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

OFFICE OF
AIR AND RADIATION

Summary of Rationale for Version 1.0 ENERGY STAR® Battery Charging Systems (BCS) Specification
February 2007

I. Introduction and Background

This memorandum provides a summary of the rationale and key inputs that culminate in Version 1.0 of the BCS specification. It contains the following information:

- Summary of the Version 1.0 specification
- Summary of key milestones in the development of the Version 1.0 specification
- Summary of comments provided by stakeholders
- EPA's rationale for deciding on key elements of the final Version 1.0 specification

II. Summary of Version 1.0 Specification

Key elements of the Version 1.0 ENERGY STAR specification for BCSs are described below.

- The ENERGY STAR BCS specification is intended to complement the ENERGY STAR external power supply (EPS) specification[1], which took effect one year earlier in January 2005, to comprehensively cover a variety of power conversion products. Manufacturers may only qualify a model under the one specification (i.e., EPS *or* BCS) that best fits or reflects the power supply and product design.

- The BCS specification applies to a range of products that are not covered by the EPS specification because of their unique designs and usage patterns. These products include: 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 with detachable batteries (e.g., some digital cameras and camcorders) and stand-alone battery chargers. BCSs with both detachable and integral batteries are eligible for the ENERGY STAR under the BCS specification.

- The specification covers three BCS product types with separable batteries and outlines the special scenarios for testing and qualifying them.

[1] *ENERGY STAR® Program Requirements for Single Voltage External Ac-Dc and Ac-Ac Power Supplies*, available at www.energystar.gov/powersupplies.

- Multi-voltage chargers, which charge batteries of various voltages.
- A la carte chargers, which are sold and packaged without batteries.
- Multi-port chargers, which are capable of simultaneously charging two or more batteries.

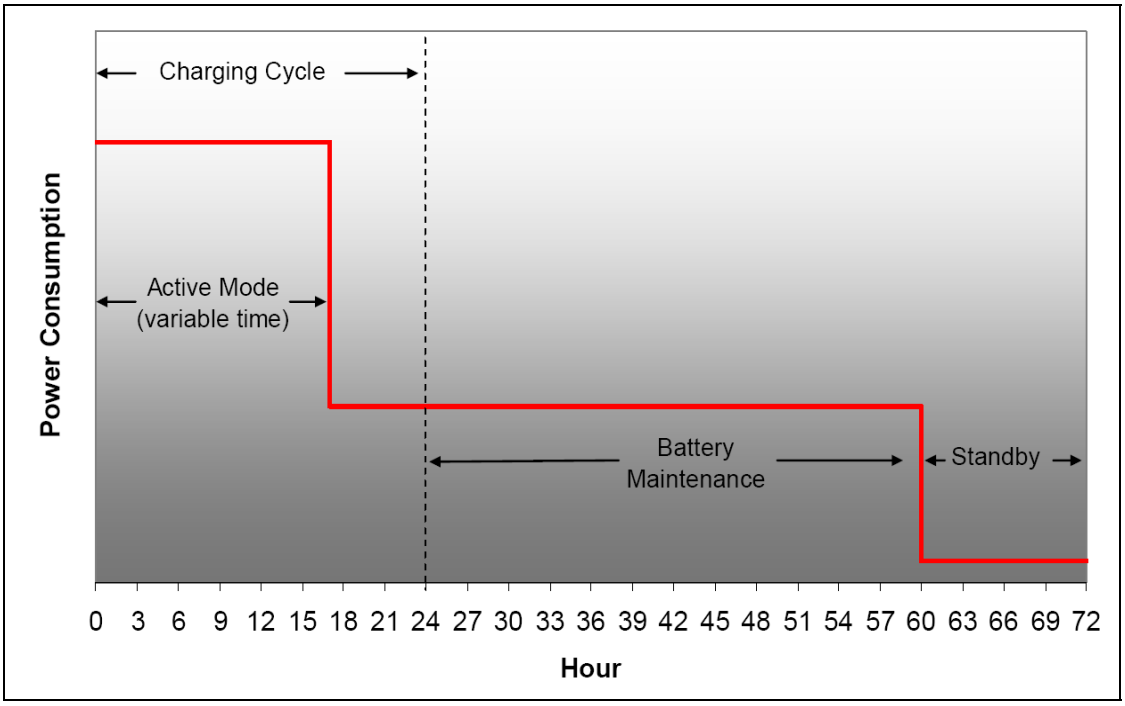
— The ENERGY STAR BCS specification does *not* cover:

