

1 **Draft 2 Energy Efficiency Battery Charger System Test Procedure**

2
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4
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7
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11
12 **I. Scope**

13
14 The purpose of the test procedure is to measure the energy efficiency of chargers
15 coupled with their batteries, which we refer to collectively as **battery charger systems**.
16 Battery charger systems include those electronic devices with a battery that are normally
17 charged from ac line voltage through an internal or external power supply and a
18 dedicated battery charger. This includes devices that are designed to run on battery
19 power during part or all of their duty cycle (such as many portable appliances and
20 commercial material handling equipment) as well as dedicated battery systems primarily
21 designed for electrical or emergency backup (such as emergency egress lighting and
22 small-scale uninterruptible power supply (UPS) systems).
23

24 The charging circuitry of battery charger systems may or may not be located within the
25 housing of the functional device itself; in many cases, the battery may be charged with a
26 dedicated external charger and power supply combination that is separate from the
27 device and runs on power from the battery. Examples of battery charger systems
28 included in this scope are: cellular and cordless telephones, cordless power tools, laptop
29 computers, cordless shavers, emergency egress lighting, golf carts, portable lawn tools,
30 and rechargeable toys.
31

32 The scope of this document also includes those devices whose primary function is to
33 charge batteries. These units include replacement chargers for power tools and
34 chargers for AA, AAA, C, D, and 9 V rechargeable batteries.
35

36 This scope is meant to cover those battery charger systems found in the residential and
37 commercial sectors that operate on single-phase voltage and have a nameplate ac
38 rating of less than 2 kW. For the purposes of this procedure, the commercial sector is
39 generally defined as businesses; federal, state, and local governments; and other private
40 and public organizations, such as religious, social, or fraternal groups; institutional living
41 quarters; and sewage treatment facilities.¹ Some battery charger systems may be used
42 in both industrial and commercial sectors (e.g., commercial floor scrubbers), and

¹ For a more complete definition of energy sectors, as defined by DOE, please see
<http://www.eia.doe.gov/neic/datadefinitions/sectors25B1.htm>

43 therefore some battery charger systems that are also found in the industrial sector may
44 be included under this scope.

45
46 This test procedure is not intended to cover laboratory test equipment used to test and
47 analyze batteries. This test procedure applies only to whole battery charger systems,
48 not components of that system. In other words, this test procedure does not specify how
49 to test a charger in the absence of a battery, nor a battery in the absence of a charger.
50 Furthermore, this document does not specify safety requirements, nor does it specify
51 limits on energy consumption or efficiency, though policy-making bodies may choose to
52 reference this test procedure in proposing such limits.
53

Authors' comment on scope: *In response to stakeholder comment, the scope of the test procedure is, in Draft 2, limited to single-phase battery chargers with nameplate rating less than 2kW. The scope no longer includes large battery charging systems that operate on three-phase input voltage, which we believe to be significantly different than the other products under consideration in this scope.*

54

55 II. References

56 The following list includes documents used and/or referenced in the development of this
57 test method:

58

- 59 1) Battery Council International, *BCI Specifications for Electric Vehicle Batteries*,
60 BCIS-05 Rev. DEC02.
- 61 2) Battery Council International, *Determination of Capacity of Lead-Acid Industrial*
62 *Storage Batteries for Motive Power Service*, BCIS-14 Rev. DEC02.
- 63 3) Battery Council International, *Standard for Deep Cycle Battery Chargers*, BCIS-
64 16 Rev. DEC02.
- 65 4) International Electrotechnical Commission, *Direct Acting Indicating Analogue*
66 *Electrical Measuring Instruments and their Accessories*, IEC 60051, parts 1-9.
- 67 5) International Electrotechnical Commission, *Household Electrical Appliances -*
68 *Measurement of Standby Power*, IEC 62301, 2005.
- 69 6) International Electrotechnical Commission, *International Electrotechnical*
70 *Vocabulary- Electrical and Electronic Measurements and Measuring Instruments*,
71 IEC 60050-300, Edition 1.0, 2005.
- 72 7) International Electrotechnical Commission, *Primary batteries – Part 1: General*,
73 IEC 60086-1. Edition 9.0.
- 74 8) International Electrotechnical Commission, *Lead-acid traction batteries – Part 1:*
75 *General requirements and methods of tests*, IEC 60254-1, Edition 4.0, 2005.
- 76 9) International Electrotechnical Commission, *General Purpose Lead-Acid Batteries*
77 *(Valve Regulated Types) – Part 1: General Requirements, Functional*
78 *Characteristics – Methods of Test*, IEC 61056-1, Edition 2.0, 2002.
- 79 10) International Electrotechnical Commission, *Secondary cells and batteries*
80 *containing alkaline or other non-acid electrolytes – Portable sealed rechargeable*
81 *single cells – Part 1: Nickel-cadmium*, IEC 61951-1. Edition 2.0, 2003-2004.
- 82 11) International Electrotechnical Commission, *Secondary cells and batteries*
83 *containing alkaline or other non-acid electrolytes – Portable sealed rechargeable*
84 *single cells – Part 2: Nickel-metal hydride*, IEC 61951-2, Edition 2.0, 2003.

