I. General Information

Definition of a Battery

A battery is a portable energy source that is made up of three basic components—an anode, a cathode and an electrolyte.

The anode is the negative portion of the battery, the cathode is the positive portion and the electrolyte is a liquid solution that aids in the flow of energy.

These three components can be made up of many different materials and combined in an almost endless array of sizes and shapes. The choice of materials used, and the quality, grade and density of these materials will play a major role in determining the energy levels and performance of batteries.

II. Chemical Systems and Construction

Primary batteries were first made in the mid-1800's. These early batteries were known as zinc carbons. Zinc carbon technology is still around but it has been updated with purer, quality grade materials and a different electrolyte. This formulation is now called zinc chloride (