- Products using inductive coupling to transfer charging energy between two separate enclosures.
- Chargers with nameplate input power less than 2 watts and greater than 300 watts.
- Charging systems that draw additional power to support added functionality such as radios, CD players, GFI AC outlets, and cleaning devices.

— To be eligible for ENERGY STAR qualification, a BCS model must not exceed a maximum Nonactive Energy Ratio, which is determined based on the nominal battery voltage. The Nonactive Energy Ratio is the ratio of the cumulative energy consumed in Battery Maintenance and Standby modes over a 48-hour cycle to the theoretical energy needed to charge the battery. For example, a Nonactive Energy Ratio of 15 means in the 48-hour cycle the BCS uses 15 times the actual energy stored in the battery.

- The test cycle starts with 24 hours of active charging, after which the charger is assumed to have entered the Battery Maintenance mode. After charging, the product is metered for 36 hours of Battery Maintenance and 12 hours of Standby. (See Figure 1 below.) Please note that the ENERGY STAR Test Methodology also includes an abbreviated test method and guidelines for its use.

Figure 1: Representative BCS Test Cycle



- The table below provides maximum allowed Nonactive Energy Ratios (ER) for select battery voltages (Vb). For intermediate voltages, the battery charging system must not exceed the maximum Energy Ratio associated with the next highest voltage represented in the table.

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

— The BCS specification references a detailed test methodology titled *Test Methodology for Determining the Energy Performance of Battery Charging Systems (December 2005)*, which was developed concurrently with the BCS specification.

— 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 energy performance at all relevant voltage/frequency combinations.

III. Key Milestones of Specification Development

— The following factors influenced EPA's decision to develop a specification for BCSs:

- Opportunity to address products excluded under the EPS specification, including floor care, personal hygiene, yard care, power tools, small kitchen appliances, and consumer battery chargers.
- Stakeholder interest in the energy use of BCSs and in developing a test method and specification for ENERGY STAR.
- Approximately 230 million products with BCSs are currently in use in American homes and businesses.
- Conventional battery chargers—even when not actively charging a product—can draw as much as 5 to 20 times more energy than is actually stored in the battery. Energy-saving designs are available that, on average, use 35 percent less energy.

— The Version 1.0 specification was developed over the course of one year, which included the following key milestones:

- Drafting of a test method to measure the energy performance of BCSs. Interested stakeholders had several opportunities to comment on draft versions of the test methodology both in writing and during meetings.
- Testing and evaluation of new power tool, small household appliance, yard care, personal care, and universal battery charger models (total of 133 data points in EPA's data set).
- Hosting of BCS Webcasts on June 2 and 8, 2005 and BCS Stakeholder Meeting in Washington, DC on June 23, 2005.
- Participating in numerous meetings and conference calls with representatives from individual manufacturers, the Association of Home Appliance Manufacturers (AHAM), the Power Tool Institute (PTI), and other stakeholders.

- Preparing two draft specifications and one final specification.

IV. Summary of Stakeholder Input

In developing the BCS specification, EPA considered comments provided during the June stakeholder meeting and individual manufacturer meetings/calls as well as written comments submitted to EPA in response to the draft specifications. All stakeholder comments were posted to the ENERGY STAR Web site, with permission from the submitter, throughout the development process. A summary of key concerns raised by stakeholders and their resolutions follows below.

