



---

**APPLICATION  
MANUAL**

---

SEVENTH EDITION

*Genesis™ Purelead  
XE and EP*





## Preface to the Seventh Edition

This edition of the Genesis™ application manual has been necessitated by several factors. First is to introduce the Genesis XE range of batteries, packaged to offer the same superior performance characteristics of the Genesis EP battery in more physically demanding applications such as high temperature and high vibration environments.

Appendix A offers exhaustive constant current (CC) and constant power (CP) performance data and graphs for the full range of Genesis XE batteries to several end voltages. Appendix B offers the same information for the EP series.

Chapter 4 is new to this edition. It offers guidelines on the installation, operation and maintenance of Genesis batteries, with the goal of maximizing performance and service life.

Finally, new and updated test data have been included throughout the text, wherever available and deemed appropriate.

## TABLE OF CONTENTS

|   |       |
|---|-------|
| <b>Preface to the Seventh Edition</b>                         | 2     |
| <b>Chapter 1: Introducing the Genesis Battery</b>             | 3     |
| 1.1 Background  | 3     |
| 1.2 Transportation classification                             | 3     |
| 1.3 UL component recognition                                  | 3     |
| 1.4 Non-halogenated plastics                                  | 3     |
| 1.5 Key Genesis benefits                                      | 3     |
| <b>Chapter 2: Technical Information</b>                       | 4     |
| 2.1 Introduction  | 4     |
| 2.2 Choosing the right Genesis version                        | 4     |
| 2.3 Battery life  | 4     |
| 2.4 Constant-power and constant-current discharge performance | 5     |
| 2.5 Charging characteristics & requirements                   | 6     |
| 2.6 Constant-voltage (CV) regime                              | 7     |
| 2.7 Constant-current (CC) regime                              | 7     |
| 2.8 Three-step (IUU) charge profile                           | 8     |
| 2.9 Storage characteristics                                   | 9     |
| 2.10 Self discharge   | 9     |
| 2.11 Open circuit voltage (OCV) and state of charge (SOC)     | 10    |
| 2.12 Procedure to recover overdischarged batteries            | 10    |
| <b>Chapter 3: General Test Data</b>                           | 11    |
| 3.1 Introduction  | 11    |
| 3.2 Thermal runaway test                                      | 11    |
| 3.3 Gassing test  | 11    |
| 3.4 DIN standard overdischarge recovery test                  | 12    |
| 3.5 High temperature storage recovery test                    | 12    |
| 3.6 Altitude test   | 12    |
| 3.7 Accelerated float life test                               | 12    |
| 3.8 Performance test at different temperatures                | 13    |
| <b>Chapter 4: Installation, Operation &amp; Maintenance</b>   | 13    |
| 4.1 Introduction  | 13    |
| 4.2 Receiving the shipment                                    | 13    |
| 4.3 Storage   | 13    |
| 4.4 Installation  | 13    |
| 4.4.1 Temperature   | 14    |
| 4.4.2 Ventilation   | 14    |
| 4.4.3 Security  | 14    |
| 4.4.4 Mounting  | 14    |
| 4.4.5 Torque  | 14    |
| 4.5 Parallel strings  | 14    |
| 4.6 Discharging   | 14    |
| <b>Appendix A: Genesis XE Discharge Characteristics</b>       | 15-24 |
| <b>Appendix B: Genesis EP Discharge Characteristics</b>       | 25-31 |

## Chapter 1: Introducing the Genesis Battery

### 1.1 Background

Since its introduction in the early 1990s, the Genesis thin plate pure lead-tin (TPPL) battery has established itself as a premium high performance battery suitable for a wide range of demanding applications. Today, TPPL technology can be found in applications as diverse as emergency power, avionics, medical, military and consumer equipment.

The Genesis TPPL battery is offered in either the EP or XE version, and Table 2.2.1 shows the differences between the two versions.

### 1.2 Transportation classification

Effective September 30, 1995, Genesis batteries were classified as "nonspillable batteries", and are excepted from the Department of Transportation's comprehensive packaging requirements if the following conditions are satisfied: <sup>(1)</sup>The battery is protected against short circuits and is securely packaged and <sup>(2)</sup>The battery and outer packaging must be plainly and durably marked "NONSPILLABLE" or "NONSPILLABLE BATTERY". Genesis shipments from the Warrensburg location, will be properly labeled in accordance with applicable regulations. **Packaging changes performed at other locations may require additional labeling, since in addition to the battery itself containing the required marking, the outer packaging of the battery must also contain the required marking: "NONSPILLABLE" or "NONSPILLABLE BATTERY".**

Genesis batteries have been tested and determined to be in compliance with the vibration and pressure differential tests contained in 49 CFR § 173.159(d).

Because Genesis batteries are classified as "Nonspillable" and meet the conditions above, [from § 173.159(d)] they do not have an assigned UN number nor do they require additional DOT hazard labeling.

### 1.3 UL component recognition

All Genesis batteries are recognized as UL components.

### 1.4 Non-halogenated plastics

As the world becomes more environmentally aware, EnerSys is striving to provide the most environmentally friendly products possible. With this in mind, we are proud to say that the plastics used in our Genesis product line are non-halogenated and therefore do not contain any of the following materials:

- Polybrominated biphenyls (PBB)
- Polybrominated biphenyl ethers (PBBE)
- Polybrominated biphenyloxides (PBBO)
- Polybrominated diphenyl ethers (PBDPE)
- Polybrominated diphenyl oxides (PBDPO)
- Tetrabromobisphenol-A (TBBA)
- Deca-bromo biphenyl ethers (DBBPE's).

The battery meets the non-halogenated flame retardancy requirements of UL 94V-0 by using plastics with non-halogenated flame retardants. Finally, the plastic material used in the manufacturing of Genesis batteries is in full compliance with the German Dioxin Ordinance of 1994.

### 1.5 Key Genesis benefits

Table 1.5.1 lists some of this battery's features and benefits. The Genesis battery is well suited for any application - high rate, low rate, float or deep discharge cycling.

**Table 1.5.1: Key features and benefits of the Genesis battery**

| Feature   | Benefit  |
|---|--|
| High volumetric and gravimetric power densities | More power in less space and weight  |
| Thin-plate design                               | Superior high rate discharge capability  |
| Low internal resistance                         | Flatter voltage profile under high-rate discharge; excellent low temperature performance <sup>1</sup>          |
| Negligible gassing under normal charge          | Safe for use in human environments such as offices and hospitals. Must be installed in non-gastight enclosures |
| 100% maintenance-free terminals                 | True fit-and-forget battery  |
| Flexible mounting orientation                   | Battery may be installed in any position except inverted   |
| Rugged construction                             | Tolerant of high shock and vibration environments, especially the XE version                                   |
| Advanced manufacturing techniques               | High reliability and consistency   |
| Very high purity lead-tin grid                  | Lower corrosion rates and longer life  |
| Non-halogenated flame retardant case and cover  | Meets UL 94 V-0 requirement, with an LOI >28%  |
| Excellent high-rate recharge capability         | Allows >90% recharge in under an hour  |
| Low self-discharge                              | Longest shelf life among VRLA batteries (2 years at 25°C or 77°F)  |
| Wide operating temperature                      | -40°C (-40°F) to +80°C (176°F) <sup>2</sup>  |

<sup>1</sup> See Table 2.4.1 and Figure 2.4.1 in Section 2.4 of Chapter 2

<sup>2</sup> The XE version of the Genesis battery may be used at 80°C (176°F) when fitted with a metal jacket

## Chapter 2: Technical Information

### 2.1 Introduction

This section is at the heart of this manual. Because of the wide variety of data and information included in this chapter, it is divided into smaller, self-contained sections, allowing the reader to locate specific information in the quickest possible time.

### 2.2 Choosing the right Genesis version

As mentioned before, the Genesis pure lead-tin battery is available in EP and XE versions. The EP battery is adequate under most operating conditions. Special application situations such as high ambient temperature or high shock and vibration require the XE version.

Table 2.2.1 summarizes the differences between the two versions and is designed to help you choose the right version for your application. In this table, the differences are highlighted in **red boldfaced**.

Table 2.2.1: Choosing the right Genesis version

| Feature                                       | Genesis EP   | Genesis XE  |
|---|--|---|
| Technology                                    | Pure lead-tin absorbed glass mat (AGM)   |   |
| Float life @ 2.27 volts per cell (Vpc) charge | 10 years @ 25°C (77°F)   | N/A   |
| Cycle life                                    | 400 to 80% depth of discharge (DOD)  |   |
| Shock & vibration tolerance                   | Good   | <b>Better</b>   |
| Operating temperature range                   | • -40°C to +45°C (-40°F to 113°F)<br>• -40°C to +60°C (-40°F to 140°F) with metal jacket (denoted EPX) | • -40°C to +45°C (-40°F to 113°F)<br><b>• -40°C to +80°C (-40°F to 176°F) with metal jacket (denoted XEX)</b> |
| Shelf life @ 25°C (77°F)                      | 2 years from 100% charged down to 12V per block  |   |
| Capacity @ 10-hr. rate                        | 100% (reference)   | ≈ 95%   |
| Weight  | 100% (reference)   | ≈ 105%  |
| Dimensions                                    | Same footprint   |   |
| Quick charge                                  | 6C to 8C charge acceptance at room temperature   |   |
| Overdischarge abuse tolerance                 | Exceeds DIN standard for overdischarge recovery  |   |
| High-rate discharge                           | 100% (reference)   | ≈ 95%   |
| Flame retardant rating                        | V-0 rated case and cover   |   |
| Case & cover color                            | Black  | Orange  |
| Shipping                                      | Air shippable with no restrictions   |   |

### 2.3 Battery life

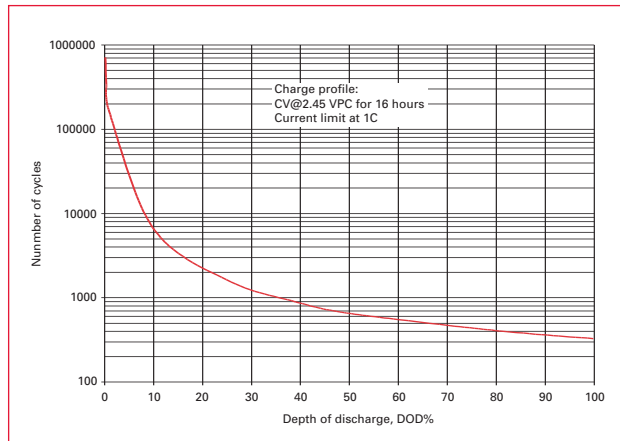
The life expectancy of a Genesis battery depends on the specific application. It is expressed in terms of either cycles or years. While life in years is self-explanatory, a cycle refers to a sequence in which a charged battery is discharged and then charged back up. One complete sequence constitutes one cycle. In general, if the battery is to be discharged frequently, cycle life rather than calendar life is more relevant. On the other hand, if the battery is to be used primarily as power backup, calendar life of the battery should be considered.

In situations where one is not quite sure whether the application is cyclic or standby (float), the following criteria may be used to determine the application category:

- If the **average** time on charge between two successive discharges is thirty (30) days, the application may be considered to be of a standby (float) nature.
- The **minimum** time between two successive discharges must not be less than fourteen (14) days.

If either of these two criteria is not satisfied, the application should be considered cyclic.

While several factors affect the life of a battery, cycle life depends primarily on the depth of discharge (DOD). At a DOD of 80%, the Genesis battery will deliver about 400 cycles; at 100% DOD, that number decreases to about 320 cycles. **All cycle life estimates assume adequate charging.** Figure 2.3.1 shows the relationship between DOD and cycle life.



**Figure 2.3.1: Cycle life and depth of discharge (DOD)**

In contrast to cycle life, ambient temperature dramatically affects float life. For roughly every 8°C rise in ambient temperature above 25°C (77°F), the float life of a VRLA battery is cut in half. In other words, a 10-year battery at 25°C (77°F) is only a 5-year battery at 33°C (91°F). Additionally, float life is cut in half for every 100mV per cell over the recommended float charge voltage.

The relationship between ambient temperature and expected float life is given by the Arrhenius equation. The equation defines the relationship between the ambient temperature and the rate of internal positive-grid corrosion of the battery, which is the normal process of battery aging.

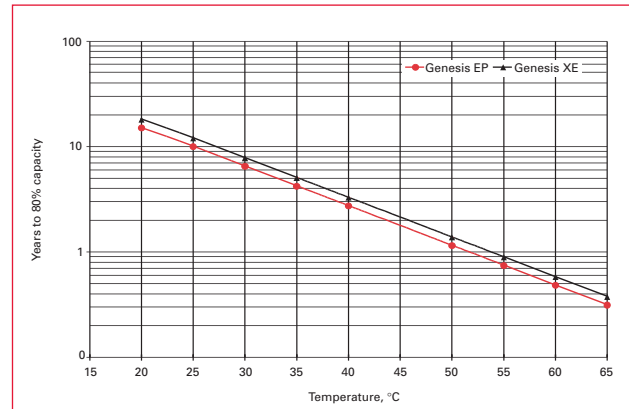
A key point to note is that the temperature in question is the battery ambient temperature. If the system is in a 25°C (77°F) environment and the battery is installed next to a power transformer where the temperature averages 32°C (90°F), then all battery calculations must be based on 32°C (90°F).

The Arrhenius equation is the theoretical foundation for the relationship used in practice to derive the acceleration factor for a given temperature. The equation is shown below, in which AF is the **acceleration factor** and T is the battery ambient temperature in °C.

$$AF = 2^{(0.125T-3.125)}$$

As an example, consider a battery in a float application at an ambient temperature of 37°C (98.6°F). Replacing T with 37 in the equation above the acceleration factor (AF)

in this case would be  $2^{(1.5)}$  or 2.83. A 10-year battery in this situation should be expected to last only about 3.5 years ( $10/2.83 = 3.5$ ). Figure 2.3.2 graphically shows the relationship between temperature and float life for the EP and XE series batteries, assuming temperature compensation and a reference temperature of 25°C (77°F).



**Figure 2.3.2: Battery temperature and float life**

## 2.4 Constant-power and constant-current discharge performance

Batteries are generally required to support either constant-power (CP) or constant-current (CC) loads. CP and CC discharge curves are provided in Appendix A for Genesis XE and in Appendix B for Genesis EP batteries. The information is provided in both tabular and graphical formats, with each curve representing the discharge profile for a specific model to a specific end voltage. *Consult an EnerSys technical support specialist for applications requiring high power or high-current deliveries for periods less than the minimum run time shown on any graph or for operating temperature significantly different from 25°C (77°F).*

If intermediate run times are required, such as *watts per battery* for 7 minutes to 1.67 volts per cell, the graphs may be used to estimate the *watts per battery* available.

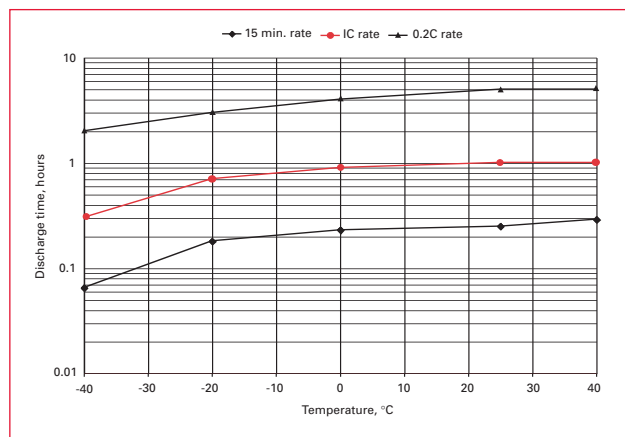
Generally speaking, most battery systems for indoor applications are in temperature-regulated environments. However, there are occasions when this is not the case. This can happen when the batteries are installed in close proximity to heat generating sources such as transformers. In such cases, the user should know what kind of life to expect from the batteries, since it is well established that a battery's overall performance is sensitive to ambient temperature.

In addition to the dependence of battery life on ambient temperature, battery capacity also varies with temperature. Table 2.4.1 shows the variation in battery capacity as a function of the ambient temperature. The capacity at 25°C (77°F) is taken as 100%.

| Temperature                | -20°C<br>(-4°F) | 0°C<br>(32°F) | 25°C<br>(77°F) | 40°C<br>(104°F) | 55°C<br>(131°F) |
|----------------------------|-----------------|---------------|----------------|-----------------|-----------------|
| Capacity @<br>15 min. rate | 65%             | 84%           | 100%           | 110%            | 120%            |

**Table 2.4.1: Effect of temperature on 15-minute discharge**

A graph of capacity as a function of temperature for the Genesis battery is shown in Figure 2.4.1 for various rates of discharge.



**Figure 2.4.1: Capacity as a function of temperature**

Although the Genesis battery may be used, with appropriate derating, from -40°C (-40°F) to 80°C (176°F), it is strongly recommended that every effort be made to install them in temperature-regulated environments. Metal jackets are required for temperatures exceeding 45°C (113°F) continuous.

All battery temperatures refer to the temperatures experienced by the active materials *inside* the battery. The time required by the active materials to reach thermal equilibrium within the battery environment may be considerable.

## 2.5 Charging characteristics & requirements

A constant-voltage (CV) regime is the preferred method of charging these batteries, although a constant-current (CC) charger with appropriate controls may also be used.

There is no limit on the magnitude of the charge current during a CV charge. Because of the Genesis battery's low internal resistance, it is able to accept any level of inrush current provided by a constant-voltage charger.

**Note:** The following paragraphs on battery charging have been considerably simplified for better understanding. For example, no account has been taken of the polarization voltage. Second, the battery resistance has been assumed to be static. This is a simplifying assumption since the battery's internal resistance will change continuously during the charge cycle.

This dynamism in the impedance occurs because of the changing state of charge and the fact that the temperature of the active materials within the battery is dynamic.

Owing to these simplifications, the current magnitudes obtained in the sample calculations are exaggerated. However, if one remembers that assumptions have been made and that the *mathematical steps are for illustration only*, then the actual current values calculated become immaterial.

It is known from basic electric-circuit theory that the current in any circuit is directly proportional to the voltage differential in the circuit (Ohm's Law). Therefore, as charging continues at a constant voltage, the charging current decreases due to the decreasing difference between the charger-output voltage and the battery-terminal voltage. Expressed differently, the charging current is at its highest value at the beginning of the charge cycle and at its lowest value at the end of the charge cycle.

Thus, in a CV charge circuit, the battery is the current regulating device in the circuit. It will draw only that amount of current as necessary to reach full charge. Once it attains 100% state of charge, it continues to draw small currents in order to compensate for standing/parasitic losses.

Assume that the battery under consideration has an internal resistance of 4mΩ (0.004Ω) when fully charged. Also, assume that it has an internal resistance of 8mΩ (0.008Ω) when discharged to an end voltage of 10.5 volts. However, the instant the load is removed from the battery, its voltage jumps back up to 12 volts, and this is the initial back electromotive force (EMF) the charger output terminals will see. The influence of this voltage on the charge-current inrush is illustrated in the initial and final charging magnitudes.

It is now decided to recharge the battery at a constant voltage of 2.25 volts per cell or 13.50 volts per battery. Further, assume that when the battery reaches a state of full charge, the internal resistance reduces to 4mΩ and the terminal voltage rises to 13.48V. *For illustrative purposes, this final end-of-charge terminal voltage has been kept deliberately slightly lower than the charging voltage.*

In reality, the charging process is dynamic. As soon as a charging source is placed across the terminals of a discharged battery, its voltage begins rising in an attempt to match the charger-output voltage. Given enough time, one would expect that the battery voltage at some point would exactly equal the charger voltage, thereby reducing the voltage difference in the charging circuit to zero and thus forcing the charge current to zero. However, this does not happen because of the internal electrochemistry, which ensures that the battery will keep drawing small charging currents even when fully charged.

However, almost immediately, the battery self-discharges, depressing its terminal voltage below the charger voltage, thereby initiating a current flow once again. The entire process, as outlined in the previous paragraph, will then repeat itself.

Applying Ohm's Law, which states that *the current in a circuit is equal to the voltage gradient (difference) in the circuit divided by the total resistance in the circuit*, and substituting the various parameters' assumed values, we have the following charging currents. Note that all connection resistances, such as those for cables, are neglected for simplicity. This omission does not affect the outcome since its influence would be the same in both cases, neglecting changes due to electrical heating.

$$\text{Initial charging current} = \frac{13.50 - 12.00}{0.008} = 188\text{A}$$

$$\text{Final charging current} = \frac{13.50 - 13.48}{0.004} = 5\text{A}$$

This example shows how the battery acts as a current regulator in a CV charge circuit, decreasing the current flow in the circuit to suit its own state of charge. Thus, even if the current limit on the charger were 200 amperes, the battery would see an inrush current of 188 amperes, before it tapered off and finally dropped to its lowest value at the end of the charge cycle.

Although the 200A figure is impractical because of prohibitive charger costs, it serves to drive home the point that as far as the battery is concerned, a specific current limit is not necessary for Genesis batteries under CV charging. In reality, the current limit would be dictated by a combination of technical and economic considerations. Note also that, in general, most other battery manufacturers recommend current limits based on battery capacity, usually  $0.25C_{10}$ , where  $C_{10}$  is the 10-hour rating.

Increasing the current limit will reduce the total recharge time, but at greater cost. The reduction in recharge time occurs mainly up to the 90% state of charge level; the impact on total recharge time is much less. The charger-output voltage exercises a much greater influence on the total recharge time.

The question then becomes whether the reduction in the time needed for a recharge can justify the additional costs. In some critical applications, this may be the case, while in other situations the added cost may not be justifiable.

The time to recharge a battery under float charge is shown in Figure 2.5.1. The graphs show the time taken to reach three different states of charge. For example, with a charge current of  $0.2C_{10}$  amps the battery will get to 100% SOC in about 12 hours when charged at 13.62V (2.27 Vpc).

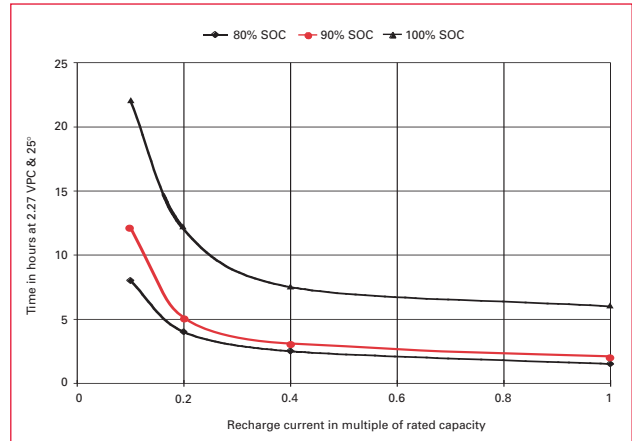


Figure 2.5.1: Recharge times under float charge

## 2.6 Constant-voltage (CV) regime

In a float or standby application the CV charger should be set at 13.5V to 13.8V at 25°C (77°F). For a cyclic application, the charge voltage should be set between 14.4V and 15V at 25°C (77°F). In both cases, the linearized temperature compensation factor is  $\pm 24\text{mV}$  per battery per °C variation from 25°C (77°F). The higher the temperature the lower the charge voltage should be and vice versa.

Figure 2.6.1 shows the temperature compensation factor for float and cyclic applications. Equations representing the compensation curves are also shown in this figure. Note that for both types of application there is no limit on the inrush current. We recommend the highest practical and economical current limit possible.

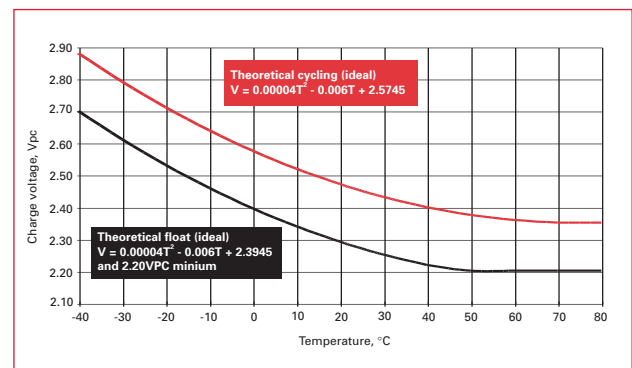


Figure 2.6.1: Temperature compensation graph

## 2.7 Constant-current (CC) regime

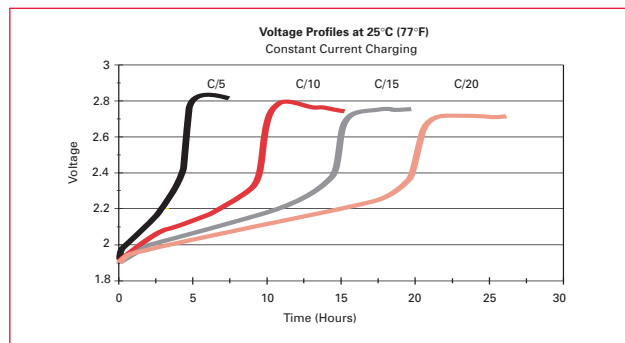
Unlike CV charging, CC charging requires the charge current to be limited to  $0.33C_{10}$  to avoid damaging the battery. Once 100% of previously discharged capacity has been returned the overcharge should be continued at a much lower rate, such as  $0.002C_{10}$ , i.e., at the 500-hour rate.

