *The battery charging systems specification, on the other hand, applies to: motor-driven battery charged products; products whose principal output is heat, light, or motion; battery charging systems intended to replace standard sized primary alkaline cells (e.g., AAA, AA, C, 9-volt, etc.); and other products (e.g., some digital cameras and camcorders) with detachable batteries and stand-alone battery chargers whose designs are not covered by the external power supply specification. To qualify for the battery charging systems specification, the battery may be either separable from or integral to the end-use product. Please see below for the complete definition. Product models meeting this definition shall be tested under the ENERGY STAR Battery Charging System Test Methodology (see Section 4) and, where appropriate, qualified as ENERGY STAR under the battery charging systems specification.*
>
> *Manufacturers are strongly encouraged to contact EPA with questions or uncertainties about ENERGY STAR eligibility.*

1) **Definitions**: Below are detailed definitions of battery charging systems and other related terms as relevant to ENERGY STAR.

General

A. Battery (also Battery Pack): An assembly of one or more rechargeable cells intended to provide electrical energy to an end-use product. Rechargeable cells are any of a number of established cell chemistries intended for repetitive charge/discharge cycles. Primary alkaline cells are not considered rechargeable. Batteries may be in one of the following forms:

a) Detachable Battery: A battery that is contained in a separate enclosure from the end-use product and is intended to be removed or disconnected from the end-use product for recharging.
b) Integral Battery: A battery that is contained within the end-use product and is not removed from the end-use product for charging purposes. A battery that is to be removed from the end-use product for disposal or recycling purposes only is considered to be an integral battery.

B. Battery Charger: A device intended to replenish the charge in a rechargeable battery. The battery charger will connect to the mains at the power input and connect to the battery at the output. The charger may be comprised of multiple components, in more than one enclosure, and may be all or partially contained in the end-use product.
   a) A La Carte Charger: A separable battery charger that is individually packaged without batteries. Batteries that the a la carte charger is designed to charge should be listed on the packaging, battery, and/or in the user materials.
   b) Multi-Voltage Charger: A battery charger that, by design, may charge a variety of batteries that are of different nominal voltages.
   c) Multi-Port Charger: A battery charger that, by design, is capable of simultaneously charging two or more batteries. These chargers also may have multi-voltage capability, allowing two or more batteries of different voltages to charge simultaneously or sequentially.
   d) Stand-Alone Charger: A battery charger that, by design, charges separable batteries disconnected from the end-use product.
   e) Batch Charger: With some multi-port chargers, such as universal AA battery chargers, single cells are charged in batches (i.e., groups of batteries charged in series). For the purposes of this specification, each of these batches shall be treated as a discrete battery pack. For example, a AA Nickel Metal Hydride charger with four ports may charge in two batches, with the batches connected in parallel. Each batch, in this case, would be treated as a single 2.4V battery pack. Charging four AA batteries in this system would be considered, for the purposes of this specification, as a multi-port charger charging two 2.4V batteries in parallel.

C. Battery Charging System: A combination of battery charger and battery, detachable or integral, which is intended to power a cordless product.

Device Types

D. Battery Operated End-use Product: Product or appliance fully powered by the battery at least part of the time.

E. Cord/Cordless: Product or appliance that is designed to run on battery power, but also is designed such that the product or appliance can run with a discharged battery when connected to the mains.

F. Inductive Coupling: A system in which power is transferred between windings in two *separate enclosures* through magnetic induction rather than metal-to-metal contact. This design limits the possibility of electric shock or a short circuit and is often used in certain small household appliances, such as cordless toothbrushes and shavers.

Operational Modes

G. Active Mode: The condition in which the battery is receiving the main charge, equalizing cells, and performing other one-time or limited-time functions necessary for bringing the battery to the fully charged state.

H. Battery Maintenance Mode: The condition in which the battery is still connected to the charger, but has been fully charged. This mode may persist for an indefinite period of time.

I. Standby (No-Load) Mode: Lowest power consumption mode which cannot be switched off (influenced) by the user and that may persist for an indefinite time when an appliance is connected to the main electricity supply and used in accordance with the manufacturer's

instructions. Note: The standby mode is usually a non-operational mode when compared to the intended use of the appliance's primary function.[1] For the purposes of this specification, standby mode is the condition in which no battery is present in the charger, or where the battery is integral to a product, the product is not attached to the charger, but the charger is plugged in and drawing power.

