

Submitted for recognition as an American National Standard

**RECOMMENDED PRACTICE FOR PERFORMANCE RATING OF  
 ELECTRIC VEHICLE BATTERY MODULES**

**Foreword**—With the rapid development and deployment of Electric Vehicles, it is important to develop performance standards and guidelines to ensure components utilized in the manufacturing of Electric Vehicles meet requirements needed for vehicle operations.

The mission of this document as an SAE Recommended Practice is to provide direction for standardization of methods and techniques to verify and determine performance characteristics of the standard Electric Vehicle battery modules, as described in SAE J1797 or manufacturer's specifications. This document will provide industry the opportunity to establish and maintain performance standards to meet vehicle requirements. It is intended that the test procedures provide guidance for battery manufacturers, test facilities, and vehicle manufacturers to assess module performance with the same testing platform. This document is a menu for recommended tests that may be run as required for comparative measurements. It is understood that all module chemistries may not be used at the temperatures specified in any given procedure.

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**1. Scope**—This SAE Recommended Practice provides for common test and verification methods to determine Electric Vehicle battery module performance. The document creates the necessary performance standards to determine (a) what the basic performance of EV battery modules is; and (b) whether battery modules meet minimum performance specification established by vehicle manufacturers or other purchasers. Specific values for these minimum performance specifications are not a part of this document.

**1.1 Field of Application**—Electric Vehicles.

**1.2 Product Classification**—Electrochemical Storage Devices.

**1.3 Form**—An Electric Vehicle propulsion battery will consist of a battery configuration of several (typically 12 V) modules interconnected in one or more series strings. This document provides test methods to determine performance of such modules, including but not limited to modules built in accordance with SAE J1797. Use of this document is intended for independently packaged modules operating at ambient temperature. Testing of a fully configured propulsion battery system, or battery subsystems designed to operate at elevated temperatures, is expected to require additional testing methods beyond those included in this document.

**2. References**

**2.1 Applicable Publications**—The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1715—Electric Vehicle Terminology

SAE J1797—Recommended Practice for Packaging of Electric Vehicle Battery Modules

2.1.2 OTHER PUBLICATIONS

United States Advanced Battery Consortium Electric Vehicle Battery Test Procedures Manual, Revision 2,  
Published January 1996

**2.2 Related Publications**—The following publications are provided for information purposes only and are not a required part of this document.

SAE TSB 001—SAE Technical Standards Board Rules and Regulations  
SAE TSB 002—SAE Preparation of SAE Technical Reports  
SAE J1115—Guidelines for Developing and Revising SAE Nomenclature and Definitions  
SAE Report—Format Guidelines for Electronic Capture of SAE Documents  
SAE Committee Guidelines Manuals

**3. Definitions**—See SAE J1715 for most definitions. The following are not currently in SAE J1715 but may be added to a later date:

**3.1 C<sub>1</sub>/1**—The constant current required to discharge modules in 1 h at 25 °C.

**3.2 C<sub>2</sub>/2**—The constant current required to discharge modules in 2 h at 25 °C.

**3.3 C<sub>3</sub>/3**—The constant current required to discharge modules in 3 h at 25 °C.

**3.4 P<sub>1</sub>/1**—The constant power required to discharge modules in 1 h at 25 °C.

**3.5 P<sub>2</sub>/2**—The constant power required to discharge modules in 2 h at 25 °C.

**3.6 P<sub>3</sub>/3**—The constant power required to discharge modules in 3 h at 25 °C.

**4. Battery Module Selection**—If battery modules are constructed to SAE J1797 or other requirements as defined by vehicle manufacturer, they should first be determined to comply with the physical requirements of SAE J1797 or other vehicle specification, including dimensions, open circuit voltage, mass, and terminations. If the measured performance is to be used to establish or verify battery ratings, modules selected for testing should be representative of those to be manufactured and delivered to the market.