- Scope of the BCS Specification. Some stakeholders felt that the scope of the BCS specification was too vague and that it was unclear whether cell phones, digital cameras, and other similar products were required to meet the EPS or BCS criteria. To address this concern, EPA added language at the beginning of the Eligibility Criteria outlining the focus of each specification and instructing manufacturers to qualify models under the one specification that best reflects the power supply and product design. In addition, once the BCS specification was final, EPA modified the language in the original EPS specification to remove the exclusion for BCSs and reference the new BCS specification.

- Specification Scheme/Approach. A few stakeholders argued that the stair-step specification approach proposed in Draft 1 would tend to misrepresent the battery voltage dependence on Energy Ratio at intermediate voltages. Based on suggestions from stakeholders, EPA changed its approach for Draft 2 by setting energy performance requirements for several reference battery voltages and calculating the Nonactive Energy Ratio for other voltages through linear interpolation. This approach, which is reflected in the final specification, provides the following benefits: 1) it allows the Nonactive Energy Ratio to vary with the battery voltage; 2) it accommodates advanced battery voltages not based on standard 1.2 volt cells; and 3) it simplifies the qualification process by eliminating any calculations needed to determine the qualifying Nonactive Energy Ratio.

- Explicit Requirements Similar to EPS Specification. A few stakeholders argued that the BCS requirements should mirror those for EPSs (i.e., explicit requirements or levels for Active and Standby modes). After further consideration, EPA decided not to implement any changes and kept Energy Ratio as its performance metric. Energy Ratio addresses the two operational modes (Battery Maintenance and Standby) where significant energy is wasted in BCSs while recognizing various battery sizes in these systems with the normalization by battery capacity. EPA's goal is to reduce overall energy use for BCSs. 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. The Energy Ratio approach also allows for designs that significantly reduce Battery Maintenance power at the cost of some increased Standby power. Since Battery Maintenance mode can be substantially higher than Standby, this approach can save significant energy.

- Including Energy from Active Charging. Some stakeholders encouraged EPA to address Active mode in the BCS specification. While a total energy approach including Active mode has the benefit of addressing all operational modes, it also would require 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) provide little to no increase in the savings estimates under a specification designed to recognize the top 25 percent of models; and 2) would not further differentiate products, as those deemed efficient under one approach would also qualify as efficient under the other approach. Finally, EPA's research and discussions with manufacturers indicate that design improvements to increase Battery Maintenance and Standby efficiency will also lead to some improvements in Active charging efficiency. As a result, EPA decided to focus on the Nonactive modes for its Version 1.0 specification, but remains interested in Active and will continue to support research in this area.

- Nominal Battery Energy. Draft 1 of the BCS specification used *nominal* battery energy to calculate the Nonactive Energy Ratio. Several stakeholders commented that this approach put manufacturers who rate their batteries more conservatively at a disadvantage (i.e., the higher the battery energy rating, the easier it is for the manufacturer to meet the ENERGY STAR requirement). In response, EPA changed the test methodology and specification to refer to battery energy and provided instructions for measuring it 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).

- Multi-voltage, Multi-port, and A La Carte Models. Based on input from the power tool industry, EPA added definitions for multi-voltage, multi-port, and a la carte models to the specification. Given that these charger models require testing with multiple battery packs, EPA also added instructions in the specification and test methodology for measuring their energy performance and calculating their Nonactive Energy Ratios. For example, 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 different model batteries, including those with the highest and lowest battery energies, as specified in the ENERGY STAR Test Methodology.

- Excluding Chargers with Nameplate Input Power Less Than 2 Watts. Several stakeholders asked EPA to consider excluding all units with 1.2 or 2.4 voltage batteries citing that these products use relatively little energy and have inherent efficiency limitations. After careful consideration, EPA decided to exclude products with very low power consumption (i.e., less than 2 watts), since the savings potential from such products would be very modest. With this approach, products designed for lower energy consumption are excluded, rather than products designed to simply operate at a lower voltage, which are inherently less efficient.