***Note**: The above standby definition is consistent with IEC 62301. The standard is available at www.iec.ch.*

Test/Measurement Terminology

J. Accumulated Nonactive Energy (Ea): The energy, in watt-hours (Wh), consumed by the battery charger in battery maintenance and standby modes of operation over a defined period. For the purposes of this specification, the 48-hour period consists of 36 hours of maintenance mode operation followed by 12 hours of standby mode operation. The accumulated nonactive energy is the sum of the energy used in these two modes.

K. Battery Capacity: The quantity of charge, measured in ampere-hours (Ah), capable of being provided by a battery during discharge, the conditions of discharge being specified.

L. Battery Energy (Eb): The energy, in watt-hours (Wh), deliverable by the battery under known discharge conditions. For the purposes of this specification and test methodology, the battery energy shall be measured at a constant current discharge rate of 0.2 C. The test shall begin with a fully charged battery, which is then discharged until the battery reaches its manufacturer specified cutoff voltage. The battery energy is determined by measuring and integrating the battery voltage over the course of discharge and multiplying by the constant current load. This value shall be reported by the manufacturer and is subject to verification by EPA.

M. Nameplate Input Power: The nameplate input power is either 1) the input power marked on the nameplate (watts), or 2) where only nameplate input voltage and current ranges are provided, the highest value achieved by multiplying a nameplate input voltage limit and its corresponding current limit (Volt-Amperes).

N. Nominal Battery Voltage (Vb): Industry standard cell voltage multiplied by the number of cells in the battery pack, normally listed on battery packaging. As of the writing of this battery charging systems specification, industry accepted nominal cell voltages for applicable chemistries include: 1.2 volts for Nickel Cadmium and Nickel Metal Hydride; 2.0 volts for sealed lead acid; and 2.5-4.2 volts for Lithium Ion (depending on material used for the positive electrode and other factors).

O. Nonactive Energy Ratio (ER): The ratio of the accumulated nonactive energy (Ea) divided by the battery energy (Eb). ER = Ea / Eb.

***Note**: Based on stakeholder feedback, several additions and revisions have been made to Section 1, Definitions. The key changes include:*

- *Providing a new definition for individual batch chargers where multiple batteries are charged with groups of two or more batteries in series. This addition also includes an explanation of key parameters for determining the qualifying Energy Ratio for these product designs;*
- *Expanding the description of how to measure battery energy and altering the definition to indicate that battery energy shall be measured at a constant current discharge rate of 0.2 C in order to be consistent with applicable IEC standards (e.g., Clause 7 of IEC 61951 and IEC 61960);*
- *Adding a definition for nameplate input power indicating how to calculate this value if it isn't readily available on the nameplate; and*
- *Revising the nominal battery voltage definition to simplify the explanation and to clarify that the provided nominal battery voltages are for applicable chemistries known to EPA as of the writing of this specification. EPA's specification is based on nominal battery voltage, as the test data has indicated that increases in voltage generally lead to decreases in energy use in the Nonactive modes.*

[1] This definition is consistent with IEC 62301: Household Electrical Appliances – Measurement of Standby Power.

2) **Qualifying Products**: This ENERGY STAR specification applies to:
   a) Battery charging systems packaged with portable, rechargeable products whose principal output is mechanical motion, light, the movement of air, or the production of heat (e.g., small home appliances, personal care products, power tools, flashlights, and floor care products);
   b) Stand-alone battery chargers sold with products that use a detachable battery (e.g., some digital camera and camcorder designs); and
   c) Battery charging systems intended to replace standard sized primary alkaline cells including: AAA, AA, C, D, 9-volt, etc. (i.e., universal battery chargers).

In addition, battery charging systems must meet the following conditions:
1. Chargers must be intended for rechargeable battery chemistries (e.g., Nickel Cadmium, Lead Acid, Lithium Ion, and Nickel Metal Hydride) and not for primary cell chemistries (e.g., alkaline "dry" cells);
2. Chargers may not rely on an inductive coupling system used to transfer energy between two separate enclosures;
3. Batteries must have voltages less than 42 volts;
4. Chargers must have nameplate input power between 2 and 300 watts;
5. Chargers may not have a secondary functionality that draws power while the battery is being charged/maintained (e.g., radio, cleaning machine, etc.) and is not related to charging, maintaining, or monitoring a battery. These systems may, however, draw power to provide a simple clock function and/or state of charge indicator. This exclusion does not apply to 1) battery charging systems that provide power from the mains to operate cord/cordless products or appliances with a discharged battery, and 2) products containing additional functions that do not draw additional power;
6. All products must meet the ENERGY STAR requirements as packaged for sale. A la carte chargers, which also may be multi-voltage and/or multi-port, may qualify as ENERGY STAR if they meet the requirements when tested using at least three currently produced batteries identified/listed as usable with the unit, as required in the ENERGY STAR Test Methodology.[2] If the same a la carte battery charger model also is packaged for sale with end-use products using batteries, these systems may only qualify if the specific charger and battery combinations also meet the ENERGY STAR requirements; and
7. Multi-port chargers may qualify if they meet the ENERGY STAR requirements when tested with multiple identical batteries as outlined in the ENERGY STAR Test Methodology. Similarly, multi-voltage chargers may qualify if they meet the ENERGY STAR requirements with all applicable batteries of differing voltages as outlined in the ENERGY STAR Test Methodology.