**5. Test Conditions**

**5.1 Test Samples**—The number of test samples required to be subjected to each test condition for each test in this document will be determined by the vehicle manufacturer or other entity requesting tests. A single battery tested does not assure that any production quantity of modules will meet the tested values obtained. Reporting  $-1.28$  standard deviation values from a statistical sample size of 23 modules will give assurance of 90% conformance, but it is not the intention to propose that any or all variations of the tests in this document be run on such a large sample size.

**5.2 Test Temperature**—Testing shall be performed at a controlled ambient temperature of 25 °C unless otherwise specified within this document. Measured module temperatures shall fall within this range at the start of discharge except for tests specifically required to be performed at other temperatures. This may require cooling to be applied to reduce the time between the end of a charge or discharge and the beginning of the next charge or discharge. If required, cooling shall be applied using the manufacturer's recommended temperature control means, which shall specify the required coolant flow rates, heat transfer properties, etc. All temperatures have a  $\pm 2$  °C tolerance. Designation of both the cooling method and soak time are to be reported in Appendix A.

- 5.3 Temperature Sensing Locations**—A minimum of one ambient temperature measurement and one temperature measurement per module, insulated from ambient environment, is recommended. Different battery manufacturers may recommend specific locations for temperature sensing such as the center of the case side wall, one of the terminals, or the center of the end wall. As a default, use the center of the side wall. Placement in any of these locations should not affect the results as long as the device is not exposed to external conditions that may skew the readings. The terminal location on a module may require precautions to ensure there is no shock hazard. Designation of the temperature sense location should be reported in Appendix A.
- 5.4 Data Recording**—Data recording should include time, temperature, voltage, current, visual observations, and profiles of any data generated by vibration or shock. Data should include a record of any maintenance performed on module during test sequence.
- 5.5 Sampling Frequency**—All parameters should be measured and stored at a sample rate adequate to ensure that all relevant changes in the parameters are recorded for later data analysis. Additionally, for tests involving short-term transient conditions (e.g., peak power measurement) both the sampling frequency (typically once per second) and the time skew between corresponding current and voltage measurements (typically 0.1 s or less) are important during the critical test periods.
- 5.6 Measurement Accuracy**—The equipment should be able to meet the requirements in Table 1:

**TABLE 1—MEASUREMENT ACCURACY**

Parameter	Accuracy
Voltage	<1% of Reading
Current	<1% of Reading
Temperature	±1.0 °C

Additionally, the combination of accuracy and sampling rate should be adequate to assure that important derived parameters, including accumulated ampere-hours and kilowatt-hours, can be determined within ±3%.

NOTE—Voltage sense leads should be located as close to the terminals as possible to avoid any ambiguous readings due to resistance, noise, or other sources for error.

- 5.7 Module Inspection**—All modules should be visually inspected to ensure that no damage has occurred to test modules during shipping or other handling. The individual weight and volume of each module should be measured and recorded prior to testing for a baseline. These measurements may be used to calculate power levels or other criteria in test procedures defined later in this document.
- 5.8 Module Conditioning**—Module(s) should be conditioned in accordance with manufacturer's specifications prior to performing the following tests. However, this is not intended to cycle the module a significant portion of its life so a maximum of 10 cycles is recommended. Peak values for a given test may require a significant number of cycles to be run prior to running a given test. This is to be done per the battery manufacturer's recommendations and is to be recorded in Appendix A as PEAK performance.
- 5.9 Data Reporting**—Appendix A is a report template of the expected output from the tests performed. This is to be used as a guide from which vehicle manufacturers may choose specific tests and derive information.

## 6. Module Performance

### 6.1 Static Capacity Test (Constant Current Method)

6.1.1 PURPOSE—The purpose of this test is to establish the ampere hour and energy capacity provided at various discharge rates and temperatures as appropriate to establish vehicle application usage. This may be used as an application screening test to establish a need for sizing thermal management systems and energy performance. These tests may also verify performance as stated by the manufacturer, therefore 100% discharge is run to a voltage cutoff for these tests not just to rated capacity.

