Proposed Approach for Developing Energy Efficiency
Battery Charger System Test Procedure

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Suzanne Foster Porter, Ecos Consulting
Haresh Kameth and Tom Geist, EPRI Solutions

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I. Introduction

Over the last two decades, numerous battery-powered products have been introduced into the consumer marketplace and are growing steadily in popularity. Today, over 600 million products that contain battery chargers are currently in use in America's homes, offices, retail spaces, and warehouses. These products offer substantial economic and environmental advantages over products powered by throwaway batteries and are more convenient than corded products. However, each rechargeable product contains an ac-dc power supply, battery-charging circuitry, and low voltage electronics whose total electricity consumption varies widely from product to product. Ecos Consulting estimates that if all U.S. battery chargers were as efficient in the Standby and Battery Maintenance modes[1] as the best designs that have been tested, the national savings would be about 4.5 billion kWh per year and nearly $400 million in electric bills. Opportunities for Charge mode savings are unknown and require further research. However, based on Ecos Consulting's knowledge of battery chargers and power supply efficiency, overall savings could substantially increase if active charge mode were addressed.

Ecos Consulting and EPRI Solutions are in the process of developing a test procedure to measure the energy efficiency of battery charger systems commonly found in today's battery-powered devices. This diverse product category includes everything from portable appliances, such as cordless telephones and drills, to electric vehicles, such as golf carts and warehouse electric forklifts. *The purpose of the test procedure is to measure the energy efficiency of chargers coupled with their batteries, which we refer to collectively as* ***battery charger systems****.*

The focus of this document is to give an update on the development progress of this draft test procedure, which we expect to be released in October 2005. Because specific aspects of the test procedure are under still under evaluation for the draft version of the test procedure, every detail is not given here. Instead, the intent of this document is to summarize the general scope and approach we are using as the starting point for the development of a test procedure draft.

The timeline for development of this test procedure is as follows:

Activity	Date
Update on test procedure approach	September 2005

[1] Please refer to Section III of this document for full definitions of Standby and Battery Maintenance modes.

Draft Battery Charger System Energy Efficiency Test Procedure	October 2005
Technical Workshop to review test procedure and receive input from industry and other stakeholders	November 2005 (exact date TBD)
Comment period on Draft Battery Charger System Efficiency Test Procedure	November to mid-December 2005 (exact dates TBD)
Final Battery Charger System Energy Efficiency Test Procedure Released	January 2006

Updates to the schedule, future drafts of this test procedure, and workshop invitations and notes will be posted on the battery charger section of www.EfficientProducts.org.

II. Approach Under Consideration: General

Scope

The purpose of the test procedure is to measure the energy efficiency of chargers coupled with their batteries, which we refer to collectively as battery charger systems. Battery charger systems include those electronic devices with a battery that are normally charged from line voltage ac through an internal or external power supply and a dedicated battery charger. This includes devices that are designed to run on battery power during part or all of their duty cycle (such as many portable appliances) and dedicated battery systems primarily designed for electrical or emergency backup (such as stationary battery charging/maintenance systems). This charger and charging circuitry may or may not be located within the housing of the functional device itself; in many cases, the battery may be charged with a dedicated external charger and power supply combination that is separate from the device that runs on the battery power. Examples of battery charger systems included in this scope are: cellular and cordless telephones, cordless power tools, laptop computers, and cordless shavers, battery powered forklifts, emergency egress lighting, golf carts, portable lawn tools, and rechargeable portable toys.

This scope also includes those units whose primary function is to charge batteries. These units include replacement chargers for power tools and chargers for AA, AAA, C, D, and 9 V rechargeable batteries.

This scope is meant to cover those battery charger systems that are used in the residential sector (private households) and commercial sector (generally defined as businesses; Federal, State, and local governments; and other private and public organizations, such as religious, social, or fraternal groups; institutional living quarters; and sewage treatment facilities). For a more complete definition of energy sectors, as defined by DOE, please see http://www.eia.doe.gov/neic/datadefinitions/sectors25B1.htm. We recognize that some battery charger systems may be used in industrial and commercial arenas (e.g. battery powered fork lifts), and therefore some battery charger systems that are used in the industrial arena may be included under this scope.

This test procedure is not intended to cover lab-grade equipment used to analyze batteries and applies to whole battery charger systems, not components of that system. Furthermore, this document does not specify safety requirements, nor does it specify limits on energy consumption.

Modes of Operation
The modes considered by this test procedure approach are meant to be comprehensive, reflecting all of the ways in which a battery charger system may be used. We recognize that some battery charger systems are charged and discharged infrequently and spend the majority of their lifecycle in battery maintenance. Other products are never attached to ac line voltage with the battery uninstalled. The purpose of measuring all ways in which a battery charger system may be used is to cast the net broadly enough to provide policymakers with a wide variety of data. It is likely that over time certain battery charger system tests may not be required for certain devices that rarely operate in that condition, but at this early stage, our approach does not include exceptions for certain battery charger systems.