- 85 12) International Electrotechnical Commission, *Secondary cells and batteries*
86 *containing alkaline or other non-acid electrolytes – Secondary lithium cells and*
87 *batteries for portable applications*, IEC 61960, Edition 1.0, 2003.
88 13) International Electrotechnical Commission, *Secondary cells and batteries*
89 *containing alkaline or other non-acid electrolytes – Safety requirements for*
90 *portable sealed secondary cells, and for batteries made from them, for use in*
91 *portable applications*, IEC 62133, Edition 1.0, 2002.
92 14) Institute of Electrical and Electronics Engineers, *The Authoritative Dictionary of*
93 *IEEE Standards Terms*, IEEE 100, Edition 7.0, 2006.
94 15) Institute of Electrical and Electronics Engineer Power Engineering Society,
95 *Livium: IEEE Standard for Rechargeable Batteries for Portable Computing*, IEEE
96 1625-2004.
97 16) Buchmann, Isidor, *Batteries in a Portable World: A Handbook on Rechargeable*
98 *Batteries for Non-Engineers*, Cadex Electronics Inc., 2001.

Authors' comment on references: *To ensure that test requirements are understood in their full context, and in the interest of brevity, this test procedure references the relevant test protocols listed above by document and section number rather than including exact wording from those documents.*

99

100 III. Definitions

101

102 A. Active Power (P)

103 The rms value, taken over one period, of the instantaneous power. Most measuring
104 instruments average active power over a number of periods (ac cycles); readings from
105 such instruments are equally valid for this measurement.

106

107 B. Ambient Temperature

108 Ambient temperature is the temperature of the ambient air immediately surrounding the
109 UUT.

110

111 C. Apparent Power (S)

112 The total or *apparent power* (S) is the product of rms ac voltage and rms ac current (VA).

113

114 D. Battery Chemistry

115 The chemistry of the battery, usually nickel cadmium, nickel metal hydride, lithium ion, or
116 lead acid. The chemistry of the battery is typically printed on the label of the battery
117 itself, can be found in product literature, or can be obtained from the manufacturer of the
118 battery system.

119

120 E. Battery Conditioning

121 A special procedure performed on a battery to ensure optimal performance. Nickel
122 cadmium and nickel metal hydride batteries, for instance, must occasionally be fully
123 discharged and then charged to deliver maximum energy output.

124

125 F. Battery Discharge Energy

126 The energy delivered by a fully charged battery when it is discharged at a constant
127 current to a specified end of discharge voltage value.

128

129 **G. Battery Maintenance Mode**
130 Refers to a condition in which the battery charger system is connected to ac line voltage,
131 and the battery charger may be delivering current to the battery in order to counteract
132 self-discharge of the battery. The battery is, in this state, at or near 100% capacity.
133

134 **H. Battery Rest Period**
135 A period of time between discharge and charge, or charge and discharge, where the
136 battery is resting open circuit in ambient air. The rest period is intended to allow the
137 battery to cool and to return to an electrochemically-relaxed state. Battery rest periods
138 are required as part of this test procedure.
139

140 **I. Charge Mode**
141 Refers to a condition in which the battery charger system is connected to ac line voltage,
142 and the battery charger is delivering current in order to bring the battery from a state of
143 discharge to a state at or near 100% capacity.
144

145 **J. C-Rate**
146 C-rate (in amperes) refers to the rate of charge or discharge. A discharge rate of one C
147 draws a current equal to the rated capacity of the battery (in ampere-hours or
148 milliamperes-hours) over one hour.
149