The capacity and energy at  $C_3/3$  at 25 °C are the recommended values for ratings of battery types. In the industry, terms such as specific energy and energy density should use this test procedure to validate the values derived. These tests correspond to the USABC test procedures (see 2.1.2 for reference).

#### 6.1.2 TEST SEQUENCE

6.1.2.1 The battery manufacturer is to define the  $C_1/1$ ,  $C_2/2$ , and  $C_3/3$  rates at 25 °C. Since these tests are comparative, the discharge rates are not changed for other discharge temperatures. For example, if  $C_1/1$  is defined at 70 A at 25 °C then this rate is to be run at any temperature.

6.1.2.2 Module(s) should be discharged at the  $C_3/3$  rate until a voltage, temperature, or other discharge limit (cutoff) is reached as specified by module manufacturer. The beginning of discharge must be at the test temperature, for initial testing the test temperature is 25 °C. The discharge temperature may be changed as described later in this procedure.

6.1.2.3 Since the discharge portion of this test may be run at temperatures other than 25 °C, place the discharged module(s) in a controlled temperature of 25 °C and allow module(s) temperature to stabilize to this value for three consecutive 1 h readings. For test temperatures at 25°C, the 3 h wait is not necessary.

6.1.2.4 When module(s) temperature has stabilized in accordance with 6.1.2.3, module(s) shall be fully charged in accordance with manufacturer's specification requirements.

6.1.2.5 Open circuit time periods between charge and discharge will be determined by module and vehicle manufacturers. This time may be dictated by the designation that the beginning of discharge temperature is defined for these tests. At 25 °C, the open circuit time may be short while at other temperatures a minimum soak of 16 h is recommended.

6.1.2.6 Repeat test sequence (6.1.2.2 through 6.1.2.5) for a minimum number of cycles determined by vehicle manufacturer, or until the measured capacity is repeatable to within 2% for three consecutive cycles.

6.1.2.7 Repeat test sequence (6.1.2.2 through 6.1.2.6), using discharge rates of  $C_1/1$  and  $C_2/2$ .

NOTE— The discharge limits specified by the manufacturer may be different for different discharge rates.

6.1.2.8 This section may be required at the discretion of the vehicle manufacturer since the temperatures chosen may not be appropriate for a given module chemistry or vehicle system that is managed thermally. Repeat test sequence (6.1.2.2 through 6.1.2.7) using the test discharge temperatures of 45 °C, 0 °C and -20 °C. To ensure the module is at temperature, the module should be soaked at the test temperature at least 16 h prior to discharge.

## 6.2 Static Capacity Test (Constant Power Method)

6.2.1 PURPOSE—The purpose of this test is to establish the ampere hour and energy capacity provided at various discharge rates and temperatures as appropriate to establish vehicle application usage. This may be used as an application screening test to establish a need for sizing thermal management systems and energy performance. These tests may also verify performance as stated by the manufacturer, therefore 100% discharge is run to a voltage cutoff for these tests not just to rated capacity. These tests correspond to the USABC test procedures (see 2.1.2 for reference).

### 6.2.2 TEST SEQUENCE

6.2.2.1 The battery manufacturer is to define the  $P_1/1$ ,  $P_2/2$ , and  $P_3/3$  rates at 25 °C. Since these tests are comparative, the discharge rates are not changed for other discharge temperatures. For example, if  $P_1/1$  is defined at 800 W at 25 °C then this rate is to be run at any temperature.

6.2.2.2 Module(s) should be discharged at the  $P_3/3$  rate until a voltage, temperature, or other discharge limit (cutoff) is reached as specified by module manufacturer. The beginning of discharge must be at the test temperature, for initial testing the test temperature is 25 °C. The discharge temperature may be changed as described later in this procedure.