- Charge Mode- refers to a condition in which the battery charger system is connected to line voltage ac, and the battery charger is delivering power to the battery

- Battery Maintenance Mode- refers to the mode where the charger system is connected to ac line voltage and has a fully charged battery installed. In general, power measured in this mode yields slightly higher power consumption than Standby mode and it may persist for an indefinite time with the battery charger system is connected to the ac supply voltage and used in accordance with the manufacturer's instructions

- Standby Mode- when the battery charger system is connected to ac line voltage, but there are no batteries installed in the unit. It is the lowest possible power mode that cannot be switched off (influenced) by the user and that may persist for an indefinite time when the battery charger is connected to ac line voltage and used in accordance with the manufacturer's instructions

References

1) IEC 62301, Household Electrical Appliances- Measurement of Standby Power, Ed. 1, 2005.
2) IEEE 100, The Authoritative Dictionary of IEEE Standards Terms
3) IEC 60050, International Electrotechnical Vocabulary- Electrical and Electronic Measurements and Measuring Instruments.
4) IEC 61951 – 2003
5) ANSI C18.2M, part 1 – 2001, section 1.4.4.5.1
6) IEC 60086-1 Ninth edition 2000-11 Primary batteries – Part 1:General

Test Conditions
- Use of a input reference ac source with specific voltage, frequency, and Total Harmonic Distortion (THD) tolerances
- Use of power metering equipment and battery analyzers with specific measurement tolerances
- Test room with specific ambient temperature air movement and humidity tolerances

Battery Charger System Setup Requirements
The battery charger system should be prepared and set up in accordance with the manufacturer's instructions, except where these conflict with the test procedure as stated. If no instructions are given, then factory or "default" settings shall be used, or

where there are no indications of such settings, the unit shall be tested as supplied. The following parameters are of particular importance:

- The battery charger system shall be used with the exact external power supply packaged with the unit, if any.
- The battery charger system shall be tested with the batteries that are commercially packaged with the unit. If the unit is not packaged with batteries, then the battery charger may be tested in one of two ways:
    - batteries that are most closely associated with the product should be used (More preferable approach because testing can incorporate the efficiency of the battery)
    - a battery emulator should be used (Less preferable because efficiency of the battery cannot be taken into account.)
- Any optional functions controlled by the user and not associated with the battery charging process may be turned off during the test.

III. Approach Under Consideration: Test Procedure

Standby Mode Test

This test should be made on devices that contain battery charger systems from which the battery itself or a component housing the battery can be readily removed from the charger during normal operation, while the charger remains connected to line voltage ac. Examples include:

1) A cordless phone with the handset off of the base unit. The base unit remains connected to line voltage ac.
2) A cordless power tool battery charger, from which the batteries are removed while the charger remains connected to line voltage ac.

NOTE: A few devices (e.g. some electric razors and some desk size uninterruptible power supplies (UPSs)) do not normally operate in such a standby condition and may not be appropriate for this test.

To measure the average power for this mode, the following steps are involved:

1) Remove the battery from the battery charger
2) Connect the measuring device to the battery charger
3) Confirm the battery charger is in standby mode and is in its lowest power state in that mode (this might require switching off other functionality of the device).
4) Record the start time of the measurement period; record the energy or power values associated with the measurement period until the completion of the test

Charge Mode and Battery Maintenance Mode Test

The Charge/Battery Maintenance mode test measures the ac energy consumed during one charge and maintenance cycle of the battery charger system. The power values should be recorded during the test period at a fixed sampling interval, and the total duration of the test period should be noted. Functions required for battery conditioning that happen rarely (e.g. equalization, automatic cycling occurring weekly or monthly) or only with some user intervention should **not** be included in the definition of Battery Maintenance power.

The following steps apply:

1) Connect the measuring device to the battery charger
2) Confirm the battery charger is in the appropriate state (batteries inserted and batteries fully discharged, all other functionality of the device turned “off”).
3) Record the start time of the measurement period, and begin recording the energy and power values associated with the measurement period
4) At the end of the measurement period, record the final time and total energy consumed over that period.
5) The batteries should be immediately removed at the end of the testing period in preparation for the Discharge Energy Test (below).

Battery Discharge Energy Test
System efficiency of the battery and charging system, as defined by policymakers, could incorporate the ac energy consumption of a battery charger with and without the battery installed, as well as the dc energy that is extractable from its battery when it is discharged.

The purpose of this test is to measure the extractable energy from the battery associated with the battery charger system. The battery that is used in this test shall be the same battery used for other tests specified in this document.

The following steps apply:
1) After the battery is charged by the battery charger according to the test specified above, the battery should be immediately removed and connected to a battery analyzer for discharge.
2) The battery should then be discharged at a specified rate until the cell voltage reaches a specified level (levels and rates still TBD)
3) The total energy extracted during that time period should be recorded as well as the active power values as a function of time. Active power should be given once per minute.