- Measured Maintenance Charge versus Nameplate Input Power. A few stakeholders suggested that the exclusion described above should allow manufacturers to base the wattage on measured maintenance charge rather than nameplate input power. EPA 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.

- Non-Continuously Plugged Battery Chargers. A few stakeholders asked EPA to exclude non-continuously plugged battery chargers (e.g., some models of shavers, beard trimmers, etc.) because of their minimal Battery Maintenance and no Standby mode power use. While

EPA understands that the instructions manual for these products advises consumers to unplug them after recharging, it is not clear whether this action is taken consistently in American homes. As such, EPA decided to include non-continuously plugged BCSs in its specification in order to recognize the better energy performers.

- Power Factor Correction. Regarding power factor correction (PFC), some stakeholders recommended that EPA add a PFC requirement to the specification for chargers above 75 watts. Other stakeholders argued that extra allowances should be given to account for the extra power draw of PFC, in order to not discourage it. While EPA understands the importance of PFC in electronic devices, adding this allowance would have required EPA to retest all models and redraw the specification levels—a task not feasible at the time of the suggestion. EPA ultimately decided not to address PFC under the current specification, but agreed to collect PFC data during the ENERGY STAR product qualification process and then analyze it for inclusion in a potential Tier 2 specification. This same approach is being employed for the EPS specification.

- BCS Graphic. Stakeholders encouraged EPA to design a BCS graphic that is language neutral, intuitive, and legible in very small sizes. EPA incorporated this feedback into its design of the BCS graphic while also creating a design similar to the existing EPS graphic.

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 guide EPA in its decision making and help EPA ensure that the ENERGY STAR mark will continue to be a trustworthy symbol for consumers to rely upon as they purchase products for the home or business and so that their purchases will deliver substantial environmental protection. These 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;
- Product differentiation and testing are feasible; and
- Labeling would be effective and recognizable in the market.

Below EPA addresses the Version 1.0 BCS specification relative to each of these criteria.

- Expected Energy Savings and Environmental Benefits. BCSs that earn the ENERGY STAR mark will on average be 35 percent more efficient than conventional models. EPA projects a potential U.S. energy bill savings of $95 million, electricity savings of over 1.1 billion kWh, and prevention of 0.64 million metric tons (MtC) of carbon dioxide pollution over the time period of 2006 to 2015 due to the new specification. A table outlining these results and the key assumptions is provided below.