6.2.2.3 Since the discharge portion of this test may be run at temperatures other than 25 °C, place the discharged module(s) in a controlled temperature of 25 °C and allow module(s) temperature to stabilize to this value for three consecutive 1-h readings. For test temperatures at 25 °C, the 3 h wait is not necessary.

6.2.2.4 When the module(s) temperature has stabilized in accordance with 6.2.2.3, module(s) shall be fully charged in accordance with manufacturer's specification requirements.

6.2.2.5 Open circuit time periods between charge and discharge will be determined by module and vehicle manufacturers. This time may be dictated by the designation that the beginning of discharge temperature is defined for these tests. At 25 °C, the open circuit time may be short while at other temperatures a minimum soak of 16 h is recommended.

6.2.2.6 Repeat test sequence (6.1.2.2 through 6.1.2.5) for a minimum number of cycles determined by vehicle manufacturer, or until the measured capacity is repeatable to within 2% for three consecutive cycles.

6.2.2.7 Repeat test sequence (6.1.2.2 through 6.1.2.6), using discharge rates of  $P_1/1$  and  $P_2/2$ .

NOTE— The discharge limits specified by the manufacturer may be different for different discharge rates.

6.2.2.8 This section may be required at the discretion of the vehicle manufacturer since the temperatures chosen may not be appropriate for a given module chemistry or vehicle system that is managed thermally. Repeat test sequence (6.2.2.2 through 6.2.2.7) using the test discharge temperatures of 45 °C, 0 °C, and -20 °C. To ensure the module is at temperature, the module should be soaked at the test temperature at least 16 h prior to discharge.

## 6.3 Charge Retention

6.3.1 PURPOSE—The purpose of this test is to establish storage characteristics of a module(s) after recharge, i.e., stand loss, for the specific module technology and design. The tests may be run in parallel by using multiple modules with different stand times or temperatures. The test is not considered catastrophic, therefore modules may be repetitively used for different portions of this procedure. This procedure is expected to be run at both 25 °C and 45 °C for baseline charge retention. These tests correspond to the USABC test procedures for stand test (see 2.1.2 for reference) with recommended temperatures different than suggested in the USABC document.

### 6.3.2 TEST SEQUENCE

6.3.2.1 Discharge the module(s) at the  $C_3/3$  at 25 °C. Discharge each module until temperature, voltage, or other termination (cutoff) limit is reached as specified by the manufacturer.

6.3.2.2 Charge the modules at 25 °C in accordance with manufacturer's recommended procedures.

6.3.2.3 Allow module(s) to stand in an open-circuit condition at 25 °C. The module(s) will be removed and discharged at the  $C_3/3$  rate after 2 days, 14 days, and 30 days of storage. Discharge each module until temperature, voltage, or other termination (cutoff) limit is reached as specified by the manufacturer.

NOTE— Care should be taken to assure that measurement devices or other potential sources of parasitic loads are disconnected during the stand period.

6.3.2.4 Charge each module at 25 °C in accordance with the manufacturer's recommendations.

6.3.2.5 Repeat test sequence (6.3.2.1 through 6.3.2.4), using a storage temperature of 45 °C. Charge and discharge sequence will remain at 25 °C and  $C_3/3$ , therefore, the module(s) must soak at 25 °C for a minimum of 16 h prior to testing. This 16-h period is in addition to the stand time at a given temperature.

### 6.4 Charge Acceptance Tests

6.4.1 PURPOSE—The purpose of this test sequence is to establish how readily the module will accept charge at various temperatures. This is not a transient test to determine initial acceptance but a complete charge acceptance test. This allows the vehicle manufacturer to estimate requirements for vehicle charger systems and thermal management requirements. The vehicle manufacturer will determine the number of modules required for each time interval and temperature. It is understood that there are a wide variety of charge methods defined by different module manufacturers. This procedure does not dictate the charge at different temperatures and must be specified by the module manufacturer and recorded as part of the test documentation.