150 **K. External Power Supply**
151 External power supplies are designed to convert ac line voltage into low voltage output
152 (either ac or dc) and are contained in a separate housing from the product they are
153 powering. For further clarification, see *Test Method for Calculating the Energy Efficiency*
154 *of Single-Voltage External Ac-Dc and Ac-Ac Power Supplies*, August 11, 2004, at
155 www.efficientpowersupplies.org.
156

157 **L. End-of-Discharge Voltage**
158 Specified closed circuit battery voltage at which discharge of a battery is terminated.
159

160 **M. No-Battery Mode**
161 The battery charger system is connected to ac line voltage, but there are no batteries
162 connected to the dc output. It is the lowest power mode that normally cannot be
163 switched off (influenced) by the user and may persist for an indefinite time when the
164 battery charger is connected to ac line voltage and used in accordance with the
165 manufacturer's instructions.
166

167 **N. Measured Energy Capacity**
168 The amount of storable energy in a battery measured with the test procedure detailed in
169 section VI of this document. It is equal to the product of the measured current during
170 constant current discharge (in amperes or milliamperes), the total time (in hours) of
171 discharge, and the average battery voltage during discharge. Measured battery capacity
172 is in units of energy (watt-hours (Wh)), and should be distinguished from rated charge
173 capacity, defined in this document below.
174

175 **O. Power Factor (True)**
176 The *true power factor* is the ratio of the active, or real, power (P) consumed in watts to
177 the apparent power (S), drawn in volt-amperes (VA).
178

179

$$PF = \frac{P}{S}$$

180

181 This definition of power factor includes the effect of both distortion and displacement.

182

183 **P. Rated Charge Capacity**

184 The capacity, usually given in ampere-hours (Ah) or milliampere-hours (mAh), specified
185 by the manufacturer and typically printed on the label of the battery itself. In general, it is
186 the quantity of electric charge the manufacturer declares the battery can store under
187 particular pre-specified test conditions.

188

189 **Q. Rated Battery Voltage**

190 The voltage of the battery that is specified by the manufacturer and typically printed on
191 the label of the battery itself. If not printed on the battery, it can be derived if the
192 electrical configuration and chemistry of the battery are both known.

193

194 **R. Rated Input Frequency**

195 Range of ac input frequencies designed to operate the UUT; assigned by the
196 manufacturer and usually printed on the housing of the charging device.

197

198 **S. Rated Input Voltage**

199 Range of ac input voltage designed to operate the UUT; assigned by the manufacturer
200 and usually printed on the housing of the charging device.

201

202 **T. Total Harmonic Distortion (THD)**

203 Total harmonic distortion is a measure of the degree to which a waveform departs from a
204 pure sinusoidal waveform. It is defined as the ratio of the vector sum of all harmonic
205 components (greater than 1) to the magnitude of the fundamental. For instance, for a
206 voltage waveform, THD is defined by the equation:

207

208

$$THD = \frac{\sqrt{V_2^2 + V_3^2 + V_4^2 + \dots + V_n^2}}{V_1}$$

209

210 Where V_n is the rms voltage of harmonic n.

211

212 **U. UUT**

213 UUT is an acronym for “unit under test,” which in this case refers to the battery charger
214 and battery being tested.

Authors' comment on definitions: Several definitions have been added or clarified in response to stakeholder comment. In particular, definitions for battery conditioning, battery discharge energy, battery rest period, and total harmonic distortion have been added; definitions for capacity have been corrected and clarified to distinguish between charge capacity and energy capacity; and definitions for rated input voltage and rated input frequency have been clarified and made consistent throughout the document.

Authors' comment on operational modes: *The operational modes considered by this test procedure are meant to be comprehensive, reflecting all of the ways in which a battery charger system may be used. The authors recognize that some battery charger systems are charged and discharged infrequently and spend the majority of their lifecycle in battery maintenance mode. The purpose of this procedure is to measure all ways in which a battery charger system may be used to provide manufacturers and policymakers with comprehensive data. Particular policymakers may not reference all battery charger tests outlined in this document, especially for devices that rarely enter certain modes of operation, but at this early stage, this approach does not include exceptions for certain battery charger systems.*

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IV. Standard Test Conditions

A. General

The test sequence outlined in this document is summarized in the table below. Although not required, the test sequence in Table A is suggested for efficient use of technician and lab equipment time:

Table A: Suggested Test Sequence

Step	Description	Data Taken?	Approx. Technician Time	Equipment Needed	Approx. Lab Equip. Time	Approx. Total Test Time
1	Record general data on UUT	Yes	15 min	battery(ies) and charger	0	15 min
2	<i>Battery conditioning (optional)</i>	No	variable	<i>battery(ies) and battery analyzer</i>	variable	variable
3	Charge the batteries with associated charger in preparation for test, according to section VI	No	5 min	Battery(ies) and charger	0	24 h
4	Store battery(ies) between charge and Battery Discharge Energy Test, according to section IV, G*	No	5 min	battery(ies)	0	1 h
5	Discharge battery(ies) according to section VI (Battery Discharge Energy Test)	Yes	15 min	battery(ies), battery analyzer	5.25 h	5.25 h
6	Store battery(ies) between Battery Discharge Energy Test and Charge and Battery Maintenance Mode Test, according to section IV, G*	No	5 min	battery(ies)	0	1 h
7	Conduct Charge Mode and Battery Maintenance Mode Test as specified in section VII	Yes	15 min	charger, battery(ies), ac power meter	24 h (test runs overnight)	24h
8	Remove battery(ies) and conduct No-Battery Mode Test detailed in section VIII	Yes	10 min	charger, ac power meter	5 min	10 min
9	Compile data into report	No	25 min	none	0	25 min
Approximate Test Times:			2 h		29 h	56 h

224 * Larger batteries may require longer rest periods
225

226 Unless otherwise specified, measurements shall be made under the test conditions and
227 with the equipment specified below.

228

229 **B. Ac Measuring Equipment**

230 All ac power measurements shall be made with a suitably calibrated power analyzer, per
231 the requirements of section 4.5 of IEC 62301, with consideration of the provisions in
232 Annex B and Annex D of the same document.

233

234 **C. Battery Measurement Equipment**

235 The overall accuracy of controlled or measured values associated with discharging the
236 battery, relative to the specified or actual values, shall be within the tolerances specified
237 in the applicable industry standard for batteries of this chemistry, as listed below:

- 238 • Flooded Lead Acid Batteries: IEC 60254-1, Section 4.1.
- 239 • VRLA Batteries: IEC 61056-1, Section 5.2.1
- 240 • Nickel Cadmium Batteries: IEC 61951-1, Section 4
- 241 • Nickel Metal Hydride Batteries: IEC 61951-2, Section 4
- 242 • Lithium Ion Batteries: IEC 61960, Section 4

243

244 If the chemistry under test is not listed above, then the applicable procedure should be
245 referenced and documented on the test report.

246

247 For assistance in selecting instrumentation, see the IEC 60051 series. The details
248 (make, model, and calibration schedule) of the instrumentation used shall be provided in
249 each report of results.

250

251 **D. Test Room**

252 All tests shall be carried out in a room with ambient conditions in accordance to Section
253 4.2 of IEC 62301. There shall be no intentional cooling of the UUT by use of separately
254 powered fans, air conditioners, or heat sinks. The UUT shall be tested on a thermally
255 non-conductive surface. Products intended for conditions outside of this specified range
256 may be tested at additional temperatures, provided those are in addition to the
257 conditions specified above and are noted in a separate section on the test report. When
258 not undergoing active testing, batteries shall be stored under per the requirements of
259 Section IV, G below.

260

Authors' comment on test room temperature: This range was chosen as coinciding with the various IEEE, IEC, and other industry test standards examined in the course of test procedure development, as listed in the Section II References.

261

262 **E. Ac Input Reference Source: Input Voltage and Input Frequency**

263 An ac reference source shall be used to provide input voltage to the UUT, as specified in
264 IEC 62301, Section 4.3.

265

Authors' comment on UUT input voltage: Although California units are likely be tested at 115 V and 60 Hz, the reference to other voltages above is meant to address the needs of international stakeholders who could potentially reference this test method in their own battery charger initiatives.

266 **F. Ac Input Reference Source: Other Specifications**
267 The total harmonic distortion (THD) of the ac supply voltage when supplying the UUT in
268 the specified mode shall conform to Section 4.4 of IEC 62301.