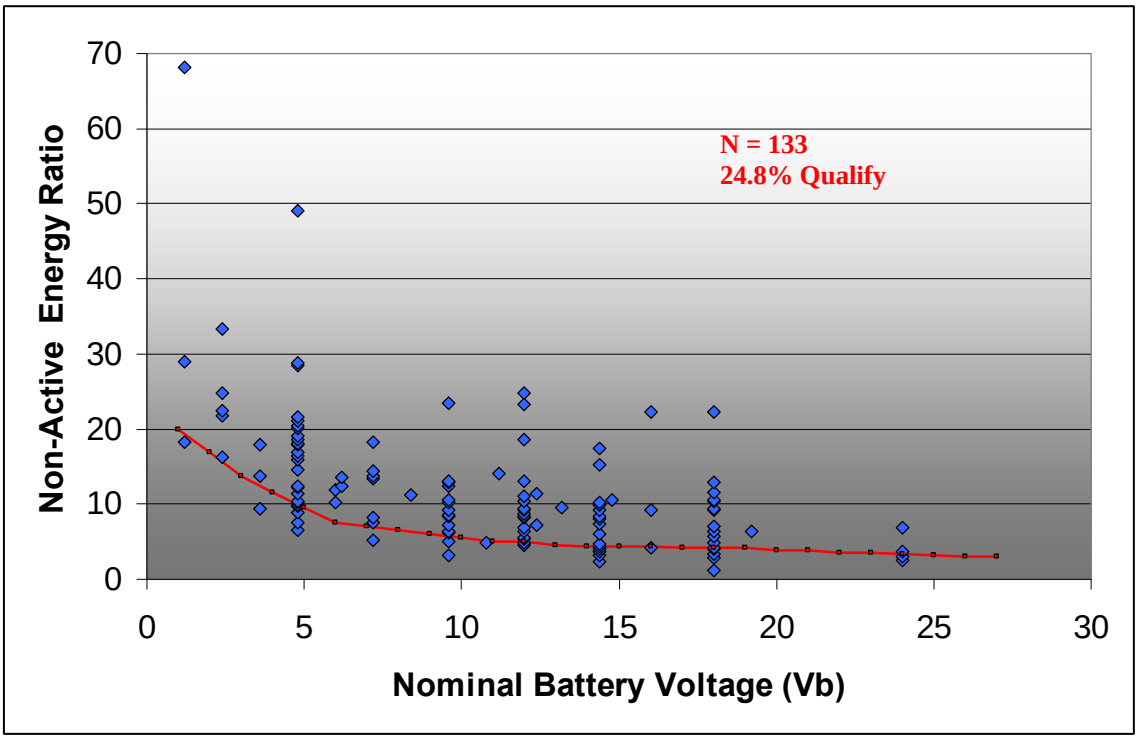
Table 2: Cumulative Savings from ENERGY STAR Qualified BCSs (2006-2015)

BCS Cumulative Savings from the Version 1.0 Specification	
U.S. energy bill savings	$95 million
U.S. energy savings	1.1 billion kWh
U.S. carbon savings	0.17 million MtC
U.S. carbon dioxide savings	0.64 million metric tons
Key Assumptions	• The price of electricity varies by year (we assume a residential rate), ranging between 8.3 and 9.5 cents/kWh during 2006 to 2015. • The percentage of stock and new shipments that are ENERGY STAR is assumed to steadily rise from 2006 to 2015. By 2015, 13% of stock is ENERGY STAR and 19% of shipments are ENERGY STAR.

— Technical Feasibility/Impact on Product Performance/Functionality. EPA believes the energy use requirements of this specification to be technically feasible and to not adversely impact product performance for the following reasons:

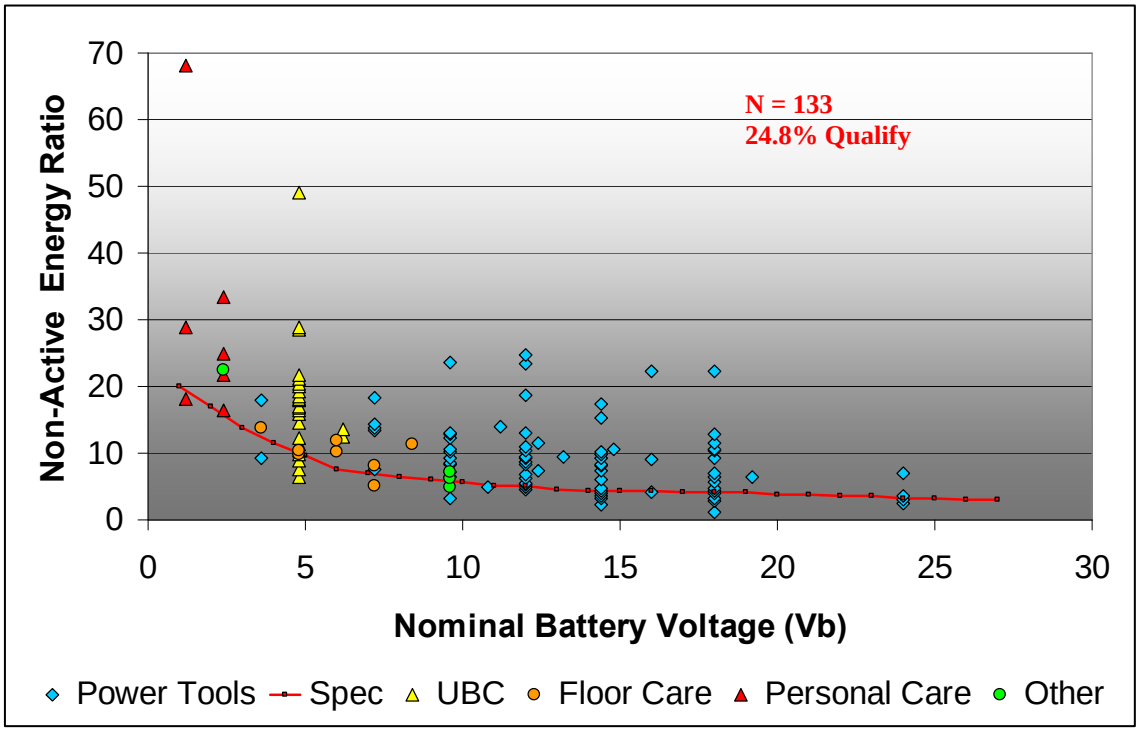
- The Final specification represents the top 24.8% of data points from EPA's data set (33 out of 133), which includes new power tool, small household appliance, yard care, personal care, and universal battery charger models. (See Figure 2 below.)