The following types of battery charging systems are not covered by this ENERGY STAR specification:
1. Inductively coupled devices used to transfer energy between two separate enclosures;
2. Chargers with nameplate input power less than 2 watts and greater than 300 watts; and
3. Charging systems that draw additional power to support added functionality such as radios, CD players, GFI AC outlets, and cleaning devices.

In order to qualify as ENERGY STAR, a model must meet the above parameters and the energy performance criteria provided in Section 3, below.

Please note that single voltage external power supplies (including some that use the power supply's dc output to charge batteries) and the end-use products they power are covered under separate ENERGY STAR agreements ("ENERGY STAR Program Requirements for Single Voltage External Ac-Dc and Ac-Ac Power Supplies" and "ENERGY STAR Program Requirements for End-Use Products Using External Power Supplies"). Visit www.energystar.gov/powersupplies for additional information.

[2] See Section 4 for "Test Method for Determining the Energy Performance of Battery Charging Systems (Final, December 2005)."

***Note**: In this final specification, EPA has revised its exclusion language for battery charging systems that draw additional power for secondary functions outside of battery charging (e.g., radios, CD players, and GFI AC outlets). EPA's intent is to exclude chargers with a secondary functionality that draws power while the battery is being charged/maintained, as it would not allow for fair comparisons among products. This exclusion does not apply to battery charging systems that provide power from the mains to operate cord/cordless products or appliances with a discharged battery.*

This final specification allows products to qualify with nameplate input power up to and including 300 watts. EPA raised this limit in order to cover battery charging systems commonly found in higher end power tools.

A few stakeholders suggested that the fourth bullet in Section 2 be revised to allow manufacturers to base the wattage on measured maintenance charge rather than nameplate input power. EPA has decided not to make this change because 1) using measured maintenance charge wattage would require the creation of a new measurement protocol and potentially increase the testing burden on manufacturers; and 2) many energy-efficient Lithium Ion products, which generally draw little battery maintenance power, could be excluded and unable to participate in this ENERGY STAR program, lowering the savings potential of this initiative.

*Under this Final specification, EPA will continue to cover battery chargers intended to be unplugged after charging. EPA understands that the instructions manual for these products advises consumers to unplug them after recharging. However, this does not preclude EPA from recognizing the better energy performers with an ENERGY STAR specification. Finally, to clarify, ENERGY STAR's guiding principles require that a new specification achieve significant energy savings potential across the entire product category—battery charging systems in this case—and not necessarily each conceivable sub-category. Each manufacturer must review its product line and **voluntarily** determine whether it wants to invest in energy efficiency and upgrade its models to ENERGY STAR levels.*

*As suggested by one stakeholder, the sixth bullet in Section 2 has been revised to only require a la carte chargers to be tested with **currently available** batteries listed as usable with the unit (i.e., manufacturers are not expected to test batteries that are no longer sold or available on the market). In addition, in cases where a large number of battery models may be used with a given charger, manufacturers are required to test a minimum of three times, each with different model batteries and including those with the highest and lowest battery energies, as specified in the ENERGY STAR Test Methodology.*

3) **Energy Performance Specifications for Qualifying Products**: To be eligible for ENERGY STAR qualification, a battery charging system must not exceed a maximum Nonactive Energy Ratio, which is based on the nominal battery voltage (Vb). The maximum allowed Nonactive Energy Ratios are provided in Table 1 below for select battery voltages. For intermediate voltages, the battery charging system must not exceed the maximum Energy Ratio associated with the next highest voltage represented in the table. (Example: A product using a battery with a nominal voltage of 14.0 volts would need to meet a maximum Energy Ratio of 4.5, consistent with the requirements for the next highest voltage of 14.4 volts, to qualify as ENERGY STAR.)