269
270 **G. Battery Rest Periods**

271 The battery shall be rested between charge and discharge, and between discharge and
272 charge, according to the applicable industry test standard for batteries of certain
273 chemistries, as listed:

- 274 ○ Flooded Lead Acid Batteries: IEC 60254-1, Section 5.2.3
- 275 ○ VRLA Batteries: IEC 61056-1, Section 6.2.1
- 276 ○ Nickel Cadmium Batteries: IEC 61951-1, Section 7.2.1
- 277 ○ Nickel Metal Hydride Batteries: IEC 61951-2, Section 7.2.1
- 278 ○ Lithium Ion Batteries: IEC 61960, Section 7.2.2, Step 2

279
280 In addition for flooded lead acid batteries, battery electrolyte temperatures shall be
281 measured per IEC 60254-1 Section 4.1.2. Charging or discharging activities shall not be
282 conducted unless battery electrolyte temperatures are less than 30°C.

283
284 Ambient conditions during rest periods shall be the same as those prescribed in Section
285 IV, D of this document.

286
287 If the chemistry under test is not listed above, then the applicable procedure for resting
288 the battery should be referenced or described on the test report.

Authors' comment on rest periods and battery electrolyte temperature: Rest periods between charge and discharge operations, and between discharge and charge operations allow the battery to reach electrochemical equilibrium and cool to ambient temperature. Stakeholders suggested that for flooded lead acid batteries, electrolyte temperature should be used as a second measure of equilibrium. We have included that additional criterion in this draft.

289
290 **V. Battery Charger System Setup Requirements**

291
292 **A. General Setup Guidance**

293 The battery charger system should be prepared and set up in accordance with the
294 manufacturer's instructions. If no instructions are given, then factory or "default" settings
295 shall be used, or where there are no indications of such settings, the UUT shall be tested
296 as supplied. In all cases, the battery charger unit shall be used with the exact external
297 power supply packaged with the unit, if any.

298
299 **B. Age of Battery Charger System**

300 The UUT, including the battery charger and its associated battery, shall be new products
301 of the type and condition that would be sold to a customer. For lead acid batteries,
302 "new" shall be defined as IEC 60254-1, Section 4.2.1.

303
304 **C. Guidance on Battery to Use for Test**

305 The battery charger unit shall be tested with the batteries that are commercially
306 packaged or most commonly sold with the unit. If the unit is not packaged with batteries,
307 then the charger should be tested in one of the following ways:

308

- 309 • The battery charger shall be tested with batteries that are most closely associated or
310 typically used with the product.
- 311 • If multiple types of batteries are used with the product, such that not one battery is
312 closely associated with the charger, then the tests specified in sections VII, and VIII
313 of this document (Battery Discharge Test, and Charge/Maintenance Mode Test) shall
314 all be conducted twice, once with the highest capacity battery that is sold or
315 associated with the charger, and once with the lowest capacity battery that is sold
316 with or associated with the charger. Measurements from both tests shall be
317 recorded.
- 318 • For chargers with multiple charging ports, the tests specified in sections VI, and VII
319 of this document (Battery Discharge Test, and Charge/Maintenance Mode Test) shall
320 all be conducted twice with battery configurations list below:
- 321 ○ The maximum number of identical batteries of maximum capacity that the
322 charger is meant to accommodate shall be used
- 323 ○ The minimum number of identical batteries of minimum capacity that the
324 charger is meant to accommodate shall be used
- 325 Data from both tests shall be recorded.
- 326

327 **D. Battery Conditioning/Preparation**

328 If desired, a battery conditioning/preparation procedure suitable to the chemistry and
329 construction of the battery may be performed before testing. If such a procedure is
330 performed, it shall be documented in the test report with reference to the
331 conditioning/preparation standard or procedure employed. Although there is no
332 requirement that a specific capacity be achieved through battery conditioning, the
333 available international standards for battery cycling are referenced below for the
334 technician's convenience.

- 335 • Flooded Lead Acid Batteries: IEC 60254-1, Section 4.2.2 and 4.3
 - 336 • VRLA Batteries: IEC 61056-1, Section 5.1.3
 - 337 • Nickel Cadmium Batteries: IEC 61951-1, Table 6, Footnote b
 - 338 • Nickel Metal Hydride Batteries: IEC 61951-2, Table 5, Footnote b
- 339

340 NOTE: If a conditioning sequence precedes the battery discharge test specified in
341 section VI, then the final charge prior to the discharge test must be completed with the
342 battery charger associated with the UUT, not a battery analyzer.