#### 6.4.2 PROCEDURE

6.4.2.1 Discharge modules at the  $C_3/3$  rate at 25 °C in accordance with manufacturer's recommended procedures.

6.4.2.2 Place the module(s) in a temperature-controlled environment set at the test temperature and allow the module temperature to stabilize for three consecutive 1-h temperature recordings. The beginning of charge must be at the test temperature, for initial testing the test temperature is 25 °C.

6.4.2.3 Charge the module(s) at the manufacturer's recommended rate until module(s) reach specified cutoff value established by module and vehicle manufacturers.

6.4.2.4 When charge is completed, remove modules from temperature and allow to stand open circuit at 25 °C until module(s) temperature stabilizes at 25 °C.

6.4.2.5 Module(s) should be discharged at the  $C_3/3$  rate, based on manufacturer's rated capacity, until a voltage, temperature, or other discharge limit (cutoff) is reached as specified by module manufacturer.

6.4.2.6 Charge at 25 °C per manufacturer recommended procedures.

6.4.2.7 Repeat test sequence (6.4.2.1 through 6.4.2.6), using test temperatures of 45 °C, 0 °C, and -20 °C using the manufacturer's recommended procedures at these temperatures.

## 6.5 Peak Power Capability Test

6.5.1 PURPOSE—The purpose of this test is to determine the ability of a battery module to deliver sustained power for 30 s over its useable discharge capacity. In contrast to 6.6, this test does not actually load the module to its peak power capability. Instead, it uses a series of 30-s high current steps at 10% depth-of-discharge intervals within the normal operating range of the module. Test results are then extrapolated to the peak power capability based on module resistance characteristics under load. It is understood that most expected peak power usage is transient but to sustain an acceleration on an uphill grade may require significant time intervals (30 s or more) therefore this procedure uses the 30-s voltage. These tests correspond to the USABC test procedures for peak power (see 2.1.2 for reference) with modifications made to accommodate the relaxation time required for modules to recover from the high current pulses before proceeding with the low current steps.

NOTE—The test is designed to give information indicative to that expected while running a power drive cycle, therefore, for this test, the rated capacity is the expected DCT capacity (see 6.6) not the Static Capacity (see 6.1) C<sub>3</sub> capacity.

### 6.5.2 TEST SEQUENCE

6.5.2.1 Charge the module in accordance with the manufacturer's recommendations, and allow the module to rest until the test temperature is reached. It is expected that open circuit on this step to be less than 24 h.

6.5.2.2 Determine the High Test Current for the module as the lessor of:

- a. The maximum rated current for the battery or
- b. 80% of the module's rated peak power divided by 2/3 open circuit voltage at 80% depth-of-discharge

6.5.2.3 Determine the Base Discharge Current for the module as: that current which, when combined with the High Test Current, gives an average discharge current corresponding to an average 3-h discharge rate. This can be calculated as follows in Equation 1:

$$\text{Base Discharge Current} = \frac{(12 \cdot \text{A h Capacity} - \text{High Test Current})}{2 \cdot (17.5 - \text{rest time})} \quad (\text{Eq. 1})$$

where:

The rest time is described in 6.5.2.5. The rest time units are in minutes.

EXAMPLE—If the module is rated at 60 A h and the High Test Current is to be 300 A, then the Base Discharge Current will be 12 A.

6.5.2.4 Discharge the module for 30 s at the Base Discharge Current, and then perform 30-s discharge step at the High Rate Current.

6.5.2.5 Since the voltage limit at High Rate Current is expected to be lower than the voltage limit at the base discharge current, rest the module for a period not to exceed 5 min for the voltage to recover. One minute is recommended.

6.5.2.6 Continue to discharge the module to 90% depth-of-discharge (based on rated capacity) at the Base Discharge Current, interrupting the discharge at 10% intervals to perform a 30-s discharge step at the High Test Current. To determine the peak power, no rest is acceptable during this part of the test, only after the high rate as stated in 6.5.2.5.