Figure 2: Data Used to Develop BCS Specification



- The test data shows that currently available models from each major product category are able to meet the ENERGY STAR requirements. (See Figure 3 below.)

Figure 3: Data Used to Develop BCS Specification by Product Type



- Industry stakeholders provided support for the BCS specifications. For example, AHAM provided the following feedback in a letter to EPA: "Overall, we believe that the Draft 2 test procedure and specification are well crafted…we wish to express our appreciation to EPA Energy Star office for its work on this important specification. Together we believe we are working to craft an excellent voluntary program that will assist consumers."

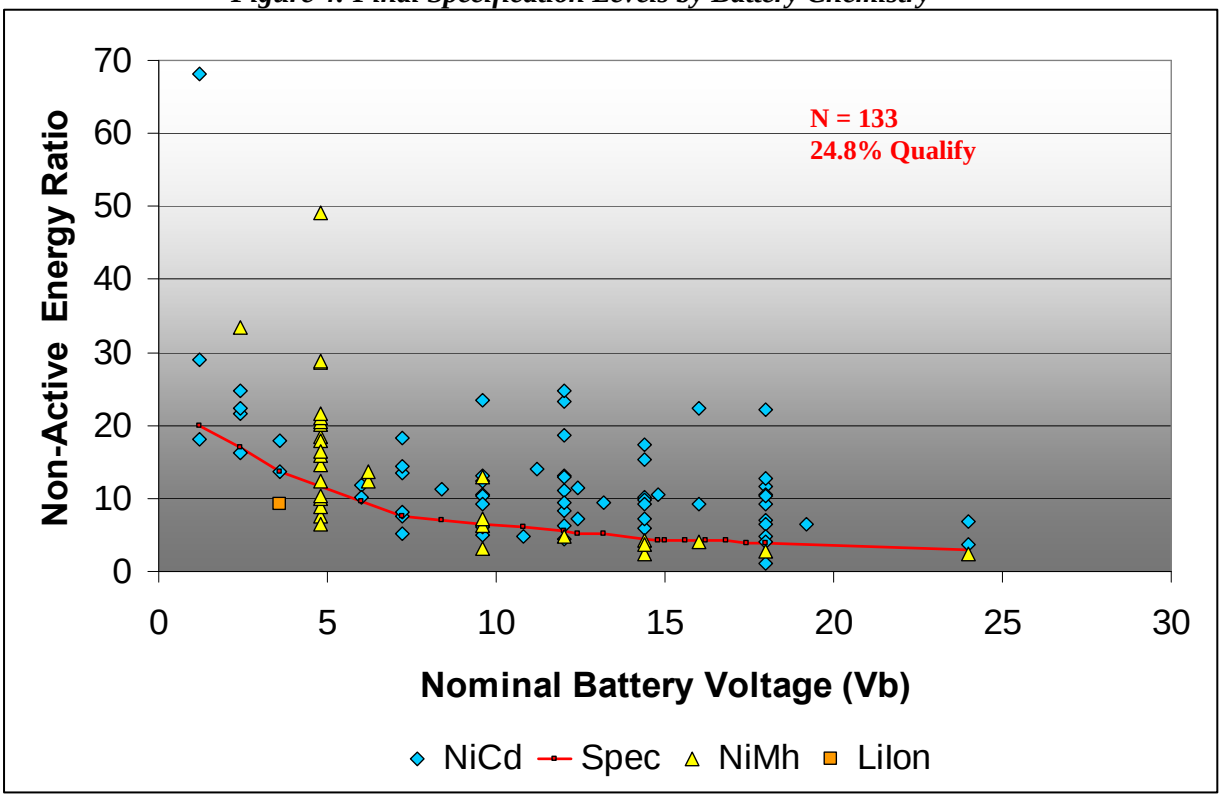
— Cost-effectiveness. EPA believes that the Version 1.0 specification can be achieved cost-effectively for the following reasons:

- Some manufacturers are already meeting the new energy performance targets and providing these models to purchasers at competitive prices. It is precisely these products that should be highlighted to purchasers when they are in the market for BCSs.

- Inductively coupled devices and units with very low power consumption (i.e., nameplate input power less than 2 watts) were excluded under this BCS specification based on a belief that compliance with ENERGY STAR would require a significant investment in product redesign, resulting in increased costs without providing substantial energy savings.

— Achieve Efficiency with Several Technology Options. EPA designs its ENERGY STAR specifications to be performance-based. This means that it strives to recognize the better performing BCSs in terms of energy consumption while encouraging industry to achieve efficiency levels with any available technology options. In this case, there are models with Nickel Cadmium, Nickel Metal Hydride, and Lithium Ion battery chemistries in EPA's data set that would currently qualify as ENERGY STAR under the BCS specification. (See Figure 4 below.)

Figure 4: Final Specification Levels by Battery Chemistry



- Testing Procedure. Prior to initiating specification development, it was clear that a new test procedure for determining the energy performance of BCSs was needed. The new procedure referenced in the Version 1.0 specification went through multiple rounds of stakeholder review and comment and borrows from applicable IEC standards.

  - A well-defined test procedure ensures that repeatable results can be generated, objective comparisons can be made between products, and loopholes can be avoided. The ENERGY STAR test method for BCSs can be found at http://www.energystar.gov/batterychargers.

- Product Differentiation and Labeling. Market research and test data analysis showed that product performance varies within a sufficient range to allow for meaningful differentiation to the purchaser.

  - **EXAMPLE**: Within EPA's data set, BCSs with 4.8-volt batteries had Nonactive Energy Ratios of 6.50 to 63.70. Similarly, BCSs with 18-volt batteries had Nonactive Energy Ratios of 1.15 to 22.21.

The BCS specification and graphic (shown to the right) were designed to complement the EPS specification and graphic. The BCS specification covers many products not currently addressed in the EPS specification, including floor care, personal hygiene, yard care, power tools, small kitchen appliances, and consumer battery chargers. Together, the EPS and BCS specifications cover a wide variety of power conversion devices.

EPA believes an ENERGY STAR graphic for BCSs serves an important role in the U.S. marketplace due to the increasing market for BCS products and the absence of any energy efficiency label for these products. Retailers are already indicating their interest in selling and promoting products, such as power tools, that come with an ENERGY STAR qualified BCS.