343

344 **E. Other Non-Battery Charger Functions**

345 Any optional functions controlled by the user and not associated with the battery
346 charging process (i.e., a radio integrated into a cordless tool charger) shall be turned off.
347 If it is not possible to turn such functions off, they should be set to their lowest power-
348 consuming mode during the test. The operations that are available to the user shall be
349 recorded.

- 350 • Example 1: If there is a radio in the same housing as a tool battery charger, the radio
351 shall be turned off for all the tests. The user is no longer able to listen to the radio, so
352 the only functionality available to the user (and what should be recorded on the
353 report) is the "On-Off switch for the radio."
 - 354 • Example 2: A cordless phone battery charger also contains the circuitry for
355 monitoring the phone line for a call. This functionality cannot be disabled and so shall
356 be recorded on the test procedure report as "monitoring phone line for incoming call."
- 357

358 If other the battery charger unit has other electrical connections that are associated with
359 operations available to the user (described above), they shall be connected during the
360 test (e.g., a cordless telephone base shall be connected to a phone line during the test).

361
362 **F. Safety Considerations**

363 In no case shall the test procedure conflict with general safety standards or safety
364 provisions in the manufacturer's instructions for set up.
365

***Authors' comment on Section V:** A number of modifications were made to section V in response to stakeholder comment including adding a section detailing safety considerations; providing more detailed guidance on non-battery charger functions; and more detailed guidance on the required age of the battery charger system.*

366
367 **VI. Battery Discharge Energy Test**
368

369 The purpose of this test is to measure the extractable energy from the battery associated
370 with the battery charger system. The battery used in this test shall be the same battery
371 used for tests specified in section VII, Charge/Maintenance Mode Test. If multiple
372 batteries are being used in this test (see section V, Battery Charger System Setup
373 Requirements), then each battery should separately undergo this discharge test to
374 determine its capacity.

375
376 For this test, the following steps apply:
377

- 378 1) The battery is charged with its associated battery charger (not with a battery
379 analyzer).
- 380 2) The cell or battery shall be rested per provisions of the applicable industry test
381 standard as listed in Section IV, G above.
- 382 3) The battery shall be discharged at a constant current of 0.2 C, until its voltage is
383 equal to the specified end-of discharge voltage (in Table B below).
- 384 4) The total energy extracted during the period of discharge should be recorded as
385 well as the battery voltage and current values as a function of time. Voltage and
386 current shall be sampled at least once per minute. For guidance on calculating
387 energy extracted during discharge, please see IEC 62301, Annex C.

388
389 **Table B: Required Battery Discharge Rates and End-of-Discharge Battery Voltage**

Battery Chemistry	Discharge Rate	End-of-Discharge
Valve-Regulated Lead Acid (VRLA)	0.2 C	1.75 volts per cell
Flooded Lead Acid	0.2 C	1.70 volts per cell
Nickel Cadmium (NiCd)	0.2 C	1.0 volts per cell
Nickel Metal Hydride (NiMH)	0.2 C	1.0 volts per cell
Lithium Ion (Li-Ion)	0.2 C	3.0 volts per cell
Rechargeable Alkaline	0.2 C	0.9 volts per cell

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***Authors' comment on end-of-discharge voltages:** The end-of-discharge voltage for flooded lead-acid batteries has been changed to 1.70 volts per cell to conform to IEC 60254-1.*

391

Authors' comment on discharge rates chosen: 0.2 C was chosen because it is referenced in the IEC and BCI test procedures reviewed and because it provides a favorable representation of battery capacity without placing an undue time burden on testing organizations. (One discharge can easily be performed in a workday.)

While standards for some chemistries, such as VRLA, cite discharge rates as low as 0.05C, we believe that a common discharge rate is important to enable fair comparisons between charger-battery systems based on different battery chemistries.

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VII. Charge Mode and Battery Maintenance Mode Test

The Charge/Battery Maintenance mode test measures the energy consumed during one charge and a significant portion of the maintenance cycle of the UUT. Functions required for battery conditioning that happen only with some user selected switch or other control should **not** be included this measurement. Regularly occurring battery conditioning/maintenance functions that are not controlled by the user will, by default, be incorporated into this measurement.