NOTE— The same Base Discharge and High Test Current values are normally used throughout the discharge. However, if the module is unable to sustain the High Test Current at any point in the discharge without dropping below the manufacturer's minimum voltage limit, the High Test Current must be reduced as necessary to sustain this minimum voltage. If the test equipment used is incapable of making this current adjustment dynamically, the test may have to be repeated with a lower High Test Current.

6.5.2.7 Terminate the discharge when any of the following conditions occur:

- a. Discharge to 100% of the rated capacity is completed.
- b. The Base Discharge Current cannot be sustained without dropping below the minimum voltage limit.

6.5.2.8 At each depth-of-discharge for which peak power capability is to be determined, calculate it based on the measured currents and voltages immediately before (i.e.,  $I_1$ ,  $V_1$ ) and near the end (i.e.,  $I_2$ ,  $V_2$ ) of the 30-s current step as shown in Figure 1.

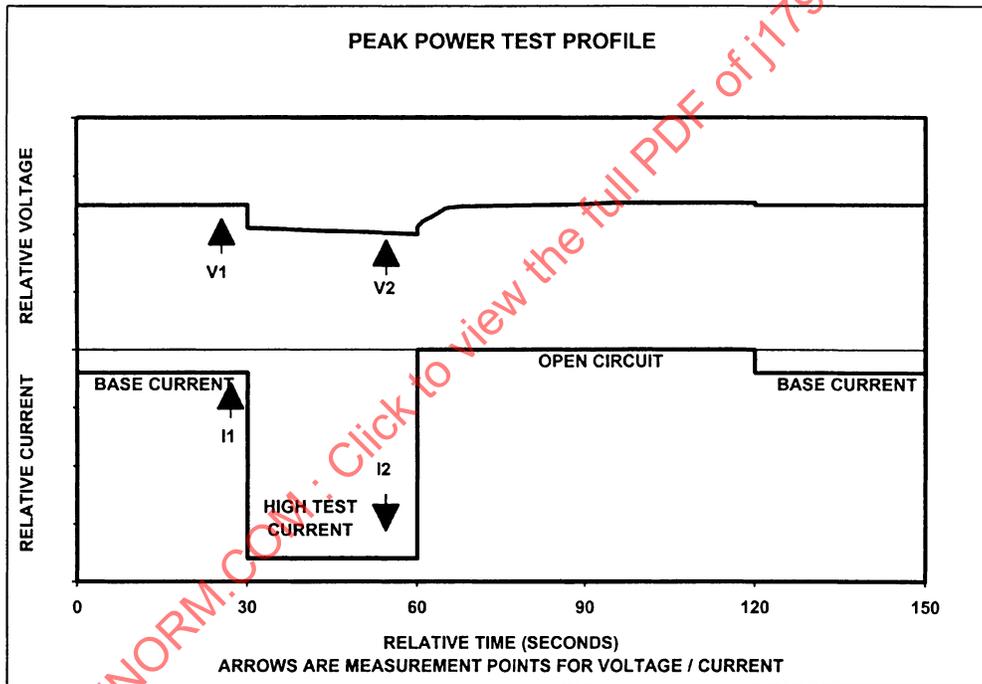


FIGURE 1—PEAK POWER TEST PROFILE

NOTE— Note that current and power out of the battery must be considered to have a negative sign in Equations 2 through 5.