Table 1: Energy Performance Criteria for Common Battery Voltages

Vb	**1.2**	**2.4**	**3.6**	**4.8**	**6.0**	**7.2**	**8.4**	**9.6**	**10.8**	**12.0**
ER	20.0	16.9	13.7	11.6	9.6	7.5	7.0	6.5	6.1	5.6
Vb	**13.2**	**14.4**	**15.6**	**16.8**	**18.0**	**19.2**	**20.4**	**21.6**	**22.8**	**≥ 24.0**
ER	5.1	4.5	4.3	4.2	3.8	3.6	3.5	3.3	3.2	3.0

Given that multi-voltage and multi-port chargers require testing more than one battery pack, their Nonactive Energy Ratios must be calculated differently. For these chargers, the Nonactive Energy Ratio is calculated by taking the total accumulated energy from all tests and dividing by the sum of all the tested battery capacities. The reference voltage used to identify the maximum allowable Nonactive Energy Ratio is determined by averaging the battery voltages of all batteries tested. For single-voltage, multi-port chargers, this calculation method leads to taking the total accumulated energy from charging identical batteries and dividing by the sum of their capacities. The nominal

voltage of a single identical battery pack is then used to identify the maximum allowable Nonactive Energy Ratio. For chargers that charge individual cells in batches, the Nonactive Energy Ratio is calculated by taking the total accumulated energy from all tests and dividing by the sum of all the tested battery capacities. The reference voltage used to identify the maximum allowable Nonactive Energy Ratio is the arithmetic mean of all of the batch voltages tested. Please refer to the ENERGY STAR Test Methodology for additional details.

***Note**: In Section 3, EPA has determined the energy performance requirements for several reference battery voltages and calculated the Nonactive Energy Ratio for other voltages through linear interpolation. Table 1 provides the ENERGY STAR criteria for typical battery voltages (in multiples of 1.2 volts, as is typical in Nickel Cadmium and Nickel Metal Hydride cells). Batteries with voltages that fall in between these typical values shall use the Nonactive Energy Ratio associated with the next highest voltage in the table. The advantages of this approach are: 1) it allows the Nonactive Energy Ratio to vary with the battery voltage; 2) it will be able to accommodate future battery voltages that may not be built in increments of 1.2 volts; and 3) it simplifies the qualification process by eliminating any calculations needed to determine the qualifying Nonactive Energy Ratio.*

In harmony with the ENERGY STAR guiding principles, the Final specification represents the top 24.8% of data points from EPA's data set (33 out of 133), which includes new power tool, small household appliance, yard care, personal care, and universal battery charger models. To be consistent with the final revision of the Test Methodology, EPA retested all of its models, leading to minor changes in the data set, particularly for a la carte multi-voltage chargers. This then led to adjustments in the specification levels to ensure that they continue to represent the top 25 percent of the market.

One stakeholder provided several comments on the scope and structure of the battery charging systems specification. Below EPA addresses each comment.

- ***Distinguish between all power conversion products (e.g., external power supplies and battery charging systems) by measuring efficiency**. EPA decided to provide a temporary exclusion for battery charging systems under the external power supply specification so that it could develop a test method and specification that best captured the energy savings opportunities for battery charging systems. After careful investigation, EPA believes that Energy Ratio is the appropriate performance metric for battery charging systems at this time. The Energy Ratio addresses the two operational modes (battery maintenance and standby) where significant energy is wasted in battery charging systems while recognizing various battery sizes in these systems with the normalization by battery capacity.*
- ***Require a specific level of light load efficiency characteristic of the maintenance mode power load.** As noted above, EPA's focus is on reducing overall energy use as opposed to conversion efficiency at specific loading levels, which may or may not be applicable for all battery charging systems. Battery maintenance is a necessary component of many of the batteries covered by this specification and, as such, EPA wants to provide incentives to drive down energy use in this mode. It would be misleading to use efficiency or something that resembles efficiency as the performance metric.*
- ***Establish maximum power consumption limits in standby mode.** EPA's goal is to reduce overall energy use for battery charging systems, which includes but is not limited to standby mode. By avoiding explicit requirements for each mode, EPA allows manufacturers to choose the most efficient design(s) for the overall operation of the product and takes into account products that do not have a standby mode. For example, some systems are designed to use less energy in maintenance mode and then consequently draw more power in standby mode. Assuming this product uses less overall energy, EPA would want to recognize it as an energy saver, regardless of its higher standby power consumption. The key benefits of EPA's approach are significant energy savings and design flexibility.*
- ***Limit variation between low voltage requirements and high voltage requirements to no more than two to one.** EPA's proposed specification is designed to recognize the top quartile of products on the market in terms of energy performance. As such, the specification levels are based on testing and analysis of approximately 100 new small household appliances and power tools. Introducing a specific ratio that was not supported by the test data would not be consistent with ENERGY STAR's guiding principles and would ultimately lead to current classes of products that could not meet the specification.*
- ***Establish active mode requirements.** EPA has decided to focus on Nonactive modes (i.e., battery maintenance and standby) because they offer significant potential for energy savings and can be consistently measured through a robust and easy-to-use test method. While a total energy approach including Active mode has the benefit of addressing all operational modes, it also would require more complex usage scenarios/assumptions per product area and may introduce measurement inconsistencies. Also of note, EPA found (based on its existing dataset) that including Active mode would: 1) only provide a modest increase in the savings estimates; and 2) would not further differentiate products, as those deemed efficient under one approach would also qualify as efficient under the other approach. EPA remains interested in addressing Active mode and will continue to support research in this area.*

4) **Test Methodology**: The specifics for testing the energy performance of a battery charging system are outlined in a separate document titled "Test Methodology for Determining the Energy Performance of Battery Charging Systems (Final, December 2005)," 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 four ENERGY STAR-specific testing requirements.

> ***Note**: For a copy of the test methodology, visit the ENERGY STAR Web site at* http://www.energystar.gov/index.cfm?c=new_specs.batterychargerdevelopment.

A. Safety Standards: ENERGY STAR qualified battery charging systems shall comply with applicable local product safety requirements in the market(s) in which the product is to be sold. It is the Partner's responsibility to ensure that its products meet acceptable standards of safety for battery charging systems.

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 Energy Ratio values for all three units as well as the average values. To qualify as ENERGY STAR, all three units must meet the ENERGY STAR specification; however, the average of the three test values will be displayed on ENERGY STAR's qualifying product list (see Section 4.D below).

C. Models Capable of Operating at Multiple Voltage/Frequency Combinations: Manufacturers shall test their products based on the market(s) in which the models will be sold and promoted as ENERGY STAR qualified. EPA and its ENERGY STAR Country Partners have developed the following table with three voltage/frequency combinations for testing purposes:

Supply Voltage:	North America/Taiwan:	115 volts ac, 60 Hz
	Europe/Australia/New Zealand:	230 volts ac, 50 Hz
	Japan:	100 Volts AC, 50 Hz or 60 Hz (either frequency is acceptable)

For products that are sold as ENERGY STAR in multiple international markets and therefore rated at multiple input voltages, the manufacturer must test at and report the required power consumption, energy performance, or efficiency values at all relevant voltage/frequency combinations. For example, a manufacturer that is shipping the same model to the United States and Europe must measure, meet the specification, and report test values at both 115 volts, 60 Hz and 230 volts, 50 Hz in order to qualify the model as ENERGY STAR in both markets. If a model qualifies as ENERGY STAR at only one voltage/frequency combination (e.g., 115 volts, 60 Hz), then it may only be qualified and promoted as ENERGY STAR in those regions that support the tested voltage/frequency combination (e.g., North America and Taiwan).

D. 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 new models as well as notification of discontinued models, must be provided at least semi-annually. If no new models are introduced during a six-month timeframe, manufacturer should notify EPA to ensure its partnership status is maintained.

***Note**: In response to stakeholder feedback, EPA has revised the test methodology for battery charging systems. The document is available for review at* http://www.energystar.gov/index.cfm?c=new_specs.batterychargerdevelopment.

No changes have been made to Section 4 of this Final specification.

5) **Effective Date**: The date that manufacturers may begin to qualify and promote battery charging systems as ENERGY STAR will be defined as the *effective date* of the agreement. The ENERGY STAR battery charging systems effective date is January 1, 2006.

***Note**: No changes have been made to Section 5, Effective Date in this Final specification.*

Battery charging systems typically found in household appliances and power tools are currently excluded from qualifying as ENERGY STAR under the external power supply specification; the temporary exclusion ends on December 31, 2005. The new battery charging systems specification will take effect on January 1, 2006, which is immediately following the expiration date for the exclusion. EPA plans to update the external power supply specification to remove any references to the exclusion and to add language directing stakeholders to the new battery charging systems specification.

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.