The following steps apply:

- 1) Ensure that the battery(ies) used in this test were rested per provisions of the applicable industry test standard as listed in Section IV, G above.
- 2) Connect the metering equipment to the battery charger.
- 3) Ensure that user-controllable device functionality not associated with battery charging is turned off.
- 4) Record the start time of the measurement period, and begin recording the energy, power, and power factor (if applicable) values associated with the measurement period.
- 5) Connect battery(ies), which have been fully discharged according to section VI of this method, to the battery charger.
- 6) After the battery(ies) are inserted, record initial time, power (W), and (if applicable) power factor.
- 7) At the end of the measurement period, record the final time and power (W) values.

The measurement period shall be 24 hours for all battery-charger systems.

During the measurement period, power values shall be recorded at least every minute. After the measurement period is complete, the average power over the last 4 hours of the test shall be computed to give the average battery maintenance mode power. This average battery maintenance mode power shall be recorded on the test report.

Also, the total energy consumed from the time that the battery is installed to 24 hours after the battery is installed shall be calculated and recorded. For guidance on energy accumulation methods of measurement and calculation, see IEC 62301 Section 5.3.2, b and Annex C.

Authors' comment on 24-hour test length: *This length was chosen in response to stakeholder comment that suggested some battery chargers do not fully charge and enter 4 hours of battery maintenance mode in 16 hours. To maintain consistency among the products tested, 24 hours was chosen for all battery charger types.*

We have not yet tested a product that charges in more than 19 hours and so encourage, in particular, stakeholder comment on this 24-hour test approach.

432

433

VIII. No-Battery Mode Test

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435

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 ac line voltage.

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438

439

Examples include:

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441

- 1) A cordless phone with the handset off of the base unit. The base unit remains connected to ac line voltage. In this case, the battery itself is in the housing of the phone and can be removed from the base station for the no battery mode test.

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443

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- 2) A cordless power tool battery charger, from which the batteries are removed while the charger remains connected to ac line voltage.

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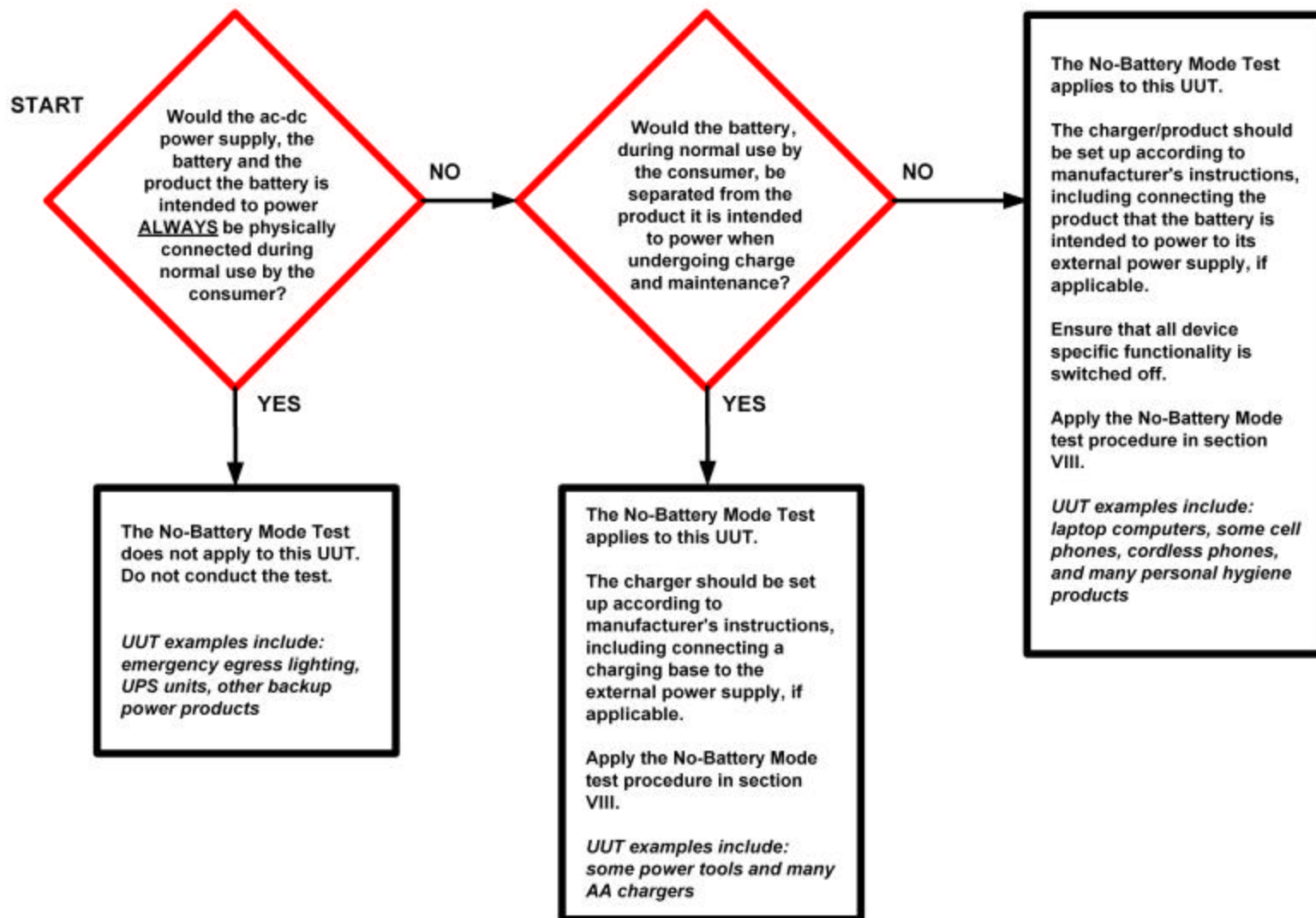
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447