Effective Resistance:

$$R = \Delta V \div \Delta I = (V_1 - V_2) \div (I_1 - I_2) \quad (\text{Eq. 2})$$

Effective Open Circuit Voltage:

$$V_{ocv} = V_2 - (I_2 \cdot R) \quad (\text{Eq. 3})$$

$$I_{peak} \text{ at } 2/3 V_{ocv} \text{ by Ohms law} = \text{polarization } (-1/3V_{ocv}) \div R \quad (\text{Eq. 4})$$

$$\text{Peak Power Capability} = \frac{2}{3} V_{ocv} \cdot I_{peak} \quad (\text{Eq. 5})$$

$$\text{substituting } I_{peak} \Rightarrow -\frac{2}{9} V_{ocv}^2 \div R$$

If this calculated peak power capability exceeds that which is physically possible at the manufacturer's maximum rated current, i.e., if it is larger than  $I_{max} \cdot (V_{ocv} + R \cdot I_{max})$ , then this lower value must be used instead. Values at other voltages or time intervals may be determined from the data gathered but are not a part of this procedure.

## 6.6 Dynamic Capacity Test

- 6.6.1 PURPOSE—This test is intended to measure the capacity of a battery module under dynamic discharge conditions similar to those which are imposed on electric vehicles in urban driving conditions. This dynamic cycle is scaled to a percentage of the rated or specified maximum power for the module to be tested. The scaled power level to be used by this procedure must be specified (in watts or kilowatts) as an input to this procedure (see 6.6.4). This test incorporates significant levels of instantaneous charging power (i.e., regeneration) during the test profile.
- 6.6.2 TEST PROFILES—Figure 2 shows a graphical representation of the 360-s test profile, which is applied repetitively over a complete module discharge. Table 2 is the tabular listing of the discharge power profile.

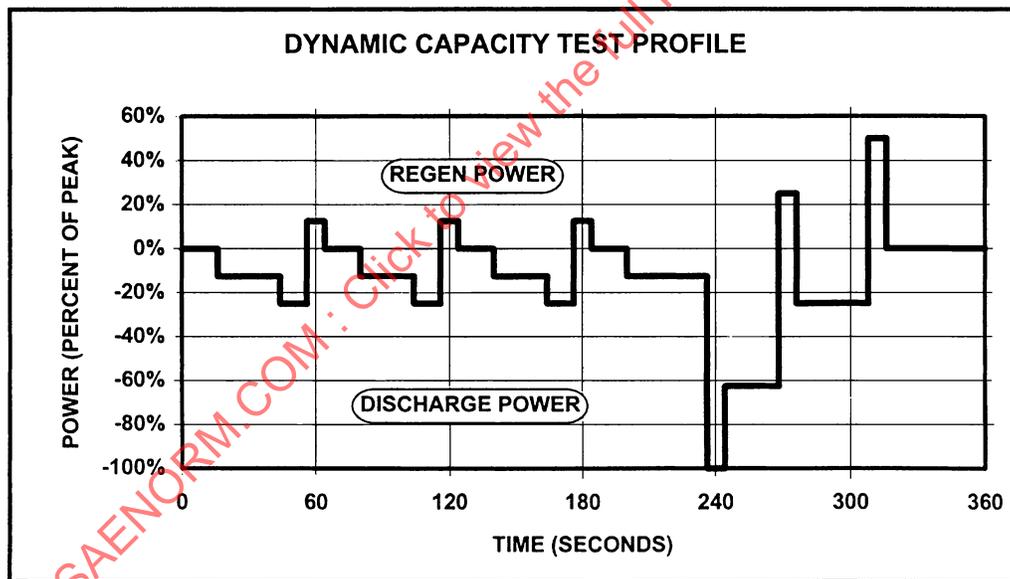


FIGURE 2—POWER PROFILE TABULAR LISTING

TABLE 2—POWER PROFILE TABULAR LISTING

Step No.	Duration (s)	Discharge Power (%)	Step No.	Duration (s)	Discharge Power (%)
1	16	0.0	11	12	-25.0
2	28	-12.5	12	8	+12.5
3	12	-25.0	13	16	0.0
4	8	+12.5	14	36	-12.5
5	16	0.0	15	8	-100.0
6	24	-12.5	16	24	-62.5
7	12	-25.0	17	8	+25.0
8	8	+12.5	18	32	-25.0
9	16	0.0	19	8	+50.0
10	24	-12.5	20	44	0.0

This procedure uses the time and power levels of the USABC Dynamic Stress Test (DST) for some chemistries but is in fact a different test. Particularly, this test does not terminate the discharge during step 15 as with DST. The reduced power point is necessary for some manufacturers and was originally in the DST procedure. Since this procedure uses the DST timing it does not correspond directly with SFUDS testing.

- 6.6.3 TEST EQUIPMENT REQUIREMENTS—The charge-discharge tester used for this test must be capable of achieving the scaled power-time profile shown in Figure 2 with a maximum transition time between power steps of 1 s or less. These transition times are included in the overall power profile length (i.e., a test profile is always 360 s long).
- 6.6.4 TEST SCALING—The maximum power level for this test should be set to a value specified by Table 3, based on the battery module technology type to be tested. If the value specified cannot be achieved by a particular test sample, the maximum power value should be set to 80% of the rated peak power of the module at 80% depth-of-discharge. Reporting of the Dynamic Capacity Test results must specify the peak power level (W/kg) that was used.

TABLE 3—MAXIMUM POWER LEVEL LISTING

Battery Technology Type	Maximum Power (W/kg)
Lead-Acid Modules	80 or 120
Nickel-Cadmium and Other Alkaline Ambient-Temperature Modules	120
Flow Modules, Limited-Power Modules	60
Advanced Modules	120

There has been much discussion as to the proper power levels for different chemistries. Use of different levels for lead acid and limited power batteries is favorable to these chemistries, while on an energy basis the peak powers are comparable between chemistries (e.g., a 20-kWh nickel cadmium battery pack will have to deliver 1.5 the W/kg of the same 20 kWh lead-acid battery pack in an application).

- 6.6.5 TEST POWER DETERMINATION—The maximum power level specified in Table 3 is the 100% level shown in Figure 2, which occurs in Step 15 of Table 2. The power levels for the remaining steps are then calculated using the percentage values shown in Table 2.

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- 6.6.6 REDUCED POWER LIMIT—The reduced power limit for Step 15 of the test profile is 5/8 of the maximum power (i.e., 0.625 times the nominal value determined for this step).
- 6.6.7 MODULE LIMITS—Module limits to be observed during the test will normally consist of some set of capacity, voltage, current, power, and/or temperature limits which should not be exceeded for the modules.
- 6.6.8 PROCEDURE
- 6.6.8.1 *Open Circuit After Charge*—With the module on open circuit, stabilize the module temperature and other initial conditions as required. The start of discharge is to be at the test temperature; unless otherwise specified this temperature is 25 °C.
- 6.6.8.2 *Discharge*—Discharge the module using the test power profile. Repeat the 360-s segments end-to-end (i.e., with no rest period between profiles) until a termination condition is reached. If the maximum power step (Step 15) cannot be performed without exceeding the module voltage limit or other limits, reduce the power for this step to stay within the module limits.
- 6.6.8.3 *Discharge Termination*—The discharge terminates when any of the following conditions is reached:
- The power achievable (within the module limits) on Step 15 is less than the reduced power limit, i.e., 5/8 of the specified power for Step 15, or
  - The power achievable on any other step (within the module limits) is less than the specified value for that step, or
  - When the module falls below the minimum voltage recommended by the manufacturer, or
  - When 100% of rated capacity has been removed from the module
- 6.6.8.4 Charge the module(s) at 25 °C in accordance with manufacturer's recommended procedures.
- 6.6.8.5 Repeat test sequence (6.6.8.1 through 6.6.8.4) for a minimum number of cycles determined by vehicle manufacturer, or until the measured capacity is repeatable to within 2% for three consecutive cycles. Since the purpose of this test is to determine capacity and not cycling, the maximum number of cycles recommended is 10.

PREPARED BY THE SAE ELECTRIC VEHICLE BATTERY SYSTEM STANDARDS COMMITTEE