When using a CC-charge regime, the charge current must switch from a high (starting) rate to a low (finishing) rate when the battery reaches 100% state of charge. The point at which this switch occurs may be determined by using a timer or by sensing the battery voltage.

The timer setting can be determined by calculating the time needed to return 105% to 110% of the ampere-hours drawn out. However, this method should not be used unless the previously discharged capacity can be reliably and consistently measured.

Alternatively, the battery-terminal voltage can be used to trigger the transition from a high charge current to a low charge current. As the battery charges up, its voltage reaches a peak value and then begins to decline to the steady-state, fully charged value. The point at which this drop (point of inflection) begins depends on the charge current's magnitude, as shown in Figure 2.7.1. Since the charge voltages in Figure 2.7.1 are on a per cell basis, simply multiply the numbers by 6 as all Genesis batteries are 12V units.

The inflection point may be used to switch the current from a high rate ( $\leq 0.33C_{10}$ ) to a low rate ( $\approx 0.002C_{10}$ ). This is a more reliable method than amp-hour counting, as it is independent of the previously discharged capacity.



**Figure 2.7.1: CC charging curves at 25°C (77°F)**

The Genesis battery may be recharged using either a constant-current (CC) or constant-voltage (CV) charger, **although the CV regime is the preferred method**. This flexibility in the charging scheme is an advantage, since it is easy for the user to replace existing batteries with Genesis without having to alter the charging circuitry.

Because of the thin plate pure lead-tin technology used in this battery, the internal resistance is significantly lower than that of conventional VRLA batteries. For example, the 26EP battery has an internal resistance of about 5mΩ when fully charged. This compares very favorably with a typical value of 10 to 15mΩ for competitive products of equal capacity.

The low internal resistance helps the Genesis battery accept large inrush currents without any harmful effects. The heat generated by the charge current is kept at a low

level because of the very low internal resistance value. The very high recharge efficiency of this battery also allows high inrush currents. In tests performed on the 26Ah product, the initial current drawn by the battery was 175 amperes. The Genesis battery may be recharged much more rapidly than conventional VRLA batteries because of its ability to safely accept very high currents. Table 2.7.1 demonstrates this quick charge capability when using a CV charge of 14.7V.

| Capacity returned | Magnitude of inrush current |                    |                    |
|-------------------|-----------------------------|--------------------|--------------------|
|                   | 0.8C <sub>10</sub>          | 1.6C <sub>10</sub> | 3.1C <sub>10</sub> |
| 60%               | 44 min.                     | 20 min.            | 10 min.            |
| 80%               | 57 min.                     | 28 min.            | 14 min.            |
| 100%              | 1.5 hrs.                    | 50 min.            | 30 min.            |

**Table 2.7.1: Inrush current and charge time**

This fast-charge capability is remarkable in a VRLA battery. This feature makes the Genesis battery competitive with a nickel-cadmium battery, which traditionally had an advantage over lead acid batteries due to its short charge times.

The quick charge capability of the Genesis battery makes it particularly suitable for applications where the battery has to be returned quickly to a high state of charge after a discharge.

## 2.8 Three-step (IUU) charge profile

A three-step charge profile developed for use with the Genesis TPPL battery is shown in Figure 2.8.1. The first step (bulk charge) is a constant current (CC) charge with a minimum current of 40% of the 10-hour (C<sub>10</sub>) rating of the battery. For example, to use this profile effectively on the 16Ah battery, the minimum charge current must be 6.4 amps.

Bulk charge continues until the battery voltage reaches 14.7V. The charger then switches to a constant voltage (CV) mode at 14.7V and the absorption charge phase begins.

The charger switches to the temperature-compensated float phase when either the current drops to 25% of the bulk charge current (0.1C<sub>10</sub> amps) or the time in the absorption phase reaches 8 hours, whichever occurs first.

If the charger has a timer override so that the absorption phase does not exceed 8 hours, the threshold current at which the charger switches from absorption phase to float phase should be reduced to 0.001C<sub>10</sub>. This equals 16mA for the 16Ah battery discussed in the earlier example.

If the charger does not have a timer the trigger to switch from absorption phase to float phase should be set at 0.1C<sub>10</sub>.



**Note:** The battery will not be fully charged when a switch from absorption to float charge is made when the current drops to  $0.1C_{10}$ . The battery will need a minimum of 16-24 hours on float charge before it is fully charged. The battery may be used as soon as the switch to float is made, but repeatedly cycling it without the necessary 16-24 hours' on float charge will cause premature failure of the battery.

Alternatively, the charger can stay in the absorption phase for a fixed 8 hours. Once this absorption charge time is over, the charger can switch to a temperature-compensated float voltage. The advantage with this design is a less complex circuit because it is not necessary to monitor the charge current in the absorption phase.

Table 2.8.1 lists the different IUU charge profile options. A check mark indicates the feature is available in the charger, while X indicates a charger that does not have the feature. Note that all three designs have bulk, absorption and float charge phases. The differences between the three designs are limited to (a) whether a timer is available, (b) whether the circuit monitors the charge current and (c) the magnitude of the threshold current, if it is used to trigger the switch from absorption charge to float charge.

**Table 2.8.1: IUU charger design options**

|          | Feature |            |       |                    |       |
|----------|---------|------------|-------|--------------------|-------|
|          | Bulk    | Absorption | Timer | Trigger            | Float |
| Design 1 | ✓       | ✓          | ✓     | $0.001C_{10}$ amps | ✓     |
| Design 2 | ✓       | ✓          | ✓     | X                  | ✓     |
| Design 3 | ✓       | ✓          | X     | $0.10C_{10}$ amps  | ✓     |

**Design 1:**

The charger has a timer and a current threshold that triggers the switch from absorption charge to float charge. Since the timer is present, the trigger current is set low. If the current does not drop to  $0.001C_{10}$  amps within 8 hours on absorption charge, the timer will force the switch to a temperature-compensated float charge.

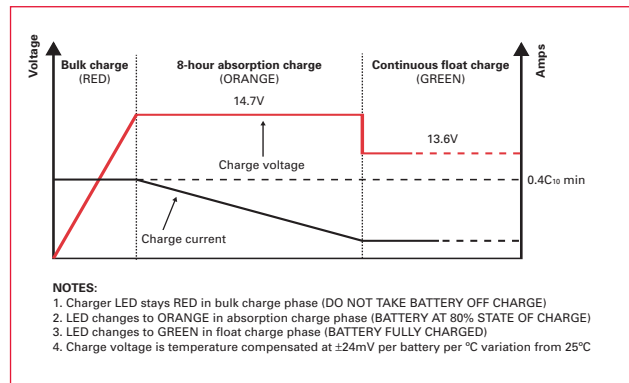
**Design 2:**

The charger does not switch to a float charge based on a preset charge current. Rather, the timer stays in the absorption phase for 8 hours before switching to a temperature-compensated float charge.

**Design 3:**

The charger has no timer. Since switching depends solely on the charge current dropping to a set level, the threshold is set high enough to ensure the charger will always switch to a float charge. In this design the battery will not be fully charged at the start of the float charge. **A minimum of 16-24 hours on float will be required to complete the charge.**

**Figure 2.8.1: Three-step (IUU) charge profile**



**2.9 Storage characteristics**

Improper storage is a common form of battery misuse. High storage temperature and inadequate frequency of freshening charges are examples of improper storage. In order to better understand the various mechanisms influencing sealed-lead batteries kept in storage, the following paragraphs discuss in general terms several aspects of the batteries' storage requirements.

**2.10 Self discharge**

All batteries lose charge over time when kept on open circuit. This phenomenon is termed *self-discharge*.

If the capacity loss due to self-discharge is not compensated by recharging in a timely fashion, the capacity loss may become irrecoverable due to irreversible sulfation, where the active materials (PbO<sub>2</sub>, lead dioxide, at the positive plates and sponge lead at the negative plates) are gradually converted into an electroinactive form of lead sulfate, PbSO<sub>4</sub>. If the capacity loss associated with self-discharge is not replenished, the battery ultimately fails because storage is electrochemically equivalent to a very low rate of discharge.

Storage temperature is the key factor influencing the self-discharge rate because it plays a major role in determining the speed at which the internal chemical reaction proceeds. The higher the temperature, the faster the speed of chemical reactions.

Just as every 8°C rise in operating temperature cuts the battery's life expectancy in half, so does every 8°C increase in ambient temperature reduce the storage life of a battery by 50%. Conversely, a reduction in storage temperature will have the reverse effect by increasing the allowable storage time.

### 2.11 Open circuit voltage (OCV) and state of charge (SOC)

Since most batteries are subject to some kind of storage, it is important for the user to have some method of accurately estimating the battery capacity after it has been in storage.

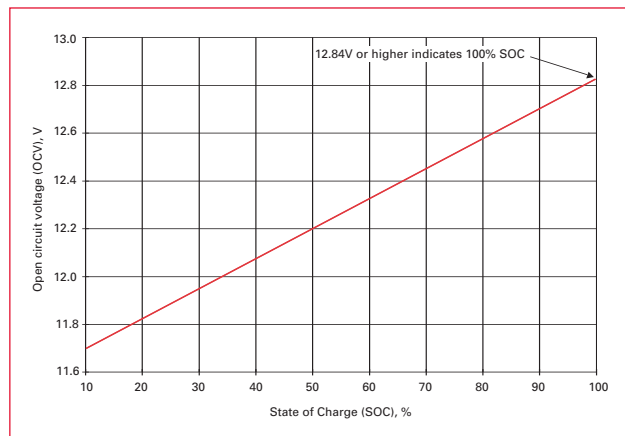


Figure 2.11.1: Open circuit voltage and state of charge

Although efforts should be made to ensure that batteries are stored in temperature-controlled environments, a freshening charge should be applied once every twenty-four (24) months or when the open-circuit voltage (OCV) reading drops to 12V, whichever comes first. As shown in Figure 2.11.1, 12V corresponds to a 35% state of charge (SOC). **The battery may be permanently damaged if the OCV is allowed to drop below 11.90V.**

Figure 2.11.1 shows the OCV and corresponding SOC for a Genesis battery. An OCV of 12.84V or more indicates a battery at 100% SOC. The figure is accurate to within 20% of the true SOC of the battery **if the battery has not been charged OR discharged in the 24 hours preceding the voltage measurement.** The accuracy improves to 5% if the period of inactivity before the voltage measurement is 5 days.

Capacity loss during storage is an important consideration, particularly in applications where performance loss due to storage is unacceptable. However, knowing how much charge is remaining in the battery at any point in its storage life is equally important as the battery must be maintained at a minimum charge level in order to prevent permanent damage. Figure 2.11.2 shows the relationship between storage time and remaining capacity at 25°C (77°F), 45°C (113°F) and 65°C (149°F).

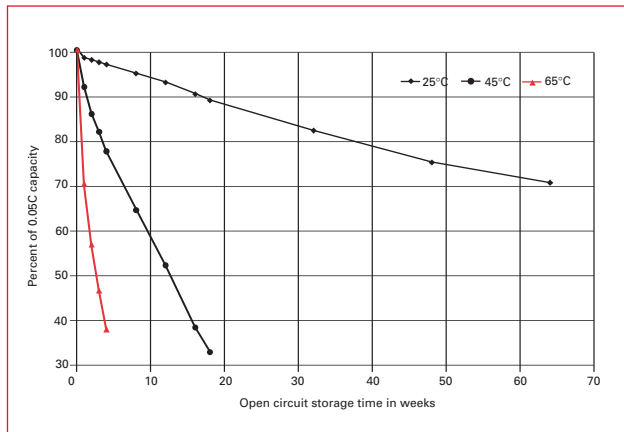


Figure 2.11.2: Storage capacity at temperatures

### 2.12 Procedure to recover overdischarged batteries

There may be instances when a Genesis battery is overdischarged to the point where a standard charger is unable to fully recharge the battery. In such cases, the following procedure may help recover the affected battery.

1. Bring the battery to room temperature (25°C or 77°F).
2. Measure the OCV. Continue to step 3 if it is at least 12V; otherwise terminate the procedure and reject the battery.
3. Charge the battery using a 0.05C<sub>10</sub> constant current for 24 hours. The charger should be capable of providing a driving voltage as high as 36V. Monitor the battery temperature; **discontinue charging if the battery temperature rises by more than 20°C.**
4. Allow the charged battery to stand on open circuit for a minimum of 1 hour before proceeding to Step 5.
5. Perform a capacity test on the battery and record the amp-hours delivered. The longer the discharge the more reliable the result. This is Cycle 1.
6. Repeat steps (3) to (5). The capacity returned in step 5 is now Cycle 2. If Cycle 2 capacity is greater than Cycle 1 capacity proceed to step 7; otherwise reject the battery.
7. Repeat steps (3) to (5) to get Cycle 3 capacity. Proceed to step 8 if Cycle 3 capacity is equal to or more than Cycle 2 capacity. Reject the battery if Cycle 3 capacity is less than Cycle 2 capacity.
8. If Cycle 3 capacity equals or exceeds Cycle 2 capacity, recharge the battery and put it back in service.

## Chapter 3: General Test Data

### 3.1 Introduction

This section's purpose is to discuss actual data from various tests conducted on Genesis batteries. These tests may be of particular interest to system designers and application engineers. Other test results serve to confirm the data published in the **Genesis Selection Guide**. Tests covered in this chapter include the following:

- Thermal runaway test
- Altitude test
- Overdischarge recovery tests (DIN standard test and high temperature storage test)
- Accelerated float life test
- Gassing test
- Performance test at different temperatures

### 3.2 Thermal runaway test

Thermal runaway (TR) describes a situation in which the battery is unable to maintain a steady current when connected to a CV charger. TR can also happen when the battery temperature increases rapidly due to inadequate heat dissipation from the battery.

As the battery draws current, its internal temperature rises. If the heat generated is not dissipated, the internal reaction rate of the battery will increase, forcing the battery to draw more current. This in turn generates more heat. The increasing heat generation and attendant higher current draw feed on each other which, if allowed to escalate will trigger TR.

Figure 3.2.1 shows the result of TR tests conducted on a 12V, 26EP Genesis TPPL battery that had been cycled 10 times to age it. After the tenth discharge the battery was fully charged using normal charging parameters, then put on a gross overcharge at 15.9V (2.65 VPC) at 25°C.

The threshold criterion for initiation of TR was set at a charge current of 4.5 amps or a battery temperature of 60°C (140°F). In other words, the battery was considered to be in TR when either the charge current reached 4.5 amps or the battery case temperature rose to 60°C (140°F). As shown in Figure 3.2.1 the battery reached the temperature threshold first, after the battery had been on overcharge for 370.9 hours, or over 15 days.

Two points are noteworthy here. First, it took over 15 days on gross overcharge (remember, the battery was fully charged when it was placed on a 15.9V charge) before it showed signs of going into TR. The battery received a staggering 565.7 amp-hours (over 2,000% of its rated capacity) during the test.

Second, there was no catastrophic failure of the battery and its case temperature rose gradually for the most part. It took over a week (169 hours) for the temperature

to rise from 45°C to 60°C. The results of this test clearly show that even in the unlikely event of a Genesis battery going into TR, its behavior does not raise safety issues.

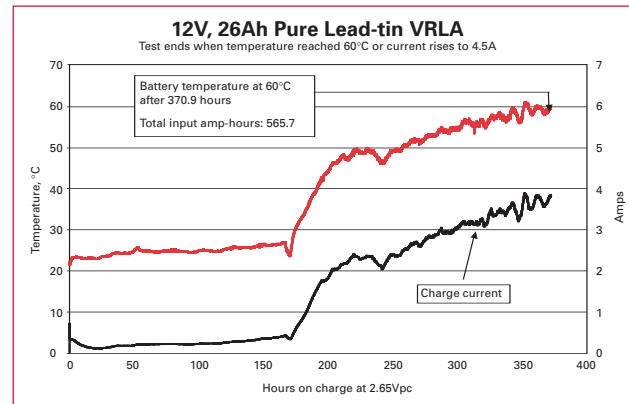


Figure 3.2.1: TR test at 15.9V (2.65Vpc) charge

### 3.3 Gassing test

The Genesis battery is safe for use in human environments, such as offices and hospitals. A test was developed to determine how much hydrogen gas is evolved under normal operating conditions. This test's assumption is that any weight loss suffered by the battery can be attributed to the water lost by the battery. Knowing the amount of water lost by the battery and the chemical composition of water, a relatively straightforward calculation yields the amount of emitted hydrogen gas. Table 3.3.1 summarizes the test data on a Genesis 26Ah battery.

|                                   |  |
|-----------------------------------|--|
| Test temperature                  | 60°C (140°F)   |
| Charge voltage                    | 2.30 Vpc   |
| Duration of test at temperature   | 180 days   |
| Weight loss at end of test period | 65.6 grams<br>= 3.65 moles (gram equiv.) H <sub>2</sub> O<br>= 3.65 moles H <sub>2</sub> and 1.82 moles O <sub>2</sub> |
| Gas evolved                       | Total 122.6 liters   |
| Duration of test at 25°C (77°F)   | 2,880 days (4,147,200 minutes)   |
| Gassing rate                      | Total 0.03 cc/min<br>Hydrogen (H <sub>2</sub> ): 0.02 cc/min.  |

Table 3.3.1: Gassing test data

The oxygen evolved is recombined, while the rate of hydrogen emission is negligible, as Table 3.3.1 shows. Nevertheless, the battery should not be recharged in a gas-tight container. Ventilation must always be provided in the charging area.

### 3.4 DIN standard overdischarge recovery test

This German standard test was designed to determine the ability of batteries to recover from overdischarge using standard chargers. In addition, the test also gives an indication of the resistance of the battery to permanent damage caused by sulfation, a phenomenon that occurs when a battery is left in a discharged condition for an extended length of time.

The test began by discharging a fully charged 26Ah battery at the 20-hour rate to 1.70 Vpc. Following the discharge, a 5Ω resistor was connected across the battery terminals and left connected for 28 days. At the end of this 28-day period, the battery was recharged at a constant voltage of 2.25 Vpc for only 48 hours.

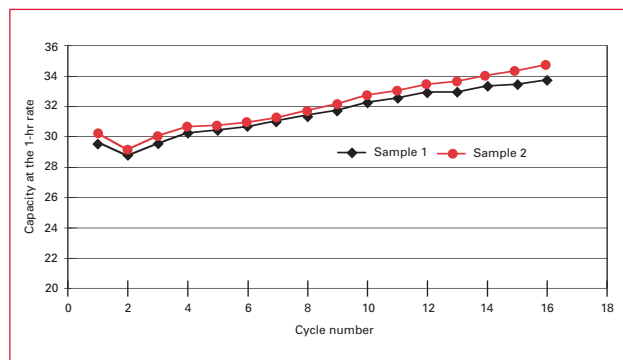
The battery was tested for capacity after the 48-hour recharge, and 97% of the initial capacity was obtained. A subsequent recharge/discharge cycle yielded a capacity of 94% of the initial capacity. The overdischarge test exercise is summarized in Table 3.4.1 below.

|                           |   |
|---------------------------|---|
| <b>Conditions</b>         | 0.05C <sub>10</sub> rate discharge to 1.70 Vpc              |
| <b>Followed by</b>        | 5Ω resistor connected across battery terminals for 28 days  |
| <b>Recharge</b>           | 2.25 Vpc CV charge for 48 hours                             |
| <b>Results</b>            | Initial capacity: 26.8Ah                                    |
| <b>Recovered capacity</b> | 25.9Ah (97%) on first cycle<br>25.3Ah (94%) on second cycle |

**Table 3.4.1: DIN standard overdischarge recovery test result**

### 3.5 High temperature storage recovery test

This test demonstrates the deep discharge recovery capability of the Genesis battery. Since the test involves storing the battery in a discharged state for 4 weeks at 50°C (122°F) it is a more difficult test than the previously described German DIN standard test. Figure 3.5.1 summarizes the test results.



**Figure 3.5.1: Recovery from discharged storage at 50°C**

<sup>1</sup> 270 days at 55°C (77°F) is equivalent to (270 x 13.454)/365 years or 9.95 years at 25°C (77°F)

Both samples were discharged at the 1-hour rate to an end of discharge voltage of 9V, then stored in a discharged condition for 4 weeks at 50°C (122°F). The batteries were then charged at 14.7V with a current limit of 0.125C<sub>10</sub> for the first two cycles and 1C<sub>10</sub> for cycles 3 through 17.

It is clear that the charge current was too low for the first two cycles, as evident from the rapid loss in capacity. Boosting the charge current to 1C<sub>10</sub> brought both batteries back to full capacity.

### 3.6 Altitude test

This test was designed to prove that the Genesis battery is capable of operating safely and without performance loss at any altitude. Since the design of the Genesis battery's Bunsen valve does not rely on atmospheric pressure to operate, the battery will operate over a wide range of external pressure, from vacuum to as much as 100 feet under water.

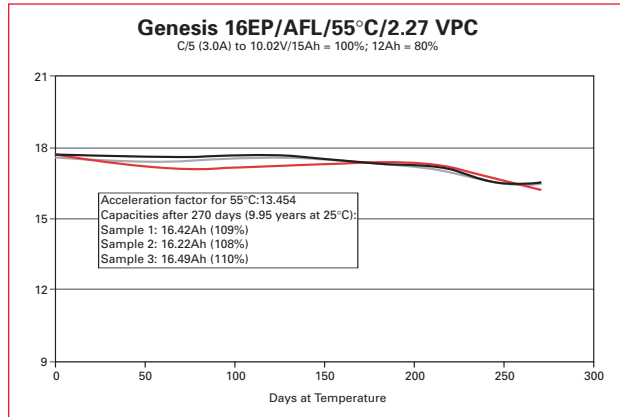
These batteries have also passed the pressure differential test required to comply with the requirements of DOT HMR 49 Non-Hazardous Materials, International Civil Aeronautics Organization (ICAO) and International Air Transport Association (IATA) Packing Instruction 806 and Special Provision A67.

In the pressure differential test, the battery is placed in a temperature-controlled altitude chamber at 24°C (75°F). It is then subjected to 6 hours of differential pressure at a minimum of 88 kPa (equivalent to an altitude of 50,000 feet). The test is repeated for each of three mutually perpendicular orientations, including the inverted position. A visual inspection showed no acid leakage, indicating the battery passed the test.

### Section 3.7: Accelerated float life test

Figure 3.7.1 shows the results of accelerated float life (AFL) tests conducted on three samples of the Genesis 16Ah battery. In AFL tests, high temperatures accelerate the aging process of the batteries. At an AFL test temperature of 55°C (131°F), the acceleration factor (AF) is 13.454, which means that every day at 55°C (131°F) is electrochemically equivalent to 13.454 days at 25°C (77°F). This is a conservative AF because the charge voltage used in the test is not temperature-compensated, as it should be. No account is taken of the accelerated aging of the battery due to a higher-than-recommended charge voltage.

As shown in Figure 3.7.1 the three batteries were at 109%, 108% and 110% of their rated capacity after 270 days on test at 55°C (131°F). This is electrochemically equivalent to 9.95 years on float at 25°C (77°F). Since end of life is defined as the failure to deliver 80% of its rated capacity, none of these batteries is close to the end of its design life of 10 years at 25°C (77°F).



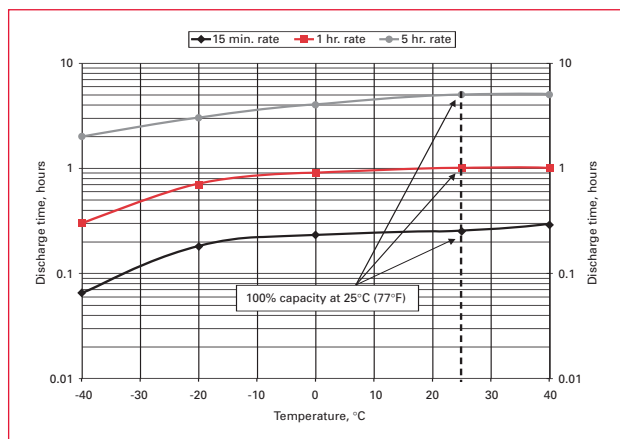
**Figure 3.7.1: AFL test data for Genesis 16EP batteries**

Similar tests on the Genesis XE batteries showed an average float life of 454 days at 55°C (131°F), or the equivalent of 16.7 years at 25°C (77°F) to 80% of rated capacity. These results validate the Genesis EP and XE published design life of 10 years and 12+ years, respectively, at 25°C (77°F) to 80% of rated capacity.

### Section 3.8: Performance test at different temperatures

Figure 3.8.1 shows the effect of temperature on the discharge performance of Genesis batteries at three rates of discharge. The vertical broken line represents 25°C (77°F), and its intersections with the graphs show the 100% capacity at the three rates of discharge.

At -40°C, the battery will run for 2 hours at the C<sub>5</sub> rate (60% of its 5-hour capacity), for 18 minutes at the C<sub>1</sub> rate (30% of its 1-hour capacity) and for 4 minutes at the 15-minute rate (27% of its 15-minute capacity). These are excellent performance numbers, considering how low the ambient temperature is.



**Figure 3.8.1: Effect of temperature on capacity**

## Chapter 4: Installation, Operation & Maintenance

### 4.1 Introduction

This chapter is designed to provide the user with guidelines to help get the most out these batteries. Even though VRLA batteries do not require the addition of water, periodic maintenance checks are strongly recommended. These are:

- Individual unit voltages
- Unit-to-unit connection resistances
- Terminal connection resistance
- Ambient temperature and battery temperature

A load test can be carried out once or twice a year. The batteries must be fully charged before any capacity test is performed.

### 4.2 Receiving the shipment

All batteries must be carefully inspected upon arrival for any sign of damage during their transportation. Use rubber gloves when handling any that are broken or physically damaged in case of acid leakage.

### 4.3 Storage

All Genesis batteries must be stored in a clean and dry location, and preferably in a temperature-controlled environment. Although these batteries are shipped fully charged and may be stored for up to 2 years at 25°C (77°F) periodic checks of their open circuit voltages are recommended. The warmer the storage environment the more frequent the voltage checks should be.

The batteries must be given a freshening charge once every 2 years or when the OCV drops to 12.00V, whichever occurs earlier. The freshening charge should be for 96 hours at 13.62V at 25°C (77°F) or until the charge current does not vary over a 3-hour period. Alternatively, the freshening charge can be set at 14.4V for 16 to 24 hours or until the charge current does not vary over a 3-hour period.

Failure to observe these conditions may result in greatly reduced capacity and service life. **FAILURE TO CHARGE AS NOTED VOIDS THE BATTERY'S WARRANTY.**

### 4.4 Installation

Batteries must be installed in a clean, dry area. Genesis batteries release negligible amounts of gas during normal operation (gas recombination efficiency ≥99%), making them safe for installation near main equipment and in close proximity to humans. Batteries must be installed in accordance with local, state and federal regulations and manufacturer's recommendations.

#### 4.4.1 Temperature

Avoid placing batteries in areas of high temperature or in direct sunlight. The optimal temperature range for performance and service life of the Genesis battery is 20°C (68°F) to 25°C (77°F). These batteries can, however be used at temperatures ranging from -40°C (-40°F) to 80°C (176°F) when fitted with a metal jacket.

#### 4.4.2 Ventilation

As stated before, under normal operating conditions the gas emission from Genesis batteries is very low. Natural ventilation is adequate for cooling and to prevent buildup of hydrogen gas. This is why Genesis batteries may be used safely in offices, hospitals and other human environments.

When installing batteries in cabinets or other enclosures, care must be taken to ensure they are not sealed enclosures. **UNDER NO CIRCUMSTANCES SHOULD THESE BATTERIES BE CHARGED IN A SEALED CONTAINER.**

#### 4.4.3 Security

All installation and ventilation must comply with applicable current local, state and federal regulations.

#### 4.4.4 Mounting

Regardless of where the batteries are mounted (cabinets, racks or other type of enclosure) the positive and negative terminals must be arranged according to the wiring diagram. Check that all contact surfaces are clean before making the interbattery connections and ensure that all batteries are mounted firmly.

Tighten the screws to the recommended torque value and follow the polarities of individual batteries to avoid short circuits. Finally, connect the battery end terminals.

Since the Genesis battery has all of its electrolyte immobilized in its separators, it can be mounted on its sides without any performance degradation.

#### 4.4.5 Torque

The recommended terminal attachment torque for the full range is given in Table 4.4.5.1. A loose connector can cause problems in charger performance, erratic battery performance, possible damage to the battery and even personal injuries.

| Battery model | Terminal torque    |
|---------------|--------------------|
| 13EP & XE13   | 50 in-lbs (5.6 Nm) |
| 16EP & XE16   | 50 in-lbs (5.6 Nm) |
| 26EP & XE30   | 60 in-lbs (6.8 Nm) |
| 42EP & XE40   | 60 in-lbs (6.8 Nm) |
| 70EP & XE70   | 60 in-lbs (6.8 Nm) |

Table 4.4.5.1: Terminal torque values

#### 4.5 Parallel strings

While there are no theoretical limits on the number of parallel battery strings, we recommend no more than 5 parallel strings per system, particularly for cyclic applications.

#### 4.6 Discharging

It is strongly recommended that a low voltage cutoff be included in the battery load circuit to protect the battery from overdischarges. The setting for end of discharge voltage (EODV) is dependent on the rate of discharge, as shown in Table 4.6.1. For optimum battery life, we recommend that the battery be disconnected from the load when the appropriate voltage is reached and put back on charge as soon as possible after a discharge.

| Discharge rate in amps                     | Suggested minimum EODV |
|--|------------------------|
| 0.05C <sub>10</sub> (C <sub>10</sub> /20)  | 10.50V                 |
| 0.10C <sub>10</sub> (C <sub>10</sub> /10)  | 10.20V                 |
| 0.20C <sub>10</sub> (C <sub>10</sub> /5)   | 10.02V                 |
| 0.40C <sub>10</sub> (C <sub>10</sub> /2.5) | 9.90V                  |
| 1C <sub>10</sub>                           | 9.60V                  |
| 2C <sub>10</sub>                           | 9.30V                  |
| >5C <sub>10</sub>                          | 9.00V                  |

Table 4.6.1: Suggested battery cutoff voltages

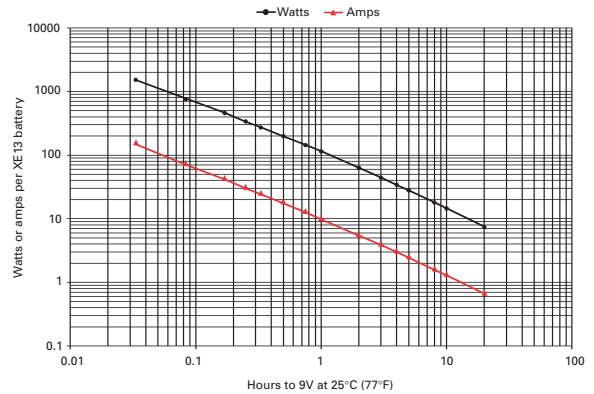
**Note:** Discharging the Genesis battery below these low voltage cutoff levels or leaving the battery connected to a load in a discharged state may impair the battery's ability to accept a charge.

# Appendix A - Genesis XE Discharge Rates



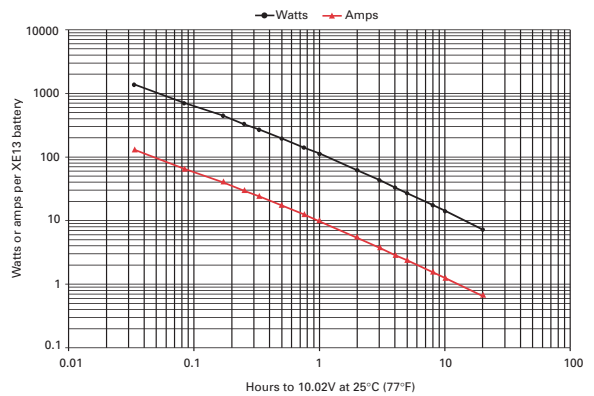
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 1529      | 149.1    | 5.0           | 50.9        | 764.8                      | 25.5     | 283.1 | 9.4   |
| 5 min.  | 760       | 71.2     | 5.9           | 63.3        | 400.2                      | 33.3     | 140.7 | 11.7  |
| 10 min. | 460       | 41.7     | 7.1           | 78.2        | 242.3                      | 41.2     | 85.2  | 14.5  |
| 15 min. | 339       | 30.2     | 7.6           | 84.8        | 178.8                      | 44.7     | 62.8  | 15.7  |
| 20 min. | 273       | 24.1     | 7.9           | 90.0        | 143.7                      | 47.4     | 50.5  | 16.7  |
| 30 min. | 199       | 17.4     | 8.7           | 99.4        | 104.7                      | 52.4     | 36.8  | 18.4  |
| 45 min. | 144       | 12.5     | 9.4           | 108.0       | 75.9                       | 56.9     | 26.7  | 20.0  |
| 1 hr.   | 114       | 9.8      | 9.8           | 113.6       | 59.9                       | 59.9     | 21.0  | 21.0  |
| 2 hr.   | 64        | 5.4      | 10.9          | 127.1       | 33.5                       | 66.9     | 11.8  | 23.5  |
| 3 hr.   | 44        | 3.8      | 11.4          | 132.9       | 23.3                       | 70.0     | 8.2   | 24.6  |
| 4 hr.   | 34        | 3.0      | 11.8          | 137.0       | 18.0                       | 72.2     | 6.3   | 25.4  |
| 5 hr.   | 28        | 2.4      | 12.0          | 139.7       | 14.7                       | 73.6     | 5.2   | 25.9  |
| 8 hr.   | 18        | 1.6      | 12.6          | 144.3       | 9.5                        | 76.0     | 3.3   | 26.7  |
| 10 hr.  | 15        | 1.3      | 12.7          | 145.5       | 7.7                        | 76.7     | 2.7   | 26.9  |
| 20 hr.  | 7         | 0.7      | 13.2          | 148.0       | 3.9                        | 78.0     | 1.4   | 27.4  |

Figure A-1: XE13 discharge data to 9.0V at 25°C (77°F)



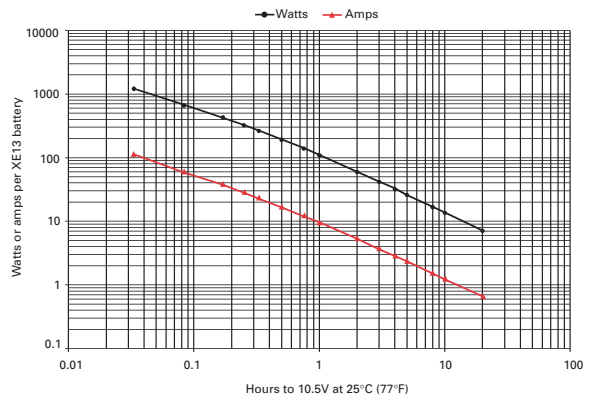
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 1361      | 128.0    | 4.3           | 45.3        | 680.8                      | 22.7     | 252.0 | 8.4   |
| 5 min.  | 701       | 64.4     | 5.4           | 58.4        | 369.4                      | 30.8     | 129.8 | 10.8  |
| 10 min. | 443       | 39.6     | 6.7           | 75.2        | 233.2                      | 39.6     | 82.0  | 13.9  |
| 15 min. | 330       | 29.2     | 7.3           | 82.6        | 174.1                      | 43.5     | 61.2  | 15.3  |
| 20 min. | 267       | 23.5     | 7.7           | 88.1        | 140.7                      | 46.4     | 49.4  | 16.3  |
| 30 min. | 195       | 16.9     | 8.5           | 97.5        | 102.7                      | 51.4     | 36.1  | 18.1  |
| 45 min. | 141       | 12.2     | 9.1           | 105.7       | 74.2                       | 55.7     | 26.1  | 19.6  |
| 1 hr.   | 111       | 9.6      | 9.6           | 111.2       | 58.6                       | 58.6     | 20.6  | 20.6  |
| 2 hr.   | 62        | 5.3      | 10.6          | 123.4       | 32.5                       | 65.0     | 11.4  | 22.8  |
| 3 hr.   | 43        | 3.7      | 11.1          | 128.7       | 22.6                       | 67.8     | 7.9   | 23.8  |
| 4 hr.   | 33        | 2.9      | 11.5          | 132.3       | 17.4                       | 69.7     | 6.1   | 24.5  |
| 5 hr.   | 27        | 2.3      | 11.7          | 134.8       | 14.2                       | 71.0     | 5.0   | 25.0  |
| 8 hr.   | 17        | 1.5      | 12.1          | 138.9       | 9.1                        | 73.2     | 3.2   | 25.7  |
| 10 hr.  | 14        | 1.2      | 12.4          | 140.6       | 7.4                        | 74.1     | 2.6   | 26.0  |
| 20 hr.  | 7         | 0.7      | 13.0          | 144.3       | 3.8                        | 76.0     | 1.3   | 26.7  |

Figure A-2: XE13 discharge data to 10.02V at 25°C (77°F)

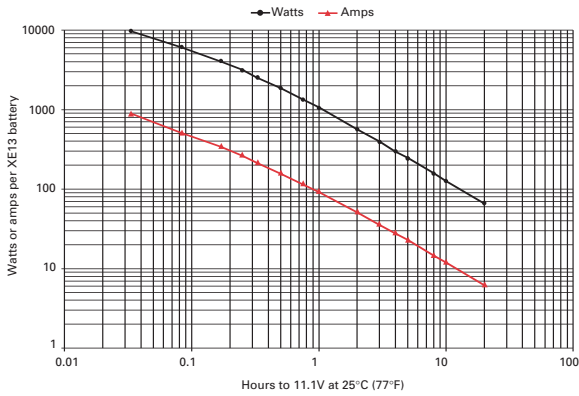


| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 1206      | 111.0    | 3.7           | 40.1        | 603.3                      | 20.1     | 223.3 | 7.4   |
| 5 min.  | 662       | 58.9     | 4.9           | 55.2        | 348.9                      | 29.1     | 122.6 | 10.2  |
| 10 min. | 429       | 37.3     | 6.3           | 72.9        | 225.9                      | 38.4     | 79.4  | 13.5  |
| 15 min. | 323       | 28.0     | 7.0           | 80.7        | 170.2                      | 42.5     | 59.8  | 15.0  |
| 20 min. | 262       | 22.6     | 7.5           | 86.3        | 137.8                      | 45.5     | 48.4  | 16.0  |
| 30 min. | 191       | 16.5     | 8.3           | 95.6        | 100.8                      | 50.4     | 35.4  | 17.7  |
| 45 min. | 138       | 12.0     | 9.0           | 103.8       | 72.9                       | 54.7     | 25.6  | 19.2  |
| 1 hr.   | 109       | 9.4      | 9.4           | 108.7       | 57.3                       | 57.3     | 20.1  | 20.1  |
| 2 hr.   | 60        | 5.2      | 10.4          | 119.3       | 31.4                       | 62.9     | 11.0  | 22.1  |
| 3 hr.   | 41        | 3.6      | 10.9          | 124.2       | 21.8                       | 65.5     | 7.7   | 23.0  |
| 4 hr.   | 32        | 2.8      | 11.3          | 127.4       | 16.8                       | 67.1     | 5.9   | 23.6  |
| 5 hr.   | 26        | 2.3      | 11.5          | 129.6       | 13.7                       | 68.3     | 4.8   | 24.0  |
| 8 hr.   | 17        | 1.5      | 11.9          | 133.5       | 8.8                        | 70.4     | 3.1   | 24.7  |
| 10 hr.  | 14        | 1.2      | 12.1          | 135.1       | 7.1                        | 71.2     | 2.5   | 25.0  |
| 20 hr.  | 7         | 0.6      | 12.8          | 140.6       | 3.7                        | 74.1     | 1.3   | 26.0  |

Figure A-3: XE13 discharge data to 10.5V at 25°C (77°F)

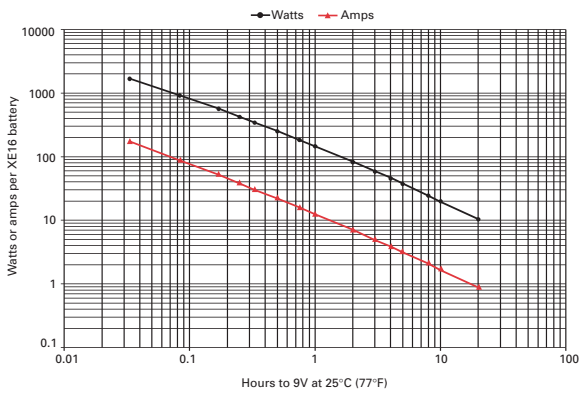


**Figure A-4: XE13 discharge data to 11.1V at 25°C (77°F)**



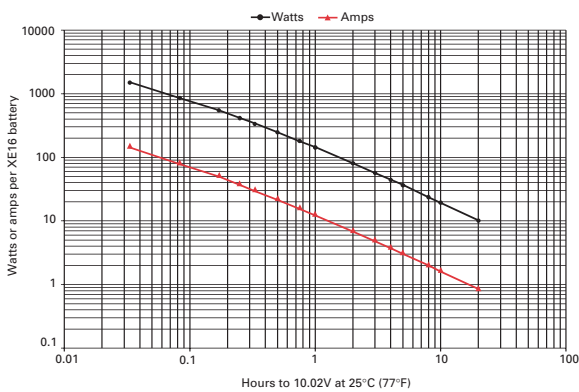
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 977       | 87.1     | 2.9           | 32.5        | 488.7                      | 16.3     | 180.9 | 6.0   |
| 5 min.  | 612       | 51.1     | 4.3           | 51.0        | 322.6                      | 26.9     | 113.4 | 9.4   |
| 10 min. | 410       | 34.0     | 5.8           | 69.7        | 216.0                      | 36.7     | 75.9  | 12.9  |
| 15 min. | 312       | 26.0     | 6.5           | 78.0        | 164.4                      | 41.1     | 57.8  | 14.4  |
| 20 min. | 254       | 21.3     | 7.0           | 83.7        | 133.7                      | 44.1     | 47.0  | 15.5  |
| 30 min. | 186       | 15.8     | 7.9           | 93.1        | 98.1                       | 49.1     | 34.5  | 17.2  |
| 45 min. | 133       | 11.4     | 8.6           | 100.1       | 70.3                       | 52.7     | 24.7  | 18.5  |
| 1 hr.   | 105       | 9.1      | 9.1           | 104.9       | 55.3                       | 55.3     | 19.4  | 19.4  |
| 2 hr.   | 57        | 5.1      | 10.1          | 113.4       | 29.9                       | 59.7     | 10.5  | 21.0  |
| 3 hr.   | 39        | 3.5      | 10.6          | 117.2       | 20.6                       | 61.8     | 7.2   | 21.7  |
| 4 hr.   | 30        | 2.7      | 11.0          | 119.8       | 15.8                       | 63.1     | 5.5   | 22.2  |
| 5 hr.   | 24        | 2.2      | 11.2          | 121.3       | 12.8                       | 63.9     | 4.5   | 22.5  |
| 8 hr.   | 16        | 1.5      | 11.6          | 124.7       | 8.2                        | 65.7     | 2.9   | 23.1  |
| 10 hr.  | 13        | 1.2      | 11.8          | 126.6       | 6.7                        | 66.7     | 2.3   | 23.4  |
| 20 hr.  | 7         | 0.6      | 12.4          | 133.3       | 3.5                        | 70.2     | 1.2   | 24.7  |

**Figure A-5: XE16 discharge data to 9V at 25°C (77°F)**



| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 1674      | 170.0    | 5.6           | 55.8        | 720.0                      | 24.0     | 261.6 | 8.7   |
| 5 min.  | 915       | 87.9     | 7.3           | 76.3        | 393.6                      | 32.8     | 143.0 | 11.9  |
| 10 min. | 566       | 52.0     | 8.8           | 96.2        | 243.4                      | 41.4     | 88.4  | 15.0  |
| 15 min. | 422       | 38.0     | 9.5           | 105.4       | 181.4                      | 45.3     | 65.9  | 16.5  |
| 20 min. | 342       | 30.3     | 10.0          | 112.7       | 146.8                      | 48.5     | 53.4  | 17.6  |
| 30 min. | 251       | 22.0     | 11.0          | 125.4       | 107.8                      | 53.9     | 39.2  | 19.6  |
| 45 min. | 183       | 15.8     | 11.8          | 137.5       | 78.8                       | 59.1     | 28.6  | 21.5  |
| 1 hr.   | 145       | 12.4     | 12.4          | 145.3       | 62.5                       | 62.5     | 22.7  | 22.7  |
| 2 hr.   | 82        | 7.0      | 13.9          | 164.1       | 35.3                       | 70.6     | 12.8  | 25.6  |
| 3 hr.   | 58        | 4.9      | 14.7          | 174.7       | 25.0                       | 75.1     | 9.1   | 27.3  |
| 4 hr.   | 45        | 3.8      | 15.3          | 181.4       | 19.5                       | 78.0     | 7.1   | 28.3  |
| 5 hr.   | 37        | 3.1      | 15.6          | 186.2       | 16.0                       | 80.1     | 5.8   | 29.1  |
| 8 hr.   | 24        | 2.1      | 16.4          | 195.2       | 10.5                       | 83.9     | 3.8   | 30.5  |
| 10 hr.  | 20        | 1.7      | 16.7          | 198.7       | 8.5                        | 85.4     | 3.1   | 31.0  |
| 20 hr.  | 10        | 0.9      | 17.3          | 206.7       | 4.4                        | 88.9     | 1.6   | 32.3  |

**Figure A-6: XE16 discharge data to 10.02V at 25°C (77°F)**

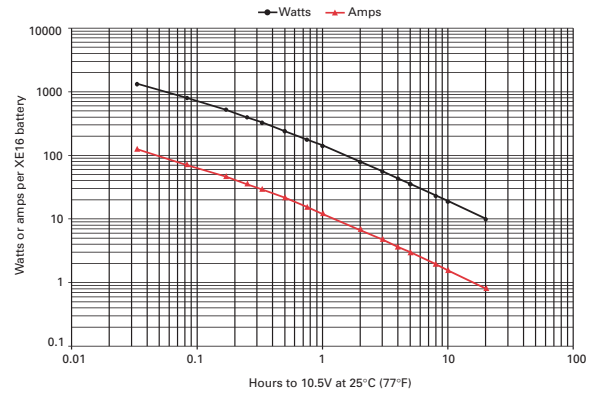


| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 1486      | 143.0    | 4.8           | 49.5        | 638.8                      | 21.3     | 232.1 | 7.7   |
| 5 min.  | 857       | 78.8     | 6.6           | 71.4        | 368.5                      | 30.7     | 133.9 | 11.2  |
| 10 min. | 546       | 49.3     | 8.4           | 92.9        | 234.9                      | 39.9     | 85.3  | 14.5  |
| 15 min. | 412       | 36.7     | 9.2           | 102.9       | 177.0                      | 44.2     | 64.3  | 16.1  |
| 20 min. | 335       | 29.6     | 9.8           | 110.4       | 143.9                      | 47.5     | 52.3  | 17.2  |
| 30 min. | 247       | 21.6     | 10.8          | 123.5       | 106.2                      | 53.1     | 38.6  | 19.3  |
| 45 min. | 180       | 15.6     | 11.7          | 135.1       | 77.5                       | 58.1     | 28.2  | 21.1  |
| 1 hr.   | 143       | 12.3     | 12.3          | 142.8       | 61.4                       | 61.4     | 22.3  | 22.3  |
| 2 hr.   | 81        | 6.9      | 13.7          | 161.6       | 34.7                       | 69.5     | 12.6  | 25.3  |
| 3 hr.   | 57        | 4.8      | 14.4          | 170.5       | 24.4                       | 73.3     | 8.9   | 26.6  |
| 4 hr.   | 44        | 3.7      | 14.8          | 176.8       | 19.0                       | 76.0     | 6.9   | 27.6  |
| 5 hr.   | 36        | 3.0      | 15.2          | 181.0       | 15.6                       | 77.8     | 5.7   | 28.3  |
| 8 hr.   | 24        | 2.0      | 15.7          | 189.3       | 10.2                       | 81.4     | 3.7   | 29.6  |
| 10 hr.  | 19        | 1.6      | 16.0          | 193.2       | 8.3                        | 83.1     | 3.0   | 30.2  |
| 20 hr.  | 10        | 0.8      | 16.7          | 201.8       | 4.3                        | 86.8     | 1.6   | 31.5  |



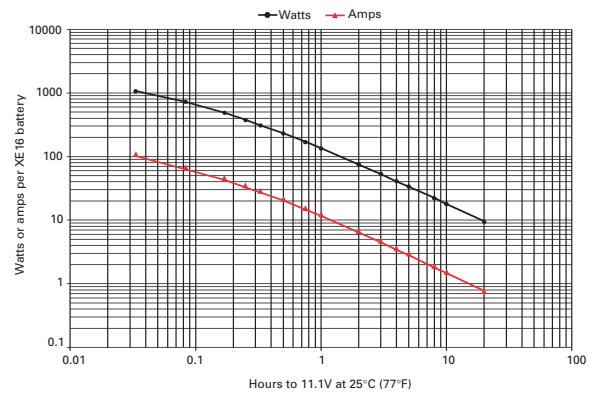
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 1312      | 124.9    | 4.2           | 43.7        | 564.3                      | 18.8     | 205.1 | 6.8   |
| 5 min.  | 799       | 71.8     | 6.0           | 66.5        | 343.4                      | 28.6     | 124.8 | 10.4  |
| 10 min. | 522       | 46.5     | 7.9           | 88.8        | 224.6                      | 38.2     | 81.6  | 13.9  |
| 15 min. | 397       | 35.1     | 8.8           | 99.3        | 170.7                      | 42.7     | 62.0  | 15.5  |
| 20 min. | 324       | 28.6     | 9.4           | 106.9       | 139.3                      | 46.0     | 50.6  | 16.7  |
| 30 min. | 240       | 21.0     | 10.5          | 120.1       | 103.3                      | 51.6     | 37.5  | 18.8  |
| 45 min. | 176       | 15.2     | 11.4          | 131.8       | 75.6                       | 56.7     | 27.5  | 20.6  |
| 1 hr.   | 140       | 12.0     | 12.0          | 139.7       | 60.1                       | 60.1     | 21.8  | 21.8  |
| 2 hr.   | 78        | 6.7      | 13.3          | 156.7       | 33.7                       | 67.4     | 12.2  | 24.5  |
| 3 hr.   | 55        | 4.7      | 14.0          | 166.1       | 23.8                       | 71.4     | 8.6   | 25.9  |
| 4 hr.   | 43        | 3.6      | 14.4          | 172.1       | 18.5                       | 74.0     | 6.7   | 26.9  |
| 5 hr.   | 35        | 2.9      | 14.7          | 176.1       | 15.1                       | 75.7     | 5.5   | 27.5  |
| 8 hr.   | 23        | 1.9      | 15.2          | 183.9       | 9.9                        | 79.1     | 3.6   | 28.7  |
| 10 hr.  | 19        | 1.6      | 15.5          | 187.7       | 8.1                        | 80.7     | 2.9   | 29.3  |
| 20 hr.  | 10        | 0.8      | 16.1          | 196.9       | 4.2                        | 84.7     | 1.5   | 30.8  |

Figure A-7: XE16 discharge data to 10.5V at 25°C (77°F)



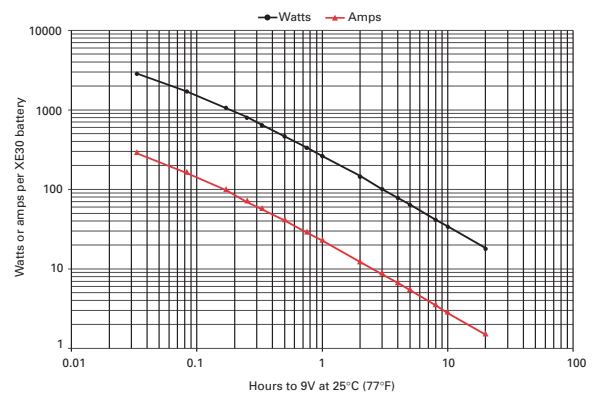
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 1058      | 100.4    | 3.3           | 35.2        | 454.8                      | 15.1     | 165.3 | 5.5   |
| 5 min.  | 721       | 62.1     | 5.2           | 60.0        | 309.9                      | 25.8     | 112.6 | 9.4   |
| 10 min. | 485       | 42.2     | 7.2           | 82.4        | 208.5                      | 35.4     | 75.8  | 12.9  |
| 15 min. | 374       | 32.5     | 8.1           | 93.4        | 160.6                      | 40.2     | 58.4  | 14.6  |
| 20 min. | 307       | 26.7     | 8.8           | 101.4       | 132.2                      | 43.6     | 48.0  | 15.9  |
| 30 min. | 230       | 19.9     | 9.9           | 114.7       | 98.7                       | 49.3     | 35.9  | 17.9  |
| 45 min. | 168       | 14.4     | 10.8          | 126.2       | 72.4                       | 54.3     | 26.3  | 19.7  |
| 1 hr.   | 134       | 11.5     | 11.5          | 134.1       | 57.7                       | 57.7     | 21.0  | 21.0  |
| 2 hr.   | 75        | 6.4      | 12.7          | 150.5       | 32.4                       | 64.7     | 11.8  | 23.5  |
| 3 hr.   | 53        | 4.4      | 13.3          | 159.3       | 22.8                       | 68.5     | 8.3   | 24.9  |
| 4 hr.   | 41        | 3.4      | 13.7          | 164.7       | 17.7                       | 70.8     | 6.4   | 25.7  |
| 5 hr.   | 34        | 2.8      | 13.9          | 168.5       | 14.5                       | 72.4     | 5.3   | 26.3  |
| 8 hr.   | 22        | 1.8      | 14.4          | 176.1       | 9.5                        | 75.7     | 3.4   | 27.5  |
| 10 hr.  | 18        | 1.5      | 14.7          | 179.1       | 7.7                        | 77.0     | 2.8   | 28.0  |
| 20 hr.  | 9         | 0.8      | 15.3          | 188.3       | 4.0                        | 81.0     | 1.5   | 29.4  |

Figure A-8: XE16 discharge data to 11.1V at 25°C (77°F)

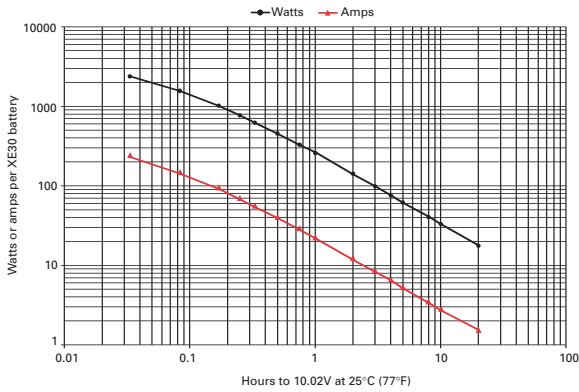


| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 2837      | 283.4    | 9.4           | 94.5        | 768.7                      | 25.6     | 267.6 | 8.9   |
| 5 min.  | 1694      | 160.1    | 13.3          | 141.1       | 459.2                      | 38.2     | 159.9 | 13.3  |
| 10 min. | 1062      | 95.6     | 16.3          | 180.5       | 287.7                      | 48.9     | 100.2 | 17.0  |
| 15 min. | 793       | 69.8     | 17.4          | 198.2       | 214.8                      | 53.7     | 74.8  | 18.7  |
| 20 min. | 638       | 55.6     | 18.3          | 210.4       | 172.8                      | 57.0     | 60.1  | 19.8  |
| 30 min. | 463       | 39.9     | 20.0          | 231.4       | 125.4                      | 62.7     | 43.7  | 21.8  |
| 45 min. | 333       | 28.4     | 21.3          | 249.7       | 90.2                       | 67.7     | 31.4  | 23.6  |
| 1 hr.   | 262       | 22.3     | 22.3          | 262.1       | 71.0                       | 71.0     | 24.7  | 24.7  |
| 2 hr.   | 144       | 12.1     | 24.3          | 288.7       | 39.1                       | 78.2     | 13.6  | 27.2  |
| 3 hr.   | 101       | 8.5      | 25.4          | 302.3       | 27.3                       | 81.9     | 9.5   | 28.5  |
| 4 hr.   | 78        | 6.6      | 26.2          | 311.8       | 21.1                       | 84.5     | 7.4   | 29.4  |
| 5 hr.   | 64        | 5.3      | 26.7          | 318.6       | 17.3                       | 86.3     | 6.0   | 30.1  |
| 8 hr.   | 41        | 3.5      | 27.9          | 331.1       | 11.2                       | 89.7     | 3.9   | 31.2  |
| 10 hr.  | 34        | 2.8      | 28.3          | 337.5       | 9.1                        | 91.5     | 3.2   | 31.8  |
| 20 hr.  | 18        | 1.5      | 30.0          | 357.1       | 4.8                        | 96.8     | 1.7   | 33.7  |

Figure A-9: XE30 discharge data to 9V at 25°C (77°F)

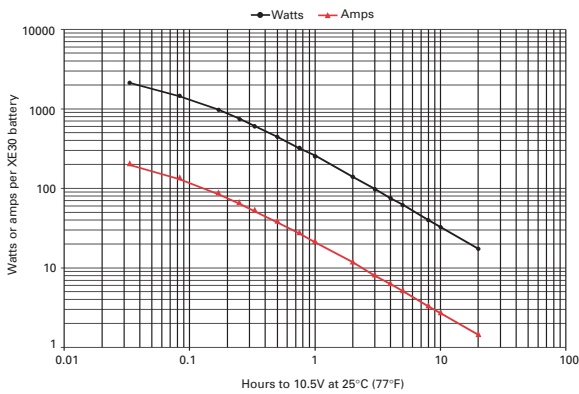


**Figure A-10: XE30 discharge data to 10.02V at 25°C (77°F)**



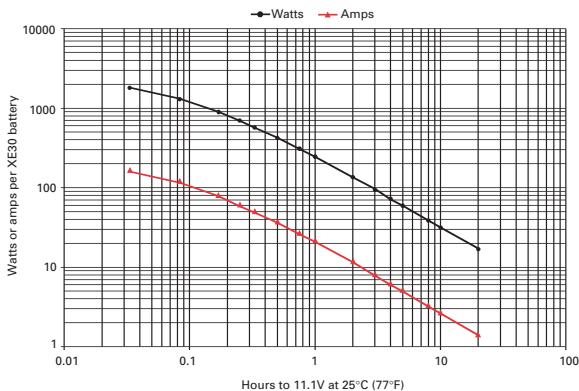
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 2381      | 224.8    | 7.5           | 79.3        | 645.3                      | 21.5     | 224.7 | 7.5   |
| 5 min.  | 1565      | 142.8    | 11.9          | 130.3       | 424.0                      | 35.3     | 147.6 | 12.3  |
| 10 min. | 1017      | 90.6     | 15.4          | 172.9       | 275.6                      | 46.8     | 95.9  | 16.3  |
| 15 min. | 767       | 67.4     | 16.9          | 191.8       | 207.9                      | 52.0     | 72.4  | 18.1  |
| 20 min. | 622       | 54.2     | 17.9          | 205.4       | 168.6                      | 55.7     | 58.7  | 19.4  |
| 30 min. | 455       | 39.2     | 19.6          | 227.6       | 123.4                      | 61.7     | 42.9  | 21.5  |
| 45 min. | 328       | 28.1     | 21.0          | 245.9       | 88.9                       | 66.6     | 30.9  | 23.2  |
| 1 hr.   | 258       | 21.9     | 21.9          | 258.3       | 70.0                       | 70.0     | 24.4  | 24.4  |
| 2 hr.   | 142       | 11.9     | 23.8          | 283.7       | 38.4                       | 76.9     | 13.4  | 26.8  |
| 3 hr.   | 98        | 8.3      | 24.8          | 294.9       | 26.6                       | 79.9     | 9.3   | 27.8  |
| 4 hr.   | 76        | 6.4      | 25.5          | 304.4       | 20.6                       | 82.5     | 7.2   | 28.7  |
| 5 hr.   | 62        | 5.2      | 25.9          | 309.4       | 16.8                       | 83.8     | 5.8   | 29.2  |
| 8 hr.   | 41        | 3.4      | 27.0          | 323.8       | 11.0                       | 87.7     | 3.8   | 30.5  |
| 10 hr.  | 33        | 2.75     | 27.5          | 330.8       | 9.0                        | 89.6     | 3.1   | 31.2  |
| 20 hr.  | 18        | 1.5      | 29.6          | 354.6       | 4.8                        | 96.1     | 1.7   | 33.5  |

**Figure A-11: XE30 discharge data to 10.5V at 25°C (77°F)**



| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 2129      | 195.7    | 6.5           | 70.9        | 576.8                      | 19.2     | 200.8 | 6.7   |
| 5 min.  | 1454      | 130.9    | 10.9          | 121.1       | 391.1                      | 32.8     | 137.2 | 11.4  |
| 10 min. | 972       | 85.5     | 14.5          | 165.3       | 263.4                      | 44.8     | 91.7  | 15.6  |
| 15 min. | 742       | 64.5     | 16.1          | 185.5       | 201.1                      | 50.3     | 70.0  | 17.5  |
| 20 min. | 603       | 52.1     | 17.2          | 198.9       | 163.3                      | 53.9     | 56.9  | 18.8  |
| 30 min. | 444       | 38.0     | 19.0          | 222.0       | 120.3                      | 60.1     | 41.9  | 20.9  |
| 45 min. | 321       | 27.3     | 20.5          | 240.8       | 87.0                       | 65.2     | 30.3  | 22.7  |
| 1 hr.   | 253       | 21.4     | 21.4          | 252.7       | 68.5                       | 68.5     | 23.8  | 23.8  |
| 2 hr.   | 139       | 11.7     | 23.4          | 278.8       | 37.8                       | 75.5     | 13.2  | 26.3  |
| 3 hr.   | 97        | 8.1      | 24.3          | 291.2       | 26.3                       | 78.9     | 9.2   | 27.5  |
| 4 hr.   | 75        | 6.2      | 25.0          | 299.5       | 20.3                       | 81.2     | 7.1   | 28.3  |
| 5 hr.   | 61        | 5.1      | 25.4          | 306.3       | 16.6                       | 83.0     | 5.8   | 28.9  |
| 8 hr.   | 40        | 3.3      | 26.4          | 317.4       | 10.8                       | 86.0     | 3.7   | 29.9  |
| 10 hr.  | 32        | 2.7      | 26.9          | 324.0       | 8.8                        | 87.8     | 3.1   | 30.6  |
| 20 hr.  | 17        | 1.4      | 28.7          | 347.3       | 4.7                        | 94.1     | 1.6   | 32.8  |

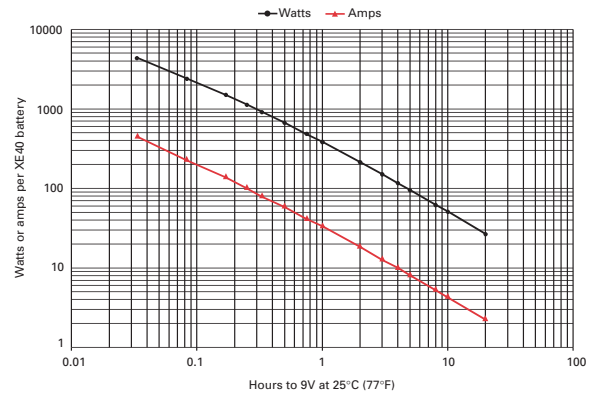
**Figure A-12: XE30 discharge data to 11.1V at 25°C (77°F)**



| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 1801      | 160.1    | 5.3           | 60.0        | 487.9                      | 16.2     | 169.9 | 5.7   |
| 5 min.  | 1298      | 113.6    | 9.5           | 108.2       | 351.8                      | 29.3     | 122.5 | 10.2  |
| 10 min. | 895       | 77.6     | 13.2          | 152.2       | 242.6                      | 41.3     | 84.5  | 14.4  |
| 15 min. | 698       | 59.6     | 14.9          | 174.4       | 189.0                      | 47.3     | 65.8  | 16.5  |
| 20 min. | 571       | 48.7     | 16.1          | 188.3       | 154.6                      | 51.0     | 53.8  | 17.8  |
| 30 min. | 425       | 36.1     | 18.0          | 212.2       | 115.0                      | 57.5     | 40.0  | 20.0  |
| 45 min. | 309       | 26.1     | 19.6          | 231.9       | 83.8                       | 62.8     | 29.2  | 21.9  |
| 1 hr.   | 245       | 20.6     | 20.6          | 244.7       | 66.3                       | 66.3     | 23.1  | 23.1  |
| 2 hr.   | 135       | 11.3     | 22.6          | 270.2       | 36.6                       | 73.2     | 12.7  | 25.5  |
| 3 hr.   | 94        | 7.9      | 23.6          | 282.0       | 25.5                       | 76.4     | 8.9   | 26.6  |
| 4 hr.   | 72        | 6.1      | 24.2          | 289.7       | 19.6                       | 78.5     | 6.8   | 27.3  |
| 5 hr.   | 59        | 4.9      | 24.7          | 296.5       | 16.1                       | 80.3     | 5.6   | 28.0  |
| 8 hr.   | 39        | 3.2      | 25.6          | 308.1       | 10.4                       | 83.5     | 3.6   | 29.1  |
| 10 hr.  | 31        | 2.6      | 26.1          | 314.3       | 8.5                        | 85.2     | 3.0   | 29.6  |
| 20 hr.  | 17        | 1.4      | 27.7          | 336.3       | 4.6                        | 91.1     | 1.6   | 31.7  |

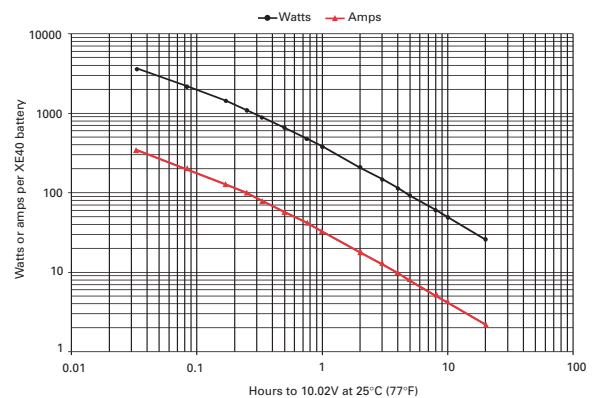
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 4338      | 436.6    | 14.5          | 144.4       | 777.0                      | 25.9     | 269.4 | 9.0   |
| 5 min.  | 2370      | 226.1    | 18.8          | 197.4       | 424.5                      | 35.4     | 147.2 | 12.3  |
| 10 min. | 1497      | 136.5    | 23.2          | 254.4       | 268.1                      | 45.6     | 93.0  | 15.8  |
| 15 min. | 1123      | 100.3    | 25.1          | 280.6       | 201.1                      | 50.3     | 69.7  | 17.4  |
| 20 min. | 909       | 80.2     | 26.5          | 299.9       | 162.8                      | 53.7     | 56.5  | 18.6  |
| 30 min. | 665       | 58.0     | 29.0          | 332.3       | 119.1                      | 59.5     | 41.3  | 20.6  |
| 45 min. | 484       | 41.6     | 31.2          | 362.8       | 86.7                       | 65.0     | 30.0  | 22.5  |
| 1 hr.   | 383       | 32.7     | 32.7          | 382.5       | 68.5                       | 68.5     | 23.8  | 23.8  |
| 2 hr.   | 213       | 18.1     | 36.2          | 426.8       | 38.2                       | 76.5     | 13.3  | 26.5  |
| 3 hr.   | 150       | 12.6     | 37.8          | 449.7       | 26.9                       | 80.6     | 9.3   | 27.9  |
| 4 hr.   | 116       | 9.8      | 39.1          | 464.0       | 20.8                       | 83.1     | 7.2   | 28.8  |
| 5 hr.   | 95        | 8.0      | 39.9          | 474.8       | 17.0                       | 85.0     | 5.9   | 29.5  |
| 8 hr.   | 62        | 5.2      | 41.6          | 494.0       | 11.1                       | 88.5     | 3.8   | 30.7  |
| 10 hr.  | 51        | 4.2      | 42.4          | 505.0       | 9.0                        | 90.5     | 3.1   | 31.4  |
| 20 hr.  | 27        | 2.2      | 44.4          | 529.5       | 4.7                        | 94.8     | 1.6   | 32.9  |

Figure A-13: XE40 discharge data to 9V at 25°C (77°F)



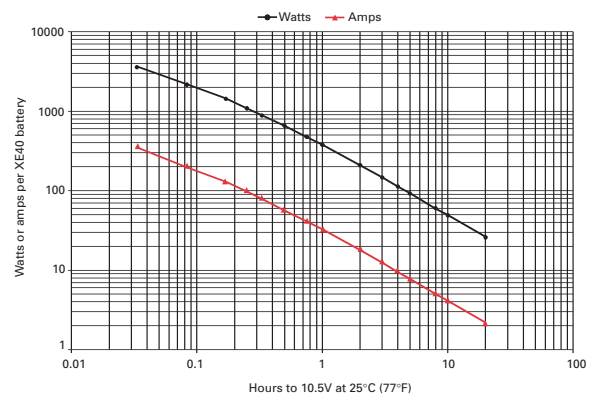
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 3580      | 337.9    | 11.3          | 119.2       | 641.2                      | 21.4     | 222.3 | 7.4   |
| 5 min.  | 2155      | 199.1    | 16.6          | 179.5       | 386.1                      | 32.2     | 133.9 | 11.2  |
| 10 min. | 1426      | 127.9    | 21.7          | 242.5       | 255.5                      | 43.4     | 88.6  | 15.1  |
| 15 min. | 1085      | 96.0     | 24.0          | 271.1       | 194.3                      | 48.6     | 67.4  | 16.8  |
| 20 min. | 884       | 77.5     | 25.6          | 291.6       | 158.3                      | 52.2     | 54.9  | 18.1  |
| 30 min. | 652       | 56.6     | 28.3          | 326.0       | 116.8                      | 58.4     | 40.5  | 20.3  |
| 45 min. | 476       | 40.8     | 30.6          | 356.7       | 85.2                       | 63.9     | 29.5  | 22.2  |
| 1 hr.   | 376       | 32.1     | 32.1          | 376.3       | 67.4                       | 67.4     | 23.4  | 23.4  |
| 2 hr.   | 209       | 17.7     | 35.4          | 418.2       | 37.5                       | 74.9     | 13.0  | 26.0  |
| 3 hr.   | 146       | 12.3     | 36.9          | 438.7       | 26.2                       | 78.6     | 9.1   | 27.2  |
| 4 hr.   | 113       | 9.5      | 37.9          | 451.8       | 20.2                       | 80.9     | 7.0   | 28.1  |
| 5 hr.   | 93        | 7.7      | 38.6          | 462.5       | 16.6                       | 82.9     | 5.7   | 28.7  |
| 8 hr.   | 60        | 5.0      | 40.1          | 481.8       | 10.8                       | 86.3     | 3.7   | 29.9  |
| 10 hr.  | 49        | 4.1      | 40.8          | 490.3       | 8.8                        | 87.8     | 3.0   | 30.5  |
| 20 hr.  | 26        | 2.2      | 43.0          | 518.5       | 4.6                        | 92.9     | 1.6   | 32.2  |

Figure A-14: XE40 discharge data to 10.02V at 25°C (77°F)

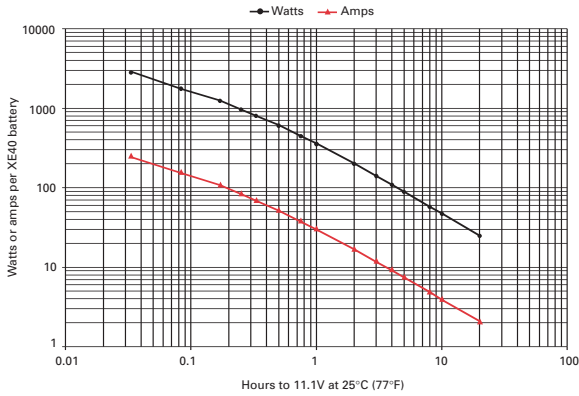


| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 3232      | 296.4    | 9.9           | 107.6       | 578.9                      | 19.3     | 200.7 | 6.7   |
| 5 min.  | 1987      | 179.6    | 15.0          | 165.5       | 355.9                      | 29.6     | 123.4 | 10.3  |
| 10 min. | 1350      | 119.4    | 20.3          | 229.4       | 241.7                      | 41.1     | 83.8  | 14.2  |
| 15 min. | 1010      | 90.9     | 22.7          | 260.0       | 186.3                      | 46.6     | 64.6  | 16.2  |
| 20 min. | 852       | 74.1     | 24.4          | 281.2       | 152.6                      | 50.4     | 52.9  | 17.5  |
| 30 min. | 633       | 54.7     | 27.3          | 316.6       | 113.4                      | 56.7     | 39.3  | 19.7  |
| 45 min. | 464       | 39.7     | 29.8          | 347.9       | 83.1                       | 62.3     | 28.8  | 21.6  |
| 1 hr.   | 368       | 31.3     | 31.3          | 368.3       | 66.0                       | 66.0     | 22.9  | 22.9  |
| 2 hr.   | 205       | 17.3     | 34.5          | 410.8       | 36.8                       | 73.6     | 12.8  | 25.5  |
| 3 hr.   | 144       | 12.1     | 36.2          | 431.3       | 25.8                       | 77.3     | 8.9   | 26.8  |
| 4 hr.   | 111       | 9.3      | 37.2          | 444.4       | 19.9                       | 79.6     | 6.9   | 27.6  |
| 5 hr.   | 91        | 7.6      | 37.9          | 453.3       | 16.2                       | 81.2     | 5.6   | 28.2  |
| 8 hr.   | 59        | 4.9      | 39.3          | 473.0       | 10.6                       | 84.7     | 3.7   | 29.4  |
| 10 hr.  | 48        | 4.0      | 39.9          | 481.8       | 8.6                        | 86.3     | 3.0   | 29.9  |
| 20 hr.  | 26        | 2.1      | 42.2          | 509.9       | 4.6                        | 91.3     | 1.6   | 31.7  |

Figure A-15: XE40 discharge data to 10.5V at 25°C (77°F)

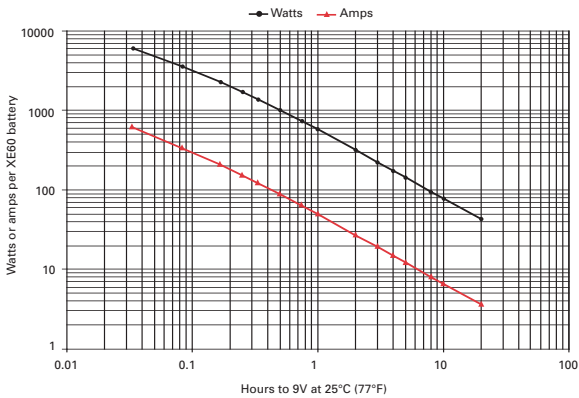


**Figure A-16: XE40 discharge data to 11.1V at 25°C (77°F)**



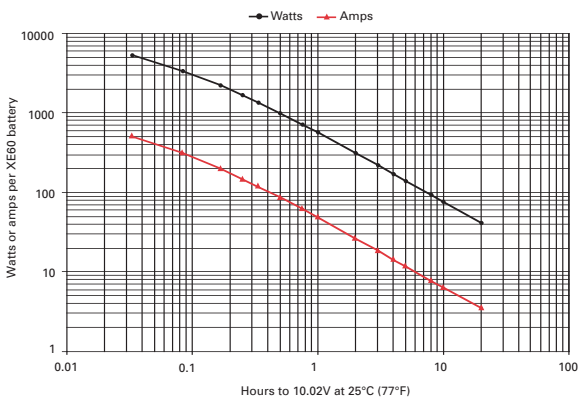
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 2814      | 249.4    | 8.3           | 93.7        | 504.1                      | 16.8     | 174.8 | 5.8   |
| 5 min.  | 1753      | 153.6    | 12.8          | 146.0       | 314.0                      | 26.2     | 108.9 | 9.1   |
| 10 min. | 1234      | 106.6    | 18.1          | 209.9       | 221.1                      | 37.6     | 76.7  | 13.0  |
| 15 min. | 964       | 83.0     | 20.7          | 241.0       | 172.7                      | 43.2     | 59.9  | 15.0  |
| 20 min. | 802       | 68.5     | 22.6          | 264.5       | 143.6                      | 47.4     | 49.8  | 16.4  |
| 30 min. | 603       | 51.3     | 25.7          | 301.3       | 107.9                      | 54.0     | 37.4  | 18.7  |
| 45 min. | 445       | 37.6     | 28.2          | 333.8       | 79.7                       | 59.8     | 27.6  | 20.7  |
| 1 hr.   | 355       | 29.9     | 29.9          | 354.6       | 63.5                       | 63.5     | 22.0  | 22.0  |
| 2 hr.   | 200       | 16.8     | 33.5          | 399.7       | 35.8                       | 71.6     | 12.4  | 24.8  |
| 3 hr.   | 140       | 11.7     | 35.0          | 420.2       | 25.1                       | 75.3     | 8.7   | 26.1  |
| 4 hr.   | 109       | 9.0      | 36.2          | 434.6       | 19.5                       | 77.8     | 6.7   | 27.0  |
| 5 hr.   | 89        | 7.4      | 36.9          | 444.1       | 15.9                       | 79.6     | 5.5   | 27.6  |
| 8 hr.   | 58        | 4.8      | 38.3          | 461.2       | 10.3                       | 82.6     | 3.6   | 28.6  |
| 10 hr.  | 47        | 3.9      | 38.9          | 469.6       | 8.4                        | 84.1     | 2.9   | 29.2  |
| 20 hr.  | 25        | 2.1      | 41.0          | 495.2       | 4.4                        | 88.7     | 1.5   | 30.8  |

**Figure A-17: XE60 discharge data to 9V at 25°C (77°F)**



| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 6050      | 605.3    | 20.2          | 201.7       | 701.1                      | 23.4     | 270.1 | 9.0   |
| 5 min.  | 3539      | 328.3    | 27.4          | 294.9       | 410.1                      | 34.2     | 158.0 | 13.2  |
| 10 min. | 2267      | 202.8    | 33.8          | 377.8       | 262.7                      | 43.8     | 101.2 | 16.9  |
| 15 min. | 1702      | 150.1    | 37.5          | 425.5       | 197.2                      | 49.3     | 76.0  | 19.0  |
| 20 min. | 1375      | 120.1    | 40.0          | 458.3       | 159.3                      | 53.1     | 61.4  | 20.5  |
| 30 min. | 1005      | 86.8     | 43.4          | 502.5       | 116.5                      | 58.2     | 44.9  | 22.4  |
| 45 min. | 725       | 62.1     | 46.6          | 544.0       | 84.1                       | 63.0     | 32.4  | 24.3  |
| 1 hr.   | 572       | 48.7     | 48.7          | 571.7       | 66.3                       | 66.3     | 25.5  | 25.5  |
| 2 hr.   | 314       | 26.3     | 52.7          | 628.3       | 36.4                       | 72.8     | 14.0  | 28.1  |
| 3 hr.   | 219       | 18.6     | 55.7          | 657.6       | 25.4                       | 76.2     | 9.8   | 29.4  |
| 4 hr.   | 170       | 14.4     | 57.7          | 681.8       | 19.8                       | 79.0     | 7.6   | 30.4  |
| 5 hr.   | 140       | 11.9     | 59.3          | 699.8       | 16.2                       | 81.1     | 6.2   | 31.2  |
| 8 hr.   | 92        | 7.8      | 62.4          | 735.5       | 10.7                       | 85.2     | 4.1   | 32.8  |
| 10 hr.  | 76        | 6.4      | 63.9          | 759.0       | 8.8                        | 88.0     | 3.4   | 33.9  |
| 20 hr.  | 42        | 3.5      | 70.8          | 841.1       | 4.9                        | 97.5     | 1.9   | 37.5  |

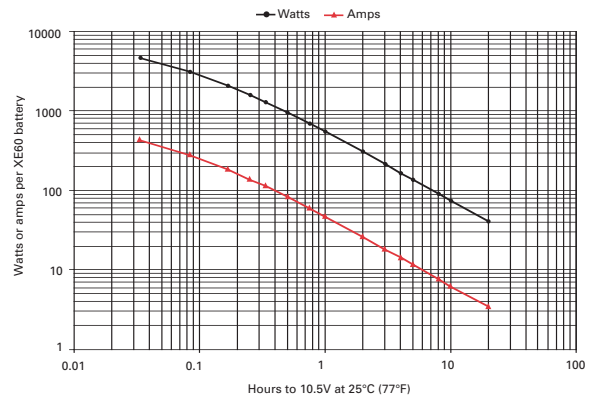
**Figure A-18: XE60 discharge data to 10.02V at 25°C (77°F)**



| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 5228      | 494.8    | 16.5          | 174.3       | 605.8                      | 20.2     | 233.4 | 6.8   |
| 5 min.  | 3337      | 304.4    | 25.4          | 278.1       | 386.7                      | 32.2     | 149.0 | 11.4  |
| 10 min. | 2175      | 193.6    | 32.3          | 362.6       | 252.1                      | 42.0     | 97.1  | 15.3  |
| 15 min. | 1644      | 144.5    | 36.1          | 411.0       | 190.5                      | 47.6     | 73.4  | 17.5  |
| 20 min. | 1332      | 116.1    | 38.7          | 444.2       | 154.4                      | 51.5     | 59.5  | 19.0  |
| 30 min. | 977       | 84.2     | 42.1          | 488.4       | 113.2                      | 56.6     | 43.6  | 21.1  |
| 45 min. | 706       | 60.3     | 45.2          | 529.3       | 81.8                       | 61.3     | 31.5  | 23.0  |
| 1 hr.   | 556       | 47.3     | 47.3          | 556.2       | 64.5                       | 64.5     | 24.8  | 24.3  |
| 2 hr.   | 307       | 25.9     | 51.7          | 615.0       | 35.6                       | 71.3     | 13.7  | 27.0  |
| 3 hr.   | 215       | 18.1     | 54.2          | 646.5       | 25.0                       | 74.9     | 9.6   | 28.4  |
| 4 hr.   | 167       | 14.0     | 56.0          | 668.4       | 19.4                       | 77.5     | 7.5   | 29.3  |
| 5 hr.   | 137       | 11.5     | 57.4          | 685.4       | 15.9                       | 79.4     | 6.1   | 30.1  |
| 8 hr.   | 90        | 7.6      | 60.6          | 723.1       | 10.5                       | 83.8     | 4.0   | 31.7  |
| 10 hr.  | 74        | 6.2      | 62.3          | 742.5       | 8.6                        | 86.0     | 3.3   | 32.6  |
| 20 hr.  | 41        | 3.4      | 68.9          | 814.0       | 4.7                        | 94.3     | 1.8   | 35.6  |

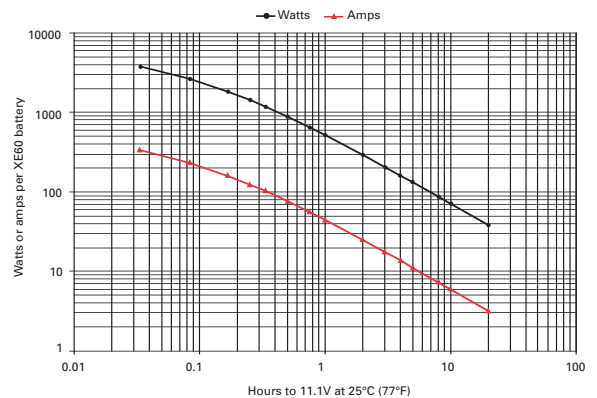
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 4587      | 422.9    | 14.1          | 152.9       | 531.6                      | 17.7     | 204.8 | 6.8   |
| 5 min.  | 3066      | 275.3    | 22.9          | 255.5       | 355.3                      | 29.6     | 136.9 | 11.4  |
| 10 min. | 2050      | 180.7    | 30.1          | 341.7       | 237.6                      | 39.6     | 91.5  | 15.3  |
| 15 min. | 1567      | 136.7    | 34.2          | 391.8       | 181.6                      | 45.4     | 70.0  | 17.5  |
| 20 min. | 1279      | 110.8    | 36.9          | 426.3       | 148.2                      | 49.4     | 57.1  | 19.0  |
| 30 min. | 945       | 81.2     | 40.6          | 472.5       | 109.5                      | 54.8     | 42.2  | 21.1  |
| 45 min. | 687       | 58.5     | 43.9          | 515.2       | 79.6                       | 59.7     | 30.7  | 23.0  |
| 1 hr.   | 543       | 46.1     | 46.1          | 543.3       | 63.0                       | 63.0     | 24.3  | 24.3  |
| 2 hr.   | 302       | 25.4     | 50.7          | 603.7       | 35.0                       | 70.0     | 13.5  | 27.0  |
| 3 hr.   | 212       | 17.7     | 53.2          | 635.6       | 24.6                       | 73.7     | 9.5   | 28.4  |
| 4 hr.   | 164       | 13.7     | 54.9          | 657.3       | 19.0                       | 76.2     | 7.3   | 29.3  |
| 5 hr.   | 135       | 11.3     | 56.3          | 674.1       | 15.6                       | 78.1     | 6.0   | 30.1  |
| 8 hr.   | 89        | 7.4      | 59.3          | 710.8       | 10.3                       | 82.4     | 4.0   | 31.7  |
| 10 hr.  | 73        | 6.1      | 60.9          | 729.4       | 8.5                        | 84.5     | 3.3   | 32.6  |
| 20 hr.  | 40        | 3.4      | 67.1          | 798.1       | 4.6                        | 92.5     | 1.8   | 35.6  |

Figure A-19: XE60 discharge data to 10.5V at 25°C (77°F)



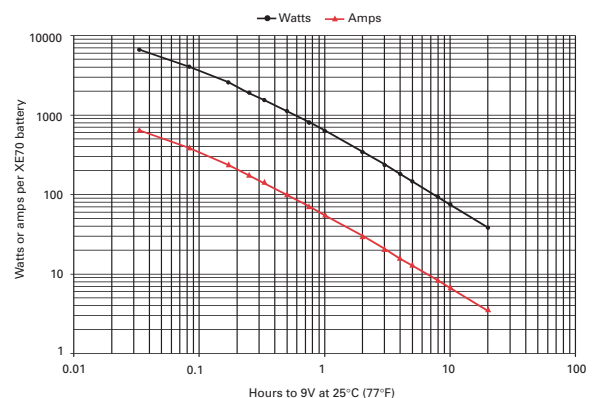
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 3684      | 328.6    | 11.0          | 122.8       | 426.9                      | 14.2     | 164.5 | 5.5   |
| 5 min.  | 2601      | 227.8    | 19.0          | 216.7       | 301.4                      | 25.1     | 116.1 | 9.7   |
| 10 min. | 1806      | 156.3    | 26.1          | 301.0       | 209.3                      | 34.9     | 80.6  | 13.4  |
| 15 min. | 1409      | 121.2    | 30.3          | 352.3       | 163.3                      | 40.8     | 62.9  | 15.7  |
| 20 min. | 1165      | 99.8     | 33.3          | 388.4       | 135.0                      | 45.0     | 52.0  | 17.3  |
| 30 min. | 876       | 74.6     | 37.3          | 437.9       | 101.5                      | 50.8     | 39.1  | 19.6  |
| 45 min. | 646       | 54.8     | 41.1          | 484.8       | 74.9                       | 56.2     | 28.9  | 21.6  |
| 1 hr.   | 516       | 43.6     | 43.6          | 515.9       | 59.8                       | 59.8     | 23.0  | 23.0  |
| 2 hr.   | 291       | 24.5     | 48.9          | 582.9       | 33.8                       | 67.5     | 13.0  | 26.0  |
| 3 hr.   | 206       | 17.2     | 51.6          | 617.1       | 23.8                       | 71.5     | 9.2   | 27.5  |
| 4 hr.   | 160       | 13.3     | 53.4          | 639.6       | 18.5                       | 74.1     | 7.1   | 28.6  |
| 5 hr.   | 131       | 10.9     | 54.7          | 656.2       | 15.2                       | 76.0     | 5.9   | 29.3  |
| 8 hr.   | 86        | 7.2      | 57.4          | 689.9       | 10.0                       | 79.9     | 3.8   | 30.8  |
| 10 hr.  | 71        | 5.9      | 58.7          | 705.8       | 8.2                        | 81.8     | 3.2   | 31.5  |
| 20 hr.  | 38        | 3.1      | 63.0          | 758.7       | 4.4                        | 87.9     | 1.7   | 33.9  |

Figure A-20: XE60 discharge data to 11.1V at 25°C (77°F)

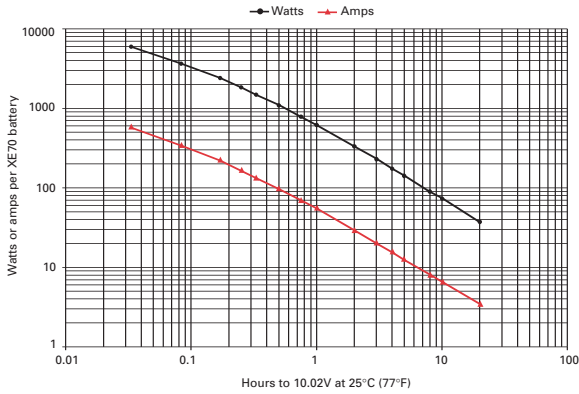


| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 6597      | 644.0    | 21.4          | 219.7       | 674.0                      | 22.4     | 256.7 | 8.5   |
| 5 min.  | 4051      | 388.4    | 32.4          | 337.4       | 413.9                      | 34.5     | 157.6 | 13.1  |
| 10 min. | 2565      | 235.6    | 40.0          | 436.0       | 262.0                      | 44.5     | 99.8  | 17.0  |
| 15 min. | 1909      | 172.3    | 43.1          | 477.2       | 195.0                      | 48.8     | 74.3  | 18.6  |
| 20 min. | 1540      | 137.8    | 45.5          | 508.2       | 157.3                      | 51.9     | 59.9  | 19.8  |
| 30 min. | 1122      | 98.5     | 49.3          | 561.2       | 114.7                      | 57.3     | 43.7  | 21.8  |
| 45 min. | 804       | 70.0     | 52.5          | 603.1       | 82.2                       | 61.6     | 31.3  | 23.5  |
| 1 hr.   | 627       | 54.7     | 54.6          | 627.2       | 64.1                       | 64.1     | 24.4  | 24.4  |
| 2 hr.   | 342       | 29.6     | 59.2          | 683.4       | 34.9                       | 69.8     | 13.3  | 26.6  |
| 3 hr.   | 235       | 20.5     | 61.4          | 705.9       | 24.0                       | 72.1     | 9.2   | 27.5  |
| 4 hr.   | 181       | 15.7     | 62.6          | 721.8       | 18.4                       | 73.7     | 7.0   | 28.1  |
| 5 hr.   | 146       | 12.8     | 63.8          | 729.0       | 14.9                       | 74.5     | 5.7   | 28.4  |
| 8 hr.   | 93        | 8.2      | 65.7          | 743.5       | 9.5                        | 76.0     | 3.6   | 28.9  |
| 10 hr.  | 75        | 6.7      | 66.6          | 752.0       | 7.7                        | 76.8     | 2.9   | 29.3  |
| 20 hr.  | 38        | 3.5      | 69.3          | 764.3       | 3.9                        | 78.1     | 1.5   | 29.7  |

Figure A-21: XE70 discharge data to 9V at 25°C (77°F)

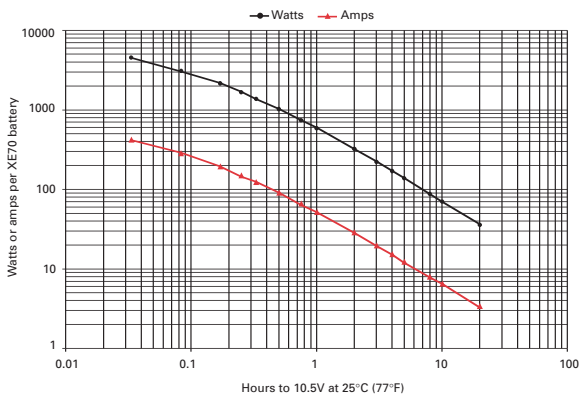


**Figure A-22: XE70 discharge data to 10.02V at 25°C (77°F)**



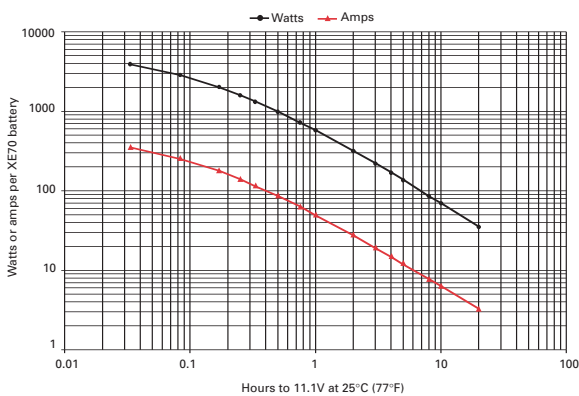
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 5942      | 569.8    | 19.0          | 197.9       | 607.0                      | 20.2     | 231.2 | 7.7   |
| 5 min.  | 3636      | 337.6    | 28.1          | 302.8       | 371.4                      | 30.9     | 141.5 | 11.8  |
| 10 min. | 2411      | 218.5    | 37.2          | 409.9       | 246.3                      | 41.9     | 93.8  | 16.0  |
| 15 min. | 1833      | 163.8    | 41.0          | 458.2       | 187.2                      | 46.8     | 71.3  | 17.8  |
| 20 min. | 1490      | 132.6    | 43.7          | 491.6       | 152.2                      | 50.2     | 58.0  | 19.1  |
| 30 min. | 1091      | 96.0     | 48.0          | 545.5       | 111.5                      | 55.7     | 42.5  | 21.2  |
| 45 min. | 786       | 68.6     | 51.4          | 589.1       | 80.2                       | 60.2     | 30.6  | 22.9  |
| 1 hr.   | 615       | 53.6     | 53.6          | 615.4       | 62.9                       | 62.9     | 23.9  | 23.9  |
| 2 hr.   | 333       | 28.9     | 57.8          | 666.1       | 34.0                       | 68.1     | 13.0  | 25.9  |
| 3 hr.   | 229       | 19.9     | 59.6          | 687.5       | 23.4                       | 70.2     | 8.9   | 26.8  |
| 4 hr.   | 175       | 15.2     | 61.0          | 699.7       | 17.9                       | 71.5     | 6.8   | 27.2  |
| 5 hr.   | 142       | 12.4     | 61.8          | 707.6       | 14.5                       | 72.3     | 5.5   | 27.5  |
| 8 hr.   | 90        | 8.0      | 63.6          | 719.0       | 9.2                        | 73.5     | 3.5   | 28.0  |
| 10 hr.  | 73        | 6.5      | 64.5          | 727.6       | 7.4                        | 74.3     | 2.8   | 28.3  |
| 20 hr.  | 37        | 3.4      | 67.9          | 748.4       | 3.8                        | 76.5     | 1.5   | 29.1  |

**Figure A-23: XE70 discharge data to 10.5V at 25°C (77°F)**



| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 5140      | 480.8    | 16.0          | 171.2       | 525.1                      | 17.5     | 200.0 | 6.7   |
| 5 min.  | 3317      | 301.9    | 25.1          | 276.3       | 338.9                      | 28.2     | 129.1 | 10.8  |
| 10 min. | 2258      | 201.5    | 34.3          | 383.8       | 230.7                      | 39.2     | 87.9  | 14.9  |
| 15 min. | 1738      | 154.3    | 38.6          | 434.4       | 177.5                      | 44.4     | 67.6  | 16.9  |
| 20 min. | 1420      | 125.2    | 41.3          | 468.7       | 145.1                      | 47.9     | 55.3  | 18.2  |
| 30 min. | 1053      | 92.0     | 46.0          | 526.7       | 107.6                      | 53.8     | 41.0  | 20.5  |
| 45 min. | 761       | 66.3     | 49.7          | 570.4       | 77.7                       | 58.3     | 29.6  | 22.2  |
| 1 hr.   | 600       | 52.1     | 52.1          | 599.9       | 61.3                       | 61.3     | 23.3  | 23.3  |
| 2 hr.   | 327       | 28.4     | 56.7          | 653.8       | 33.4                       | 66.8     | 12.7  | 25.4  |
| 3 hr.   | 225       | 19.6     | 58.7          | 674.6       | 23.0                       | 68.9     | 8.7   | 26.2  |
| 4 hr.   | 172       | 15.0     | 60.2          | 687.5       | 17.6                       | 70.2     | 6.7   | 26.7  |
| 5 hr.   | 139       | 12.2     | 60.7          | 695.3       | 14.2                       | 71.0     | 5.4   | 27.1  |
| 8 hr.   | 89        | 7.8      | 62.6          | 709.2       | 9.1                        | 72.5     | 3.4   | 27.6  |
| 10 hr.  | 72        | 6.4      | 63.5          | 715.3       | 7.3                        | 73.1     | 2.8   | 27.8  |
| 20 hr.  | 37        | 3.3      | 66.4          | 730.0       | 3.7                        | 74.6     | 1.4   | 28.4  |

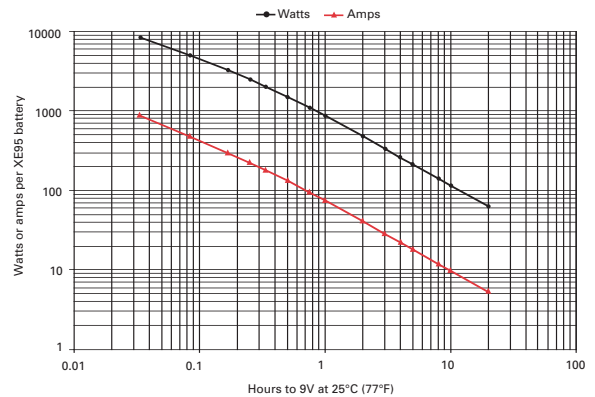
**Figure A-24: XE70 discharge data to 11.1V at 25°C (77°F)**



| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 3911      | 351.5    | 11.7          | 130.2       | 399.5                      | 13.3     | 152.2 | 5.1   |
| 5 min.  | 2870      | 254.3    | 21.2          | 239.0       | 293.2                      | 24.4     | 111.7 | 9.3   |
| 10 min. | 2028      | 177.0    | 30.1          | 344.7       | 207.1                      | 35.2     | 78.9  | 13.4  |
| 15 min. | 1586      | 137.4    | 34.4          | 396.4       | 162.0                      | 40.5     | 61.7  | 15.4  |
| 20 min. | 1313      | 113.6    | 37.5          | 433.3       | 134.1                      | 44.3     | 51.1  | 16.9  |
| 30 min. | 984       | 85.2     | 42.6          | 492.2       | 100.6                      | 50.3     | 38.3  | 19.2  |
| 45 min. | 723       | 62.4     | 46.8          | 542.4       | 73.9                       | 55.4     | 28.1  | 21.1  |
| 1 hr.   | 574       | 49.5     | 49.5          | 574.4       | 58.7                       | 58.7     | 22.4  | 22.4  |
| 2 hr.   | 317       | 27.5     | 54.9          | 634.1       | 32.4                       | 64.8     | 12.3  | 24.7  |
| 3 hr.   | 219       | 19.1     | 57.1          | 658.0       | 22.4                       | 67.2     | 8.5   | 25.6  |
| 4 hr.   | 168       | 14.7     | 58.9          | 672.7       | 17.2                       | 68.7     | 6.5   | 26.2  |
| 5 hr.   | 136       | 12.0     | 59.7          | 680.0       | 13.9                       | 69.5     | 5.3   | 26.5  |
| 8 hr.   | 86        | 7.7      | 61.4          | 689.7       | 8.8                        | 70.5     | 3.4   | 26.8  |
| 10 hr.  | 69        | 6.2      | 62.2          | 697.0       | 7.1                        | 71.2     | 2.7   | 27.1  |
| 20 hr.  | 35        | 3.2      | 64.4          | 701.9       | 3.6                        | 71.7     | 1.4   | 27.3  |

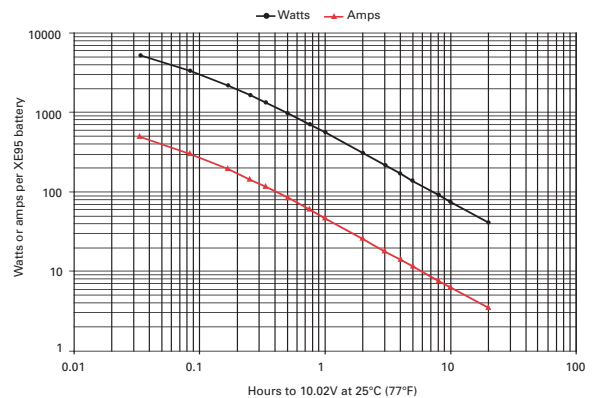
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 8787      | 903.7    | 30.1          | 292.9       | 696.5                      | 23.2     | 250.3 | 8.3   |
| 5 min.  | 5263      | 491.0    | 40.9          | 438.6       | 417.2                      | 34.8     | 149.9 | 12.5  |
| 10 min. | 3371      | 304.5    | 50.8          | 561.8       | 267.2                      | 44.5     | 96.0  | 16.0  |
| 15 min. | 2578      | 228.8    | 57.2          | 644.6       | 204.4                      | 51.1     | 73.5  | 18.4  |
| 20 min. | 2089      | 183.5    | 61.2          | 696.4       | 165.6                      | 55.2     | 59.5  | 19.8  |
| 30 min. | 1539      | 133.5    | 66.8          | 769.5       | 122.0                      | 61.0     | 43.8  | 21.9  |
| 45 min. | 1112      | 95.5     | 71.6          | 833.9       | 88.1                       | 66.1     | 31.7  | 23.8  |
| 1 hr.   | 885       | 75.5     | 75.5          | 885.0       | 70.1                       | 70.1     | 25.2  | 25.2  |
| 2 hr.   | 486       | 41.1     | 82.2          | 972.0       | 38.5                       | 77.0     | 13.8  | 27.7  |
| 3 hr.   | 342       | 28.6     | 85.8          | 1026.0      | 27.1                       | 81.3     | 9.7   | 29.2  |
| 4 hr.   | 264       | 22.3     | 89.2          | 1056.0      | 20.9                       | 83.7     | 7.5   | 30.1  |
| 5 hr.   | 216       | 18.2     | 91.0          | 1080.0      | 17.1                       | 85.6     | 6.2   | 30.8  |
| 8 hr.   | 142       | 12.0     | 96.0          | 1132.8      | 11.2                       | 89.8     | 4.0   | 32.3  |
| 10 hr.  | 116       | 9.8      | 98.0          | 1158.0      | 9.2                        | 91.8     | 3.3   | 33.0  |
| 20 hr.  | 63        | 5.3      | 106.0         | 1260.0      | 5.0                        | 100.0    | 1.8   | 35.9  |

Figure A-25: XE95 discharge data to 9V at 25°C (77°F)



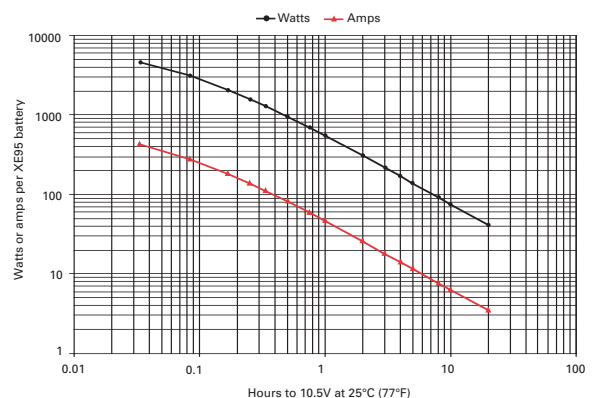
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 7390      | 707.0    | 23.6          | 246.3       | 585.8                      | 19.5     | 210.5 | 7.0   |
| 5 min.  | 4883      | 449.5    | 37.5          | 407.0       | 387.1                      | 32.3     | 139.1 | 11.6  |
| 10 min. | 3242      | 290.7    | 48.5          | 540.3       | 257.0                      | 42.8     | 92.4  | 15.4  |
| 15 min. | 2482      | 219.5    | 54.9          | 620.4       | 196.7                      | 49.2     | 70.7  | 17.7  |
| 20 min. | 2020      | 177.0    | 59.0          | 673.2       | 160.1                      | 53.4     | 57.5  | 19.2  |
| 30 min. | 1494      | 129.5    | 64.8          | 747.0       | 118.4                      | 59.2     | 42.6  | 21.3  |
| 45 min. | 1082      | 92.8     | 69.6          | 811.4       | 85.7                       | 64.3     | 30.8  | 23.1  |
| 1 hr.   | 862       | 73.5     | 73.5          | 861.6       | 68.3                       | 68.3     | 24.5  | 24.5  |
| 2 hr.   | 478       | 40.2     | 80.4          | 955.2       | 37.9                       | 75.7     | 13.6  | 27.2  |
| 3 hr.   | 335       | 28.1     | 84.3          | 1004.4      | 26.5                       | 79.6     | 9.5   | 28.6  |
| 4 hr.   | 260       | 21.8     | 87.2          | 1039.2      | 20.6                       | 82.4     | 7.4   | 29.6  |
| 5 hr.   | 212       | 17.8     | 89.0          | 1062.0      | 16.8                       | 84.2     | 6.1   | 30.3  |
| 8 hr.   | 140       | 11.7     | 93.6          | 1118.4      | 11.1                       | 88.7     | 4.0   | 31.9  |
| 10 hr.  | 114       | 9.6      | 96.0          | 1140.0      | 9.0                        | 90.4     | 3.2   | 32.5  |
| 20 hr.  | 61        | 5.2      | 104.0         | 1224.0      | 4.9                        | 97.0     | 1.7   | 34.9  |

Figure A-26: XE95 discharge data to 10.02V at 25°C (77°F)

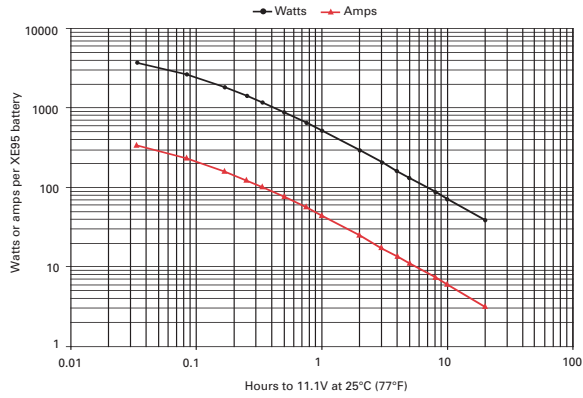


| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 6300      | 585.0    | 19.5          | 210.0       | 499.4                      | 16.6     | 179.5 | 6.0   |
| 5 min.  | 4427      | 399.9    | 33.3          | 368.9       | 350.9                      | 29.2     | 126.1 | 10.5  |
| 10 min. | 3036      | 268.9    | 44.8          | 506.0       | 240.7                      | 40.1     | 86.5  | 14.4  |
| 15 min. | 2358      | 206.6    | 51.7          | 589.5       | 186.9                      | 46.7     | 67.2  | 16.8  |
| 20 min. | 1935      | 168.3    | 56.1          | 645.0       | 153.4                      | 51.1     | 55.1  | 18.4  |
| 30 min. | 1445      | 124.5    | 62.3          | 722.7       | 114.6                      | 57.3     | 41.2  | 20.6  |
| 45 min. | 1054      | 90.0     | 57.5          | 790.2       | 83.5                       | 62.6     | 30.0  | 22.5  |
| 1 hr.   | 842       | 81.6     | 71.6          | 842.4       | 66.8                       | 66.8     | 24.0  | 24.0  |
| 2 hr.   | 469       | 39.4     | 78.8          | 938.4       | 37.2                       | 74.4     | 13.4  | 26.7  |
| 3 hr.   | 329       | 27.6     | 82.8          | 988.2       | 26.1                       | 78.3     | 9.4   | 28.2  |
| 4 hr.   | 256       | 21.4     | 85.6          | 1022.4      | 20.3                       | 81.0     | 7.3   | 29.1  |
| 5 hr.   | 209       | 17.5     | 87.5          | 1047.0      | 16.6                       | 83.0     | 6.0   | 29.8  |
| 8 hr.   | 137       | 11.5     | 92.0          | 1099.2      | 10.9                       | 87.1     | 3.9   | 31.3  |
| 10 hr.  | 112       | 9.4      | 94.0          | 1122.0      | 8.9                        | 88.9     | 3.2   | 32.0  |
| 20 hr.  | 61        | 5.1      | 102.0         | 1212.0      | 4.8                        | 96.1     | 1.7   | 34.5  |

Figure A-27: XE95 discharge data to 10.5V at 25°C (77°F)



**Figure A-28: XE95 discharge data to 11.1V at 25°C (77°F)**

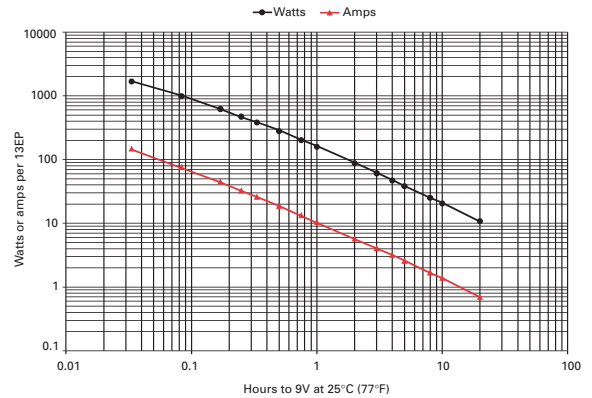


| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 4810      | 431.9    | 14.4          | 160.3       | 381.3                      | 12.7     | 137.0 | 4.6   |
| 5 min.  | 3681      | 323.1    | 26.9          | 306.8       | 291.8                      | 24.3     | 104.9 | 8.7   |
| 10 min. | 2656      | 229.8    | 38.3          | 442.7       | 210.5                      | 35.1     | 75.7  | 12.6  |
| 15 min. | 2115      | 181.6    | 45.4          | 528.8       | 167.6                      | 41.9     | 60.3  | 15.1  |
| 20 min. | 1762      | 150.6    | 50.2          | 587.4       | 139.7                      | 46.6     | 50.2  | 16.7  |
| 30 min. | 1341      | 113.9    | 57.0          | 670.5       | 106.3                      | 53.1     | 38.2  | 19.1  |
| 45 min. | 993       | 83.9     | 62.9          | 744.8       | 78.7                       | 59.0     | 28.3  | 21.2  |
| 1 hr.   | 801       | 67.5     | 67.5          | 801.0       | 63.5                       | 63.5     | 22.8  | 22.8  |
| 2 hr.   | 453       | 37.9     | 75.8          | 906.0       | 35.9                       | 71.8     | 12.9  | 25.8  |
| 3 hr.   | 320       | 26.7     | 80.1          | 959.4       | 25.3                       | 76.0     | 9.1   | 27.3  |
| 4 hr.   | 248       | 20.8     | 83.2          | 993.6       | 19.7                       | 78.8     | 7.1   | 28.3  |
| 5 hr.   | 203       | 17.0     | 85.0          | 1017.0      | 16.1                       | 80.6     | 5.8   | 29.0  |
| 8 hr.   | 133       | 11.1     | 88.8          | 1065.6      | 10.6                       | 84.5     | 3.8   | 30.4  |
| 10 hr.  | 109       | 9.1      | 91.0          | 1086.0      | 8.6                        | 86.1     | 3.1   | 30.9  |
| 20 hr.  | 58        | 4.8      | 96.0          | 1164.0      | 4.6                        | 92.3     | 1.7   | 33.2  |



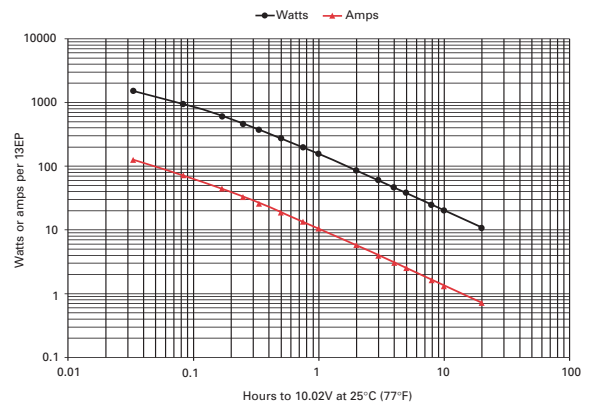
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 1437      | 149.6    | 5.0           | 47.9        | 756.2                      | 25.2     | 293.3 | 9.8   |
| 5 min.  | 791       | 76.7     | 6.4           | 65.9        | 416.3                      | 34.7     | 161.4 | 13.4  |
| 10 min. | 488       | 45.3     | 7.7           | 83.0        | 256.8                      | 43.7     | 99.6  | 16.9  |
| 15 min. | 364       | 33.0     | 8.3           | 91.0        | 191.6                      | 47.9     | 74.3  | 18.6  |
| 20 min. | 293       | 26.2     | 8.7           | 97.6        | 154.2                      | 51.3     | 59.8  | 19.9  |
| 30 min. | 215       | 18.9     | 9.5           | 107.5       | 113.1                      | 56.6     | 43.9  | 21.9  |
| 45 min. | 156       | 13.5     | 10.1          | 117.0       | 82.1                       | 61.6     | 31.8  | 23.9  |
| 1 hr.   | 124       | 10.6     | 10.6          | 124.0       | 65.3                       | 65.3     | 25.3  | 25.3  |
| 2 hr.   | 69        | 5.8      | 11.6          | 138.0       | 36.3                       | 72.6     | 14.1  | 28.2  |
| 3 hr.   | 49        | 4.1      | 12.3          | 147.0       | 25.8                       | 77.4     | 10.0  | 30.0  |
| 4 hr.   | 38        | 3.2      | 12.8          | 152.0       | 20.0                       | 80.0     | 7.8   | 31.0  |
| 5 hr.   | 31        | 2.6      | 13.0          | 155.0       | 16.3                       | 81.6     | 6.3   | 31.6  |
| 8 hr.   | 20        | 1.7      | 13.6          | 160.0       | 10.5                       | 84.2     | 4.1   | 32.7  |
| 10 hr.  | 16        | 1.4      | 14.0          | 160.0       | 8.4                        | 84.2     | 3.3   | 32.7  |
| 20 hr.  | 8         | 0.7      | 14.0          | 160.0       | 4.2                        | 84.2     | 1.6   | 32.7  |

Figure B-1: 13EP discharge data to 9V at 25°C (77°F)



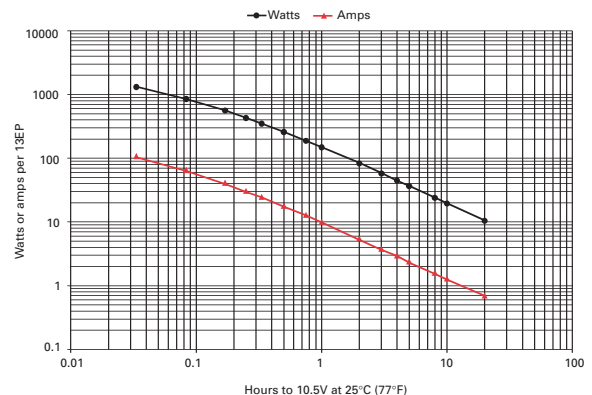
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 1268.0    | 123.9    | 4.1           | 42.2        | 667.3                      | 22.2     | 258.8 | 8.6   |
| 5 min.  | 758.0     | 70.8     | 5.9           | 63.1        | 398.9                      | 33.2     | 154.7 | 12.9  |
| 10 min. | 482.0     | 43.6     | 7.4           | 81.9        | 253.7                      | 43.1     | 98.4  | 16.7  |
| 15 min. | 361.0     | 32.2     | 8.1           | 90.3        | 190.0                      | 47.5     | 73.7  | 18.4  |
| 20 min. | 292.0     | 25.7     | 8.6           | 97.2        | 153.7                      | 51.2     | 59.6  | 19.8  |
| 30 min. | 214.0     | 18.6     | 9.3           | 107.0       | 112.6                      | 56.3     | 43.7  | 21.8  |
| 45 min. | 154.0     | 13.2     | 9.9           | 115.5       | 81.0                       | 60.8     | 31.4  | 23.6  |
| 1 hr.   | 121.0     | 10.4     | 10.4          | 121.0       | 63.7                       | 63.7     | 24.7  | 24.7  |
| 2 hr.   | 67.0      | 5.7      | 11.4          | 134.0       | 35.3                       | 70.5     | 13.7  | 27.3  |
| 3 hr.   | 47.0      | 3.9      | 11.7          | 141.0       | 24.7                       | 74.2     | 9.6   | 28.8  |
| 4 hr.   | 36.0      | 3.0      | 12.0          | 144.0       | 18.9                       | 75.8     | 7.3   | 29.4  |
| 5 hr.   | 29.0      | 2.5      | 12.5          | 145.0       | 15.3                       | 76.3     | 5.9   | 29.6  |
| 8 hr.   | 19.0      | 1.6      | 12.8          | 152.0       | 10.0                       | 80.0     | 3.9   | 31.0  |
| 10 hr.  | 16.0      | 1.3      | 13.0          | 160.0       | 8.4                        | 84.2     | 3.3   | 32.7  |
| 20 hr.  | 8.0       | 0.7      | 14.0          | 160.0       | 4.2                        | 84.2     | 1.6   | 32.7  |

Figure B-2: 13EP discharge data to 10.02V at 25°C (77°F)

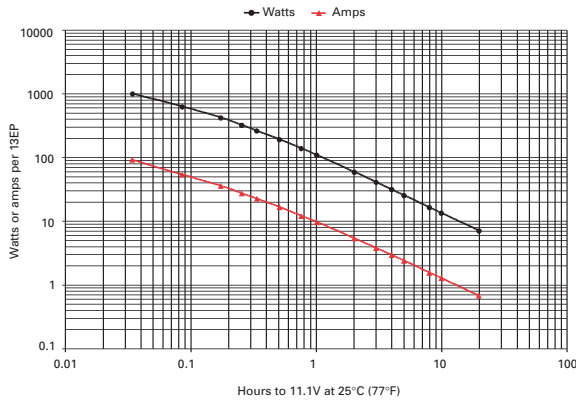


| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 1153.0    | 108.6    | 3.6           | 38.4        | 606.8                      | 20.2     | 235.3 | 7.8   |
| 5 min.  | 715.0     | 65.5     | 5.5           | 59.6        | 376.3                      | 31.3     | 145.9 | 12.2  |
| 10 min. | 463.0     | 41.4     | 7.0           | 78.7        | 243.7                      | 41.4     | 94.5  | 16.1  |
| 15 min. | 349.0     | 30.9     | 7.7           | 87.3        | 183.7                      | 45.9     | 71.2  | 17.8  |
| 20 min. | 283.0     | 24.8     | 8.3           | 94.2        | 148.9                      | 49.6     | 57.8  | 19.2  |
| 30 min. | 208.0     | 18.0     | 9.0           | 104.0       | 109.5                      | 54.7     | 42.4  | 21.2  |
| 45 min. | 151.0     | 12.9     | 9.7           | 113.3       | 79.5                       | 59.6     | 30.8  | 23.1  |
| 1 hr.   | 119.0     | 10.1     | 10.1          | 119.0       | 62.6                       | 62.6     | 24.3  | 24.3  |
| 2 hr.   | 66.0      | 5.5      | 11.0          | 132.0       | 34.7                       | 69.5     | 13.5  | 26.9  |
| 3 hr.   | 46.0      | 3.8      | 11.4          | 138.0       | 24.2                       | 72.6     | 9.4   | 28.2  |
| 4 hr.   | 36.0      | 3.0      | 12.0          | 144.0       | 18.9                       | 75.8     | 7.3   | 29.4  |
| 5 hr.   | 29.0      | 2.4      | 12.0          | 145.0       | 15.3                       | 76.3     | 5.9   | 29.6  |
| 8 hr.   | 19.0      | 1.6      | 12.8          | 152.0       | 10.0                       | 80.0     | 3.9   | 31.0  |
| 10 hr.  | 16.0      | 1.3      | 13.0          | 160.0       | 8.4                        | 84.2     | 3.3   | 32.7  |
| 20 hr.  | 8.0       | 0.7      | 14.0          | 160.0       | 4.2                        | 84.2     | 1.6   | 32.7  |

Figure B-3: 13EP discharge data to 10.5V at 25°C (77°F)

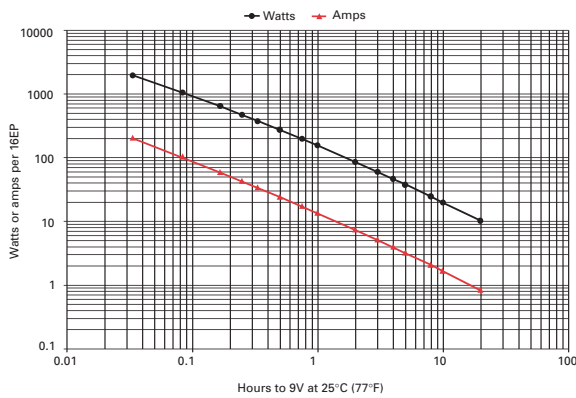


**Figure B-4: 13EP discharge data to 11.1V at 25°C (77°F)**



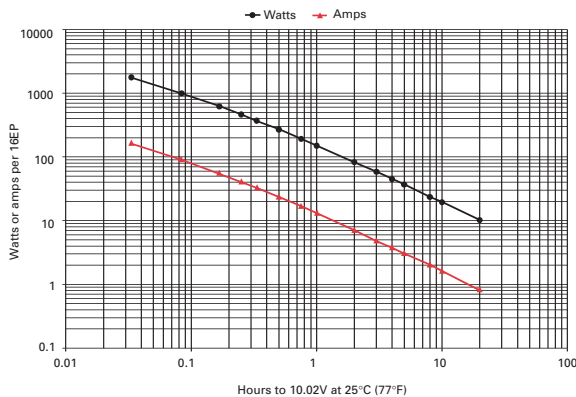
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 1001.0    | 89.2     | 3.0           | 33.3        | 526.8                      | 17.5     | 204.3 | 6.8   |
| 5 min.  | 647.0     | 57.8     | 4.8           | 53.9        | 340.5                      | 28.4     | 132.0 | 11.0  |
| 10 min. | 428.0     | 37.9     | 6.4           | 72.8        | 225.2                      | 38.3     | 87.3  | 14.8  |
| 15 min. | 328.0     | 28.8     | 7.2           | 82.0        | 172.6                      | 43.2     | 66.9  | 16.7  |
| 20 min. | 268.0     | 23.3     | 7.8           | 89.2        | 141.0                      | 47.0     | 54.7  | 18.2  |
| 30 min. | 199.0     | 17.1     | 8.6           | 99.5        | 104.7                      | 52.4     | 40.6  | 20.3  |
| 45 min. | 145.0     | 12.4     | 9.3           | 108.8       | 76.3                       | 57.2     | 29.6  | 22.2  |
| 1 hr.   | 115.0     | 9.7      | 9.7           | 115.0       | 60.5                       | 60.5     | 23.5  | 23.5  |
| 2 hr.   | 64.0      | 5.3      | 10.6          | 128.0       | 33.7                       | 67.4     | 13.1  | 26.1  |
| 3 hr.   | 45.0      | 3.7      | 11.1          | 135.0       | 23.7                       | 71.0     | 9.2   | 27.6  |
| 4 hr.   | 35.0      | 2.9      | 11.6          | 140.0       | 18.4                       | 73.7     | 7.1   | 28.6  |
| 5 hr.   | 29.0      | 2.3      | 11.5          | 145.0       | 15.3                       | 76.3     | 5.9   | 29.6  |
| 8 hr.   | 19.0      | 1.5      | 12.0          | 152.0       | 10.0                       | 80.0     | 3.9   | 31.0  |
| 10 hr.  | 15.0      | 1.2      | 12.0          | 150.0       | 7.9                        | 78.9     | 3.1   | 30.6  |
| 20 hr.  | 8.0       | 0.7      | 14.0          | 160.0       | 4.2                        | 84.2     | 1.6   | 32.7  |

**Figure B-5: 16EP discharge data to 9V at 25°C (77°F)**



| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 1900      | 195.7    | 6.5           | 63.3        | 817.0                      | 27.2     | 311.5 | 10.4  |
| 5 min.  | 1028      | 98.4     | 8.2           | 85.6        | 442.0                      | 36.8     | 168.5 | 14.0  |
| 10 min. | 624       | 57.2     | 9.5           | 104.0       | 268.3                      | 44.7     | 102.3 | 17.1  |
| 15 min. | 460       | 41.3     | 10.3          | 115.0       | 197.8                      | 49.5     | 75.4  | 18.9  |
| 20 min. | 368       | 32.7     | 10.9          | 122.7       | 158.2                      | 52.7     | 60.3  | 20.1  |
| 30 min. | 268       | 23.4     | 11.7          | 134.0       | 115.2                      | 57.6     | 43.9  | 22.0  |
| 45 min. | 192       | 16.6     | 12.5          | 144.0       | 82.6                       | 61.9     | 31.5  | 23.6  |
| 1 hr.   | 151       | 13.0     | 13.0          | 151.0       | 64.9                       | 64.9     | 24.8  | 24.8  |
| 2 hr.   | 83        | 7.1      | 14.2          | 166.0       | 35.7                       | 71.4     | 13.6  | 27.2  |
| 3 hr.   | 58        | 4.9      | 14.7          | 174.0       | 24.9                       | 74.8     | 9.5   | 28.5  |
| 4 hr.   | 45        | 3.8      | 15.2          | 180.0       | 19.4                       | 77.4     | 7.4   | 29.5  |
| 5 hr.   | 37        | 3.1      | 15.5          | 185.0       | 15.9                       | 79.6     | 6.1   | 30.3  |
| 8 hr.   | 24        | 2.0      | 16.0          | 192.0       | 10.3                       | 82.6     | 3.9   | 31.5  |
| 10 hr.  | 19        | 1.6      | 16.0          | 190.0       | 8.2                        | 81.7     | 3.1   | 31.1  |
| 20 hr.  | 10        | 0.8      | 16.0          | 200.0       | 4.3                        | 86.0     | 1.6   | 32.8  |

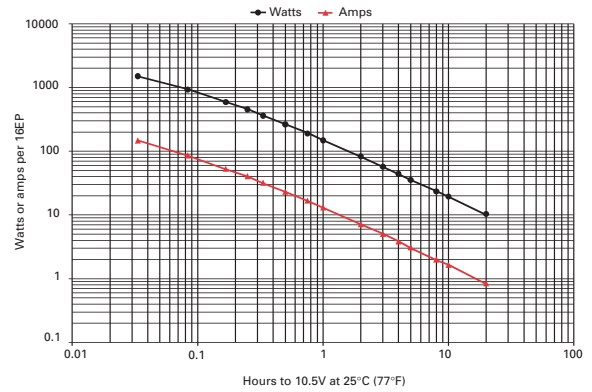
**Figure B-6: 16EP discharge data to 10.02V at 25°C (77°F)**



| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 1674      | 161.2    | 5.4           | 55.7        | 719.8                      | 24.0     | 274.4 | 9.1   |
| 5 min.  | 976       | 90.0     | 7.5           | 81.3        | 419.7                      | 35.0     | 160.0 | 13.3  |
| 10 min. | 610       | 54.8     | 9.1           | 101.7       | 262.3                      | 43.7     | 100.0 | 16.7  |
| 15 min. | 454       | 40.1     | 10.0          | 113.5       | 195.2                      | 48.8     | 74.4  | 18.6  |
| 20 min. | 364       | 32.0     | 10.7          | 121.3       | 156.5                      | 52.2     | 59.7  | 19.9  |
| 30 min. | 265       | 23.0     | 11.5          | 132.5       | 114.0                      | 57.0     | 43.4  | 21.7  |
| 45 min. | 190       | 16.3     | 12.2          | 142.5       | 81.7                       | 61.3     | 31.1  | 23.4  |
| 1 hr.   | 149       | 12.7     | 12.7          | 149.0       | 64.1                       | 64.1     | 24.4  | 24.4  |
| 2 hr.   | 82        | 6.9      | 13.8          | 164.0       | 35.3                       | 70.5     | 13.4  | 26.9  |
| 3 hr.   | 57        | 4.8      | 14.4          | 171.0       | 24.5                       | 73.5     | 9.3   | 28.0  |
| 4 hr.   | 44        | 3.7      | 14.8          | 176.0       | 18.9                       | 75.7     | 7.2   | 28.9  |
| 5 hr.   | 36        | 3.0      | 15.0          | 180.0       | 15.5                       | 77.4     | 5.9   | 29.5  |
| 8 hr.   | 23        | 2.0      | 16.0          | 184.0       | 9.9                        | 79.1     | 3.8   | 30.2  |
| 10 hr.  | 19        | 1.6      | 16.0          | 190.0       | 8.2                        | 81.7     | 3.1   | 31.1  |
| 20 hr.  | 10        | 0.8      | 16.0          | 200.0       | 4.3                        | 86.0     | 1.6   | 32.8  |

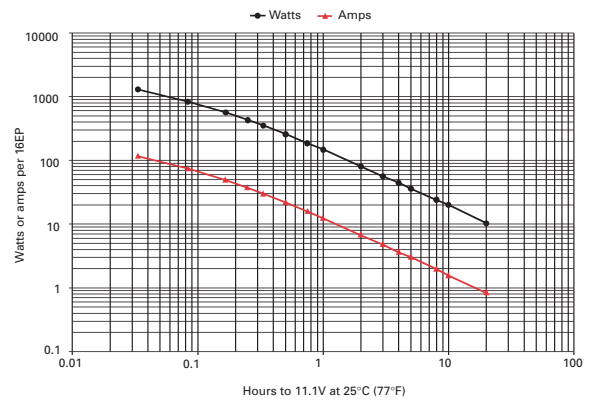
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 1502      | 140.0    | 4.7           | 50.0        | 645.9                      | 21.5     | 246.2 | 8.2   |
| 5 min.  | 919       | 83.0     | 6.9           | 76.6        | 395.2                      | 32.9     | 150.7 | 12.5  |
| 10 min. | 587       | 52.0     | 8.7           | 97.9        | 252.4                      | 42.1     | 96.2  | 16.0  |
| 15 min. | 441       | 38.6     | 9.7           | 110.3       | 189.6                      | 47.4     | 72.3  | 18.1  |
| 20 min. | 356       | 30.9     | 10.3          | 118.7       | 153.1                      | 51.0     | 58.4  | 19.5  |
| 30 min. | 260       | 22.3     | 11.2          | 130.0       | 111.8                      | 55.9     | 42.6  | 21.3  |
| 45 min. | 187       | 15.9     | 11.9          | 140.3       | 80.4                       | 60.3     | 30.7  | 23.0  |
| 1 hr.   | 147       | 12.5     | 12.5          | 147.0       | 63.2                       | 63.2     | 24.1  | 24.1  |
| 2 hr.   | 81        | 6.8      | 13.6          | 162.0       | 34.8                       | 69.7     | 13.3  | 26.6  |
| 3 hr.   | 56        | 4.7      | 14.1          | 168.0       | 24.1                       | 72.2     | 9.2   | 27.5  |
| 4 hr.   | 43        | 3.6      | 14.4          | 172.0       | 18.5                       | 74.0     | 7.0   | 28.2  |
| 5 hr.   | 35        | 3.0      | 15.0          | 175.0       | 15.1                       | 75.3     | 5.7   | 28.7  |
| 8 hr.   | 23        | 1.9      | 15.2          | 184.0       | 9.9                        | 79.1     | 3.8   | 30.2  |
| 10 hr.  | 19        | 1.6      | 16.0          | 190.0       | 8.2                        | 81.7     | 3.1   | 31.1  |
| 20 hr.  | 10        | 0.8      | 16.0          | 200.0       | 4.3                        | 86.0     | 1.6   | 32.8  |

Figure B-7: 16EP discharge data to 10.5V at 25°C (77°F)



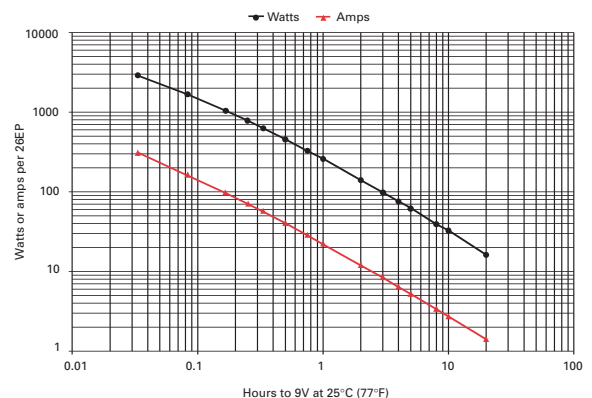
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 1267      | 113.2    | 3.8           | 42.2        | 544.8                      | 18.1     | 207.7 | 6.9   |
| 5 min.  | 832       | 72.9     | 6.1           | 69.3        | 357.8                      | 29.8     | 136.4 | 11.4  |
| 10 min. | 551       | 47.6     | 7.9           | 91.9        | 236.9                      | 39.5     | 90.3  | 15.1  |
| 15 min. | 419       | 36.0     | 9.0           | 104.8       | 180.2                      | 45.0     | 68.7  | 17.2  |
| 20 min. | 341       | 29.1     | 9.7           | 113.7       | 146.6                      | 48.9     | 55.9  | 18.6  |
| 30 min. | 251       | 21.3     | 10.7          | 125.5       | 107.9                      | 54.0     | 41.1  | 20.6  |
| 45 min. | 181       | 15.3     | 11.5          | 135.8       | 77.8                       | 58.4     | 29.7  | 22.3  |
| 1 hr.   | 143       | 12.0     | 12.0          | 143.0       | 61.5                       | 61.5     | 23.4  | 23.4  |
| 2 hr.   | 79        | 6.6      | 13.2          | 158.0       | 34.0                       | 67.9     | 13.0  | 25.9  |
| 3 hr.   | 55        | 4.6      | 13.8          | 165.0       | 23.7                       | 71.0     | 9.0   | 27.0  |
| 4 hr.   | 43        | 3.5      | 14.0          | 172.0       | 18.5                       | 74.0     | 7.0   | 28.2  |
| 5 hr.   | 35        | 2.9      | 14.5          | 175.0       | 15.1                       | 75.3     | 5.7   | 28.7  |
| 8 hr.   | 23        | 1.9      | 15.2          | 184.0       | 9.9                        | 79.1     | 3.8   | 30.2  |
| 10 hr.  | 19        | 1.5      | 15.0          | 190.0       | 8.2                        | 81.7     | 3.1   | 31.1  |
| 20 hr.  | 10        | 0.8      | 16.0          | 200.0       | 4.3                        | 86.0     | 1.6   | 32.8  |

Figure B-8: 16EP discharge data to 11.1V at 25°C (77°F)

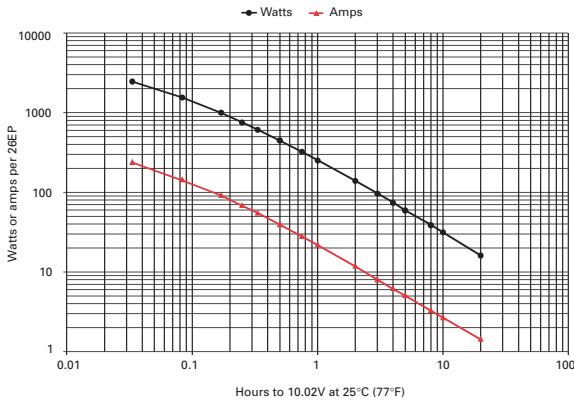


| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 2898      | 302.4    | 10.1          | 96.5        | 785.3                      | 26.2     | 286.9 | 9.6   |
| 5 min.  | 1674      | 162.2    | 13.5          | 139.4       | 453.6                      | 37.8     | 165.7 | 13.8  |
| 10 min. | 1045      | 96.9     | 16.2          | 174.2       | 283.2                      | 47.2     | 103.5 | 17.2  |
| 15 min. | 778       | 70.6     | 17.7          | 194.5       | 210.8                      | 52.7     | 77.0  | 19.3  |
| 20 min. | 625       | 56.0     | 18.7          | 208.3       | 169.4                      | 56.4     | 61.9  | 20.6  |
| 30 min. | 454       | 40.0     | 20.0          | 227.0       | 123.0                      | 61.5     | 45.0  | 22.5  |
| 45 min. | 326       | 28.4     | 21.3          | 244.5       | 88.3                       | 66.3     | 32.3  | 24.2  |
| 1 hr.   | 256       | 22.1     | 22.1          | 256.0       | 69.4                       | 69.4     | 25.3  | 25.3  |
| 2 hr.   | 140       | 11.9     | 23.8          | 280.0       | 37.9                       | 75.9     | 13.9  | 27.7  |
| 3 hr.   | 97        | 8.3      | 24.9          | 291.0       | 26.3                       | 78.9     | 9.6   | 28.8  |
| 4 hr.   | 75        | 6.3      | 25.2          | 300.0       | 20.3                       | 81.3     | 7.4   | 29.7  |
| 5 hr.   | 61        | 5.1      | 25.5          | 305.0       | 16.5                       | 82.6     | 6.0   | 30.2  |
| 8 hr.   | 39        | 3.3      | 26.4          | 312.0       | 10.6                       | 84.5     | 3.9   | 30.9  |
| 10 hr.  | 32        | 2.7      | 27.0          | 320.0       | 8.7                        | 86.7     | 3.2   | 31.7  |
| 20 hr.  | 16        | 1.4      | 28.0          | 320.0       | 4.3                        | 86.7     | 1.6   | 31.7  |

Figure B-9: 26EP discharge data to 9V at 25°C (77°F)

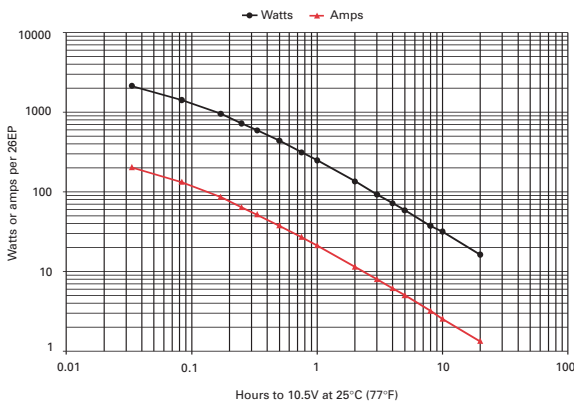


**Figure B-10: 26EP discharge data to 10.02V at 25°C (77°F)**



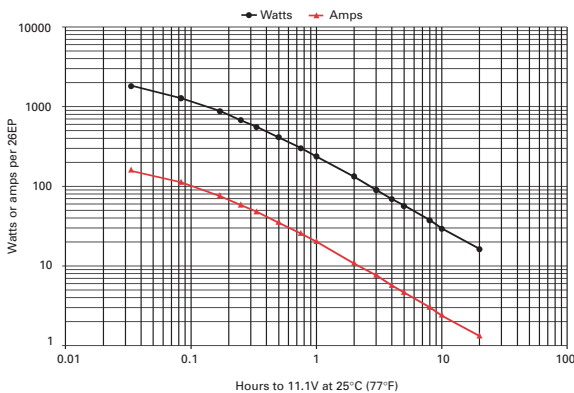
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 2419      | 235.8    | 7.9           | 80.6        | 655.5                      | 21.8     | 239.5 | 8.0   |
| 5 min.  | 1532      | 143.4    | 11.9          | 127.6       | 415.1                      | 34.6     | 151.7 | 12.6  |
| 10 min. | 995       | 90.7     | 15.1          | 165.9       | 269.6                      | 44.9     | 98.5  | 16.4  |
| 15 min. | 751       | 67.4     | 16.9          | 187.8       | 203.5                      | 50.9     | 74.4  | 18.6  |
| 20 min. | 607       | 54.1     | 18.0          | 202.3       | 164.5                      | 54.8     | 60.1  | 20.0  |
| 30 min. | 444       | 39.0     | 19.5          | 222.0       | 120.3                      | 60.2     | 44.0  | 22.0  |
| 45 min. | 319       | 27.8     | 20.9          | 239.3       | 86.4                       | 64.8     | 31.6  | 23.7  |
| 1 hr.   | 251       | 21.7     | 21.7          | 251.0       | 68.0                       | 68.0     | 24.9  | 24.9  |
| 2 hr.   | 137       | 11.7     | 23.4          | 274.0       | 37.1                       | 74.2     | 13.6  | 27.1  |
| 3 hr.   | 95        | 8.0      | 24.0          | 285.0       | 25.7                       | 77.2     | 9.4   | 28.2  |
| 4 hr.   | 73        | 6.1      | 24.4          | 292.0       | 19.8                       | 79.1     | 7.2   | 28.9  |
| 5 hr.   | 59        | 5.0      | 25.0          | 295.0       | 16.0                       | 79.9     | 5.8   | 29.2  |
| 8 hr.   | 38        | 3.2      | 25.6          | 304.0       | 10.3                       | 82.4     | 3.8   | 30.1  |
| 10 hr.  | 31        | 2.6      | 26.0          | 310.0       | 8.4                        | 84.0     | 3.1   | 30.7  |
| 20 hr.  | 16        | 1.4      | 28.0          | 320.0       | 4.3                        | 86.7     | 1.6   | 31.7  |

**Figure B-11: 26EP discharge data to 10.5V at 25°C (77°F)**



| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 2141      | 200.9    | 6.7           | 71.3        | 580.2                      | 19.3     | 212.0 | 7.1   |
| 5 min.  | 1424      | 129.9    | 10.8          | 118.6       | 385.9                      | 32.1     | 141.0 | 11.7  |
| 10 min. | 947       | 84.7     | 14.1          | 157.9       | 256.6                      | 42.8     | 93.8  | 15.6  |
| 15 min. | 721       | 63.8     | 16.0          | 180.3       | 195.4                      | 48.8     | 71.4  | 17.8  |
| 20 min. | 587       | 51.5     | 17.2          | 195.6       | 159.1                      | 53.0     | 58.1  | 19.4  |
| 30 min. | 431       | 37.5     | 18.8          | 215.5       | 116.8                      | 58.4     | 42.7  | 21.3  |
| 45 min. | 311       | 26.9     | 20.2          | 233.3       | 84.3                       | 63.2     | 30.8  | 23.1  |
| 1 hr.   | 245       | 21.0     | 21.0          | 245.0       | 66.4                       | 66.4     | 24.3  | 24.3  |
| 2 hr.   | 134       | 11.3     | 22.6          | 268.0       | 36.3                       | 72.6     | 13.3  | 26.5  |
| 3 hr.   | 93        | 7.8      | 23.4          | 279.0       | 25.2                       | 75.6     | 9.2   | 27.6  |
| 4 hr.   | 71        | 6.0      | 24.0          | 284.0       | 19.2                       | 77.0     | 7.0   | 28.1  |
| 5 hr.   | 58        | 4.9      | 24.5          | 290.0       | 15.7                       | 78.6     | 5.7   | 28.7  |
| 8 hr.   | 37        | 3.1      | 24.8          | 296.0       | 10.0                       | 80.2     | 3.7   | 29.3  |
| 10 hr.  | 31        | 2.5      | 25.0          | 310.0       | 8.4                        | 84.0     | 3.1   | 30.7  |
| 20 hr.  | 16        | 1.3      | 26.0          | 320.0       | 4.3                        | 86.7     | 1.6   | 31.7  |

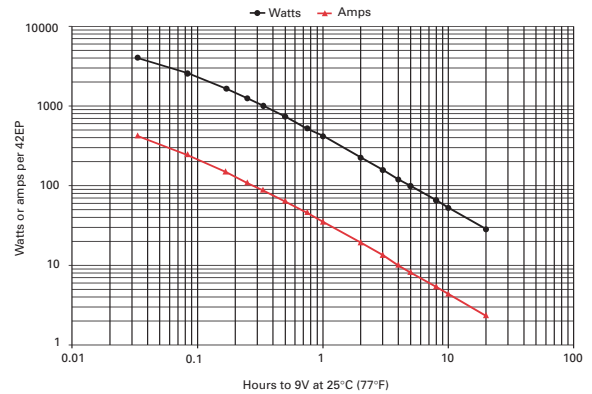
**Figure B-12: 26EP discharge data to 11.1V at 25°C (77°F)**



| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 1795      | 159.4    | 5.3           | 59.8        | 486.4                      | 16.2     | 177.7 | 5.9   |
| 5 min.  | 1273      | 111.4    | 9.3           | 106.0       | 345.0                      | 28.7     | 126.0 | 10.5  |
| 10 min. | 876       | 75.8     | 12.6          | 146.0       | 237.4                      | 39.6     | 86.7  | 14.5  |
| 15 min. | 677       | 58.2     | 14.6          | 169.3       | 183.5                      | 45.9     | 67.0  | 16.8  |
| 20 min. | 555       | 47.5     | 15.8          | 185.0       | 150.4                      | 50.1     | 55.0  | 18.3  |
| 30 min. | 412       | 35.0     | 17.5          | 206.0       | 111.6                      | 55.8     | 40.8  | 20.4  |
| 45 min. | 299       | 25.3     | 19.0          | 224.3       | 81.0                       | 60.8     | 29.6  | 22.2  |
| 1 hr.   | 236       | 19.9     | 19.9          | 236.0       | 64.0                       | 64.0     | 23.4  | 23.4  |
| 2 hr.   | 130       | 10.8     | 21.6          | 260.0       | 35.2                       | 70.5     | 12.9  | 25.7  |
| 3 hr.   | 90        | 7.5      | 22.5          | 270.0       | 24.4                       | 73.2     | 8.9   | 26.7  |
| 4 hr.   | 69        | 5.7      | 22.8          | 276.0       | 18.7                       | 74.8     | 6.8   | 27.3  |
| 5 hr.   | 56        | 4.7      | 23.5          | 280.0       | 15.2                       | 75.9     | 5.5   | 27.7  |
| 8 hr.   | 37        | 3.0      | 24.0          | 296.0       | 10.0                       | 80.2     | 3.7   | 29.3  |
| 10 hr.  | 29        | 2.4      | 24.0          | 290.0       | 7.9                        | 78.6     | 2.9   | 28.7  |
| 20 hr.  | 16        | 1.3      | 26.0          | 320.0       | 4.3                        | 86.7     | 1.6   | 31.7  |

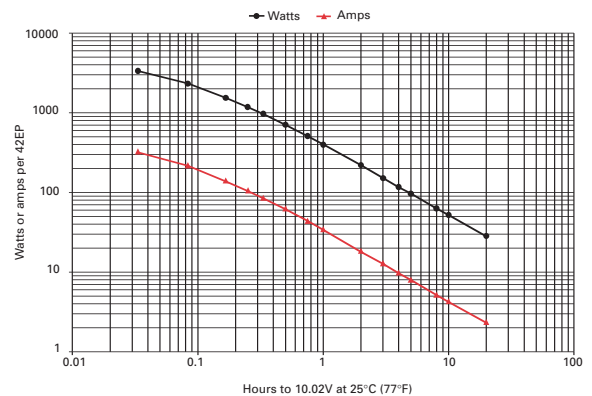
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 4046      | 417.0    | 13.9          | 134.7       | 724.8                      | 24.1     | 271.5 | 9.0   |
| 5 min.  | 2498      | 240.5    | 20.0          | 208.1       | 447.5                      | 37.3     | 167.7 | 14.0  |
| 10 min. | 1607      | 148.3    | 24.7          | 267.9       | 287.9                      | 48.0     | 107.9 | 18.0  |
| 15 min. | 1210      | 109.2    | 27.3          | 302.5       | 216.7                      | 54.2     | 81.2  | 20.3  |
| 20 min. | 979       | 87.2     | 29.1          | 326.3       | 175.4                      | 58.5     | 65.7  | 21.9  |
| 30 min. | 716       | 62.7     | 31.4          | 358.0       | 128.3                      | 64.1     | 48.1  | 24.0  |
| 45 min. | 516       | 44.6     | 33.5          | 387.0       | 92.4                       | 69.3     | 34.6  | 26.0  |
| 1 hr.   | 406       | 34.8     | 34.8          | 406.0       | 72.7                       | 72.7     | 27.2  | 27.2  |
| 2 hr.   | 223       | 18.8     | 37.6          | 446.0       | 39.9                       | 79.9     | 15.0  | 29.9  |
| 3 hr.   | 155       | 13.1     | 39.3          | 465.0       | 27.8                       | 83.3     | 10.4  | 31.2  |
| 4 hr.   | 119       | 10.0     | 40.0          | 476.0       | 21.3                       | 85.3     | 8.0   | 31.9  |
| 5 hr.   | 98        | 8.2      | 41.0          | 490.0       | 17.6                       | 87.8     | 6.6   | 32.9  |
| 8 hr.   | 64        | 5.3      | 42.4          | 512.0       | 11.5                       | 91.7     | 4.3   | 34.4  |
| 10 hr.  | 52        | 4.3      | 43.0          | 520.0       | 9.3                        | 93.1     | 3.5   | 34.9  |
| 20 hr.  | 28        | 2.3      | 46.0          | 560.0       | 5.0                        | 100.3    | 1.9   | 37.6  |

Figure B-13: 42EP discharge data to 9V at 25°C (77°F)



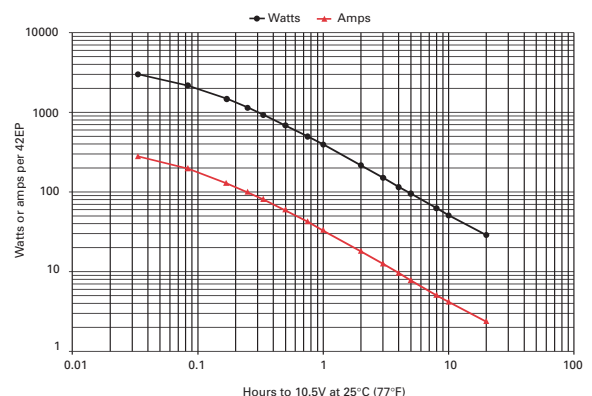
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 3317      | 322.3    | 10.7          | 110.5       | 594.2                      | 19.8     | 222.6 | 7.4   |
| 5 min.  | 2291      | 212.0    | 17.7          | 190.8       | 410.4                      | 34.2     | 153.8 | 12.8  |
| 10 min. | 1540      | 138.4    | 23.1          | 256.7       | 275.9                      | 46.0     | 103.4 | 17.2  |
| 15 min. | 1173      | 104.1    | 26.0          | 293.3       | 210.1                      | 52.5     | 78.7  | 19.7  |
| 20 min. | 953       | 83.8     | 27.9          | 317.6       | 170.7                      | 56.9     | 64.0  | 21.3  |
| 30 min. | 698       | 60.8     | 30.4          | 349.0       | 125.0                      | 62.5     | 46.8  | 23.4  |
| 45 min. | 502       | 43.3     | 32.5          | 376.5       | 89.9                       | 67.4     | 33.7  | 25.3  |
| 1 hr.   | 394       | 33.8     | 33.8          | 394.0       | 70.6                       | 70.6     | 26.4  | 26.4  |
| 2 hr.   | 215       | 18.2     | 36.4          | 430.0       | 38.5                       | 77.0     | 14.4  | 28.9  |
| 3 hr.   | 149       | 12.6     | 37.8          | 447.0       | 26.7                       | 80.1     | 10.0  | 30.0  |
| 4 hr.   | 115       | 9.7      | 38.8          | 460.0       | 20.6                       | 82.4     | 7.7   | 30.9  |
| 5 hr.   | 94        | 7.9      | 39.5          | 470.0       | 16.8                       | 84.2     | 6.3   | 31.5  |
| 8 hr.   | 62        | 5.1      | 40.8          | 496.0       | 11.1                       | 88.8     | 4.2   | 33.3  |
| 10 hr.  | 51        | 4.2      | 42.0          | 510.0       | 9.1                        | 91.4     | 3.4   | 34.2  |
| 20 hr.  | 28        | 2.3      | 46.0          | 560.0       | 5.0                        | 100.3    | 1.9   | 37.6  |

Figure B-14: 42EP discharge data to 10.02V at 25°C (77°F)

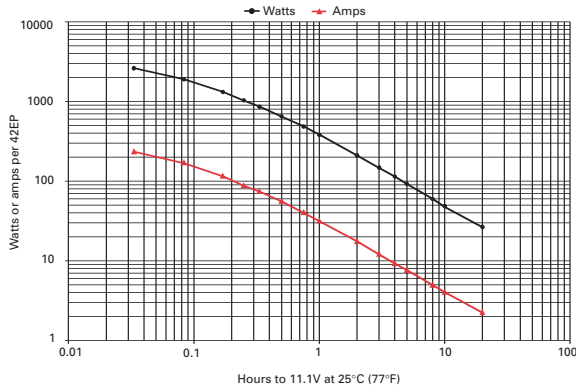


| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 2978      | 279.9    | 9.3           | 99.2        | 533.5                      | 17.8     | 199.9 | 6.7   |
| 5 min.  | 2130      | 193.0    | 16.1          | 177.4       | 381.6                      | 31.8     | 143.0 | 11.9  |
| 10 min. | 1461      | 129.4    | 21.6          | 243.5       | 261.7                      | 43.6     | 98.1  | 16.3  |
| 15 min. | 1124      | 98.5     | 24.6          | 281.0       | 201.3                      | 50.3     | 75.4  | 18.9  |
| 20 min. | 919       | 80.0     | 26.7          | 306.3       | 164.6                      | 54.9     | 61.7  | 20.6  |
| 30 min. | 678       | 58.5     | 29.3          | 339.0       | 121.5                      | 60.7     | 45.5  | 22.8  |
| 45 min. | 491       | 42.0     | 31.5          | 368.3       | 88.0                       | 66.0     | 33.0  | 24.7  |
| 1 hr.   | 386       | 32.9     | 32.9          | 386.0       | 69.1                       | 69.1     | 25.9  | 25.9  |
| 2 hr.   | 212       | 17.9     | 35.8          | 424.0       | 38.0                       | 76.0     | 14.2  | 28.5  |
| 3 hr.   | 147       | 12.4     | 37.2          | 441.0       | 26.3                       | 79.0     | 9.9   | 29.6  |
| 4 hr.   | 113       | 9.5      | 38.0          | 452.0       | 20.2                       | 81.0     | 7.6   | 30.3  |
| 5 hr.   | 93        | 7.7      | 38.5          | 465.0       | 16.7                       | 83.3     | 6.2   | 31.2  |
| 8 hr.   | 61        | 5.0      | 40.0          | 488.0       | 10.9                       | 87.4     | 4.1   | 32.8  |
| 10 hr.  | 50        | 4.1      | 41.0          | 500.0       | 9.0                        | 89.6     | 3.4   | 33.6  |
| 20 hr.  | 28        | 2.3      | 46.0          | 560.0       | 5.0                        | 100.3    | 1.9   | 37.6  |

Figure B-15: 42EP discharge data to 10.5V at 25°C (77°F)

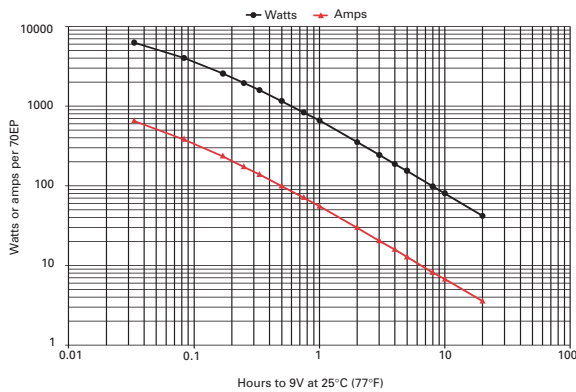


**Figure B-16: 42EP discharge data to 11.1V at 25°C (77°F)**



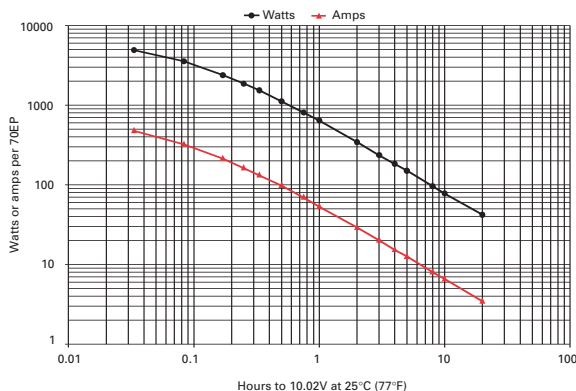
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 2581      | 231.2    | 7.7           | 85.9        | 462.3                      | 15.4     | 173.2 | 5.8   |
| 5 min.  | 1901      | 167.4    | 13.9          | 158.4       | 340.5                      | 28.4     | 127.6 | 10.6  |
| 10 min. | 1338      | 116.1    | 19.4          | 223.0       | 239.7                      | 40.0     | 89.8  | 15.0  |
| 15 min. | 1046      | 90.0     | 22.5          | 261.5       | 187.4                      | 46.8     | 70.2  | 17.6  |
| 20 min. | 863       | 73.9     | 24.6          | 287.6       | 154.6                      | 51.5     | 57.9  | 19.3  |
| 30 min. | 646       | 54.9     | 27.5          | 323.0       | 115.7                      | 57.9     | 43.4  | 21.7  |
| 45 min. | 473       | 39.9     | 29.9          | 354.8       | 84.7                       | 63.5     | 31.7  | 23.8  |
| 1 hr.   | 376       | 31.5     | 31.5          | 376.0       | 67.4                       | 67.4     | 25.2  | 25.2  |
| 2 hr.   | 208       | 17.3     | 34.6          | 416.0       | 37.3                       | 74.5     | 14.0  | 27.9  |
| 3 hr.   | 145       | 12.1     | 36.3          | 435.0       | 26.0                       | 77.9     | 9.7   | 29.2  |
| 4 hr.   | 112       | 9.3      | 37.2          | 448.0       | 20.1                       | 80.3     | 7.5   | 30.1  |
| 5 hr.   | 91        | 7.6      | 38.0          | 455.0       | 16.3                       | 81.5     | 6.1   | 30.5  |
| 8 hr.   | 59        | 4.9      | 39.2          | 472.0       | 10.6                       | 84.6     | 4.0   | 31.7  |
| 10 hr.  | 48        | 4.0      | 40.0          | 480.0       | 8.6                        | 86.0     | 3.2   | 32.2  |
| 20 hr.  | 26        | 2.2      | 44.0          | 520.0       | 4.7                        | 93.1     | 1.7   | 34.9  |

**Figure B-17: 70EP discharge data to 9V at 25°C (77°F)**



| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 6186      | 655.5    | 21.8          | 206.0       | 632.0                      | 21.0     | 254.6 | 8.5   |
| 5 min.  | 3924      | 380.3    | 31.7          | 326.9       | 400.9                      | 33.4     | 161.5 | 13.5  |
| 10 min. | 2552      | 235.0    | 39.2          | 425.4       | 260.7                      | 43.5     | 105.0 | 17.5  |
| 15 min. | 1926      | 173.1    | 43.3          | 481.5       | 196.8                      | 49.2     | 79.3  | 19.8  |
| 20 min. | 1560      | 138.2    | 46.1          | 519.9       | 159.4                      | 53.1     | 64.2  | 21.4  |
| 30 min. | 1143      | 99.6     | 49.8          | 571.5       | 116.8                      | 58.4     | 47.0  | 23.5  |
| 45 min. | 822       | 70.7     | 53.0          | 616.5       | 84.0                       | 63.0     | 33.8  | 25.4  |
| 1 hr.   | 644       | 55.0     | 55.0          | 644.0       | 65.8                       | 65.8     | 26.5  | 26.5  |
| 2 hr.   | 349       | 29.5     | 59.0          | 698.0       | 35.7                       | 71.3     | 14.4  | 28.7  |
| 3 hr.   | 241       | 20.3     | 60.9          | 723.0       | 24.6                       | 73.9     | 9.9   | 29.8  |
| 4 hr.   | 185       | 15.6     | 62.4          | 740.0       | 18.9                       | 75.6     | 7.6   | 30.5  |
| 5 hr.   | 151       | 12.6     | 63.0          | 755.0       | 15.4                       | 77.1     | 6.2   | 31.1  |
| 8 hr.   | 97        | 8.1      | 64.8          | 776.0       | 9.9                        | 79.3     | 4.0   | 31.9  |
| 10 hr.  | 79        | 6.6      | 66.0          | 790.0       | 8.1                        | 80.7     | 3.3   | 32.5  |
| 20 hr.  | 41        | 3.5      | 70.0          | 820.0       | 4.2                        | 83.8     | 1.7   | 33.7  |

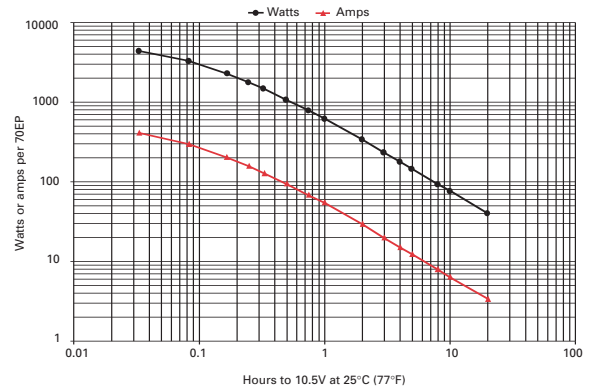
**Figure B-18: 70EP discharge data to 10.02V at 25°C (77°F)**



| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 4938      | 476.2    | 15.9          | 164.4       | 504.5                      | 16.8     | 203.2 | 6.8   |
| 5 min.  | 3525      | 325.6    | 27.1          | 293.6       | 360.1                      | 30.0     | 145.1 | 12.1  |
| 10 min. | 2416      | 217.2    | 36.2          | 402.7       | 246.8                      | 41.1     | 99.4  | 16.6  |
| 15 min. | 1858      | 164.8    | 41.2          | 464.5       | 189.8                      | 47.5     | 76.5  | 19.1  |
| 20 min. | 1517      | 133.4    | 44.5          | 505.6       | 155.0                      | 51.7     | 62.4  | 20.8  |
| 30 min. | 1118      | 97.2     | 48.6          | 559.0       | 114.2                      | 57.1     | 46.0  | 23.0  |
| 45 min. | 806       | 69.5     | 52.1          | 604.5       | 82.3                       | 61.8     | 33.2  | 24.9  |
| 1 hr.   | 633       | 54.2     | 54.2          | 633.0       | 64.7                       | 64.7     | 26.0  | 26.0  |
| 2 hr.   | 343       | 29.1     | 58.2          | 686.0       | 35.0                       | 70.1     | 14.1  | 28.2  |
| 3 hr.   | 237       | 20.0     | 60.0          | 711.0       | 24.2                       | 72.6     | 9.8   | 29.3  |
| 4 hr.   | 182       | 15.2     | 60.8          | 728.0       | 18.6                       | 74.4     | 7.5   | 30.0  |
| 5 hr.   | 148       | 12.4     | 62.0          | 740.0       | 15.1                       | 75.6     | 6.1   | 30.5  |
| 8 hr.   | 95        | 7.9      | 63.2          | 760.0       | 9.7                        | 77.6     | 3.9   | 31.3  |
| 10 hr.  | 77        | 6.5      | 65.0          | 770.0       | 7.9                        | 78.7     | 3.2   | 31.7  |
| 20 hr.  | 41        | 3.4      | 68.0          | 820.0       | 4.2                        | 83.8     | 1.7   | 33.7  |

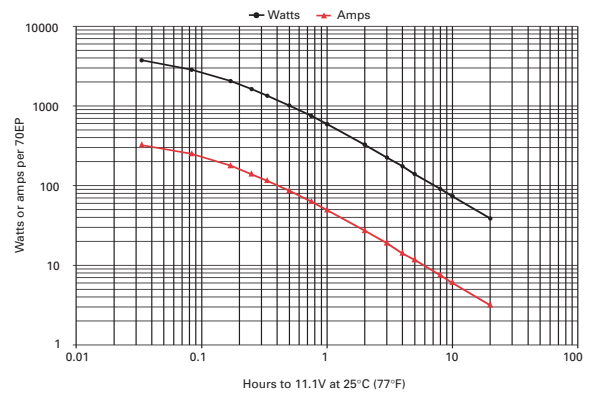
| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 4328      | 404.1    | 13.5          | 144.1       | 442.2                      | 14.7     | 178.1 | 5.9   |
| 5 min.  | 3241      | 293.3    | 24.4          | 270.0       | 331.1                      | 27.6     | 133.4 | 11.1  |
| 10 min. | 2279      | 202.2    | 33.7          | 379.9       | 232.8                      | 38.8     | 93.8  | 15.6  |
| 15 min. | 1773      | 155.6    | 38.9          | 443.3       | 181.1                      | 45.3     | 73.0  | 18.2  |
| 20 min. | 1458      | 127.1    | 42.4          | 486.0       | 149.0                      | 49.6     | 60.0  | 20.0  |
| 30 min. | 1082      | 93.5     | 46.8          | 541.0       | 110.5                      | 55.3     | 44.5  | 22.3  |
| 45 min. | 785       | 67.3     | 50.5          | 588.8       | 80.2                       | 60.1     | 32.3  | 24.2  |
| 1 hr.   | 619       | 52.8     | 52.8          | 619.0       | 63.2                       | 63.2     | 25.5  | 25.5  |
| 2 hr.   | 337       | 28.5     | 57.0          | 674.0       | 34.4                       | 68.9     | 13.9  | 27.7  |
| 3 hr.   | 233       | 19.6     | 58.8          | 699.0       | 23.8                       | 71.4     | 9.6   | 28.8  |
| 4 hr.   | 179       | 14.9     | 59.6          | 716.0       | 18.3                       | 73.1     | 7.4   | 29.5  |
| 5 hr.   | 145       | 12.1     | 60.5          | 725.0       | 14.8                       | 74.1     | 6.0   | 29.8  |
| 8 hr.   | 94        | 7.8      | 62.4          | 752.0       | 9.6                        | 76.8     | 3.9   | 30.9  |
| 10 hr.  | 76        | 6.3      | 63.0          | 760.0       | 7.8                        | 77.6     | 3.1   | 31.3  |
| 20 hr.  | 40        | 3.3      | 66.0          | 800.0       | 4.1                        | 81.7     | 1.6   | 32.9  |

Figure B-19: 70EP discharge data to 10.5V at 25°C (77°F)



| Time    | Watts (W) | Amps (A) | Capacity (Ah) | Energy (Wh) | ENERGY AND POWER DENSITIES |          |       |       |
|---------|-----------|----------|---------------|-------------|----------------------------|----------|-------|-------|
|         |           |          |               |             | W/liter                    | Wh/liter | W/kg  | Wh/kg |
| 2 min.  | 3791      | 326.1    | 10.9          | 126.2       | 387.3                      | 12.9     | 156.0 | 5.2   |
| 5 min.  | 2846      | 251.8    | 21.0          | 237.1       | 290.8                      | 24.2     | 117.1 | 9.8   |
| 10 min. | 2071      | 180.3    | 30.1          | 345.2       | 211.6                      | 35.3     | 85.2  | 14.2  |
| 15 min. | 1638      | 141.4    | 35.4          | 409.5       | 167.3                      | 41.8     | 67.4  | 16.9  |
| 20 min. | 1361      | 116.9    | 39.0          | 453.6       | 139.0                      | 46.3     | 56.0  | 18.7  |
| 30 min. | 1024      | 87.3     | 43.7          | 512.0       | 104.6                      | 52.3     | 42.1  | 21.1  |
| 45 min. | 751       | 63.6     | 47.7          | 563.3       | 76.7                       | 57.5     | 30.9  | 23.2  |
| 1 hr.   | 595       | 50.2     | 50.2          | 595.0       | 60.8                       | 60.8     | 24.5  | 24.5  |
| 2 hr.   | 328       | 27.4     | 54.8          | 656.0       | 33.5                       | 67.0     | 13.5  | 27.0  |
| 1 hr.   | 227       | 18.9     | 56.7          | 681.0       | 23.2                       | 69.6     | 9.3   | 28.0  |
| 4 hr.   | 174       | 14.5     | 58.0          | 696.0       | 17.8                       | 71.1     | 7.2   | 28.6  |
| 5 hr.   | 141       | 11.8     | 59.0          | 705.0       | 14.4                       | 72.0     | 5.8   | 29.0  |
| 8 hr.   | 91        | 7.5      | 60.0          | 728.0       | 9.3                        | 74.4     | 3.7   | 30.0  |
| 10 hr.  | 74        | 6.1      | 61.0          | 740.0       | 7.6                        | 75.6     | 3.0   | 30.5  |
| 20 hr.  | 39        | 3.2      | 64.0          | 780.0       | 4.0                        | 79.7     | 1.6   | 32.1  |

Figure B-20: 70EP discharge data to 11.1V at 25°C (77°F)





Wherever in the world you do business, EnerSys is with you all the way. With large manufacturing plants strategically located throughout Asia, Europe and North and South America, combined with a strong global sales and support team, and backed with a reputation for world-leading technology, our customers benefit through supply reliability, high quality products designed to meeting ever increasing technical requirements, and our commitment to providing the best solution to meeting their Reserve Power needs.

For more information, visit our website at [www.enersys.com](http://www.enersys.com), or contact an EnerSys Reserve Power sales office.



[www.enersys.com](http://www.enersys.com)

**EnerSys**  
 P.O. Box 14145  
 Reading, PA 19612-4145  
 USA  
 Tel: +1-610-208-1991  
 +1-800-538-3627  
 Fax: +1-610-372-8613

**EnerSys EMEA**  
 Brussels, Belgium  
 Tel: +32 (0)2 247 94 47

**EnerSys Asia**  
 Guangdong, China  
 Tel: +86-755-2689 3639

Distributed by:

Printed in USA  
 © 2006 EnerSys. All rights reserved.  
 Trademarks and logos are the property of  
 EnerSys and its affiliates unless otherwise noted.