The flowchart on the following page shall be used to determine whether or not the product should be tested in no battery mode, and if so, how the product should be configured.

448

449



Authors' comment on flowchart: *This flowchart was created to simplify the decision of what no-battery mode test, if any, would be appropriate for a particular product.*

451
452 The No-Battery Mode power may be measured in two ways, depending on the stability
453 of the power measurement.

454
455 **A. Where the selected mode is stable**

456 This method may only be used where the mode and measured power are stable, as
457 defined in IEC 62301, Section 5.3.1. The following steps apply:

- 458
459 1) Configure the charger according to the flow chart.
460 2) Conduct testing per IEC 62301, Section 5.3.1.

461
462 **B. All other cases**

463 This method shall be used where either the no-battery mode or measured power is not
464 stable, as defined in IEC 62301, Section 5.3.2. This mode is acceptable for use with
465 stable modes as well, however, and is recommended when the stability of the mode
466 cannot be clearly determined. The following steps apply:

- 467
468 1) Configure the charger according to the flow chart.
469 2) Conduct testing per IEC 62301, Section 5.3.2.

470
471 **IX. Reporting Requirements**

472
473 The following information shall be recorded about each UUT:

474
475 **A. General:**

- 476
477 1) Name of technician performing the test
478 2) Organization performing the test
479 3) Time and date of each test
480 4) Manufacturer and model number of battery charger
481 5) Manufacturer and model number of battery
482 6) Dual functionality of battery charger, if any (see section V for more details)
483 7) Battery chemistry
484 8) Make and model of measurement equipment
485 9) Rated battery voltage (volts)
486 10) Rated battery capacity (milliampere-hours)
487 11) Ac input voltage (volts)
488 12) Ac input frequency (hertz)
489 13) Record of battery conditioning procedure with reference to specific document (if
490 performed)

491
492 **B. Battery Discharge Test:**

- 493
494 1) Energy during discharge (watt-hours)
495 2) Starting battery voltage (volts)
496 3) Ending battery voltage (volts)

497 4) Sample rate used during test

498

499 **C. Charge /Maintenance Mode Test:**

500

501 1) Total accumulated energy over the course of the test (watt-hours)

502 2) Average power during maintenance mode (watts)

503 3) For all appliances with ac power ratings greater than 75 watts (ac), true power
504 factor at beginning of the charge (expressed as a percent)

505 4) Sample rate used during test

506

507 **D. No-Battery Mode Test:**

508

509 1) Average no-battery mode power (watts)

510 2) Sample rate used during test

511 3) Methodology used for test (accumulated energy or average power as per IEC
512 62301 Section 5.3.1 and 5.3.2)

513

Authors' comment on test report information: *We made efforts in this draft to reduce the number of items required on the test report. For example, in the Charge/Maintenance Mode Test, rather than requiring every power and time measurement be reported, we required only that the sample rate, total Charge/Maintenance mode energy, and average Battery Maintenance Mode power be recorded.*

In addition, we place restrictions on when power factor needed to be recorded and added a provision to record any non-battery-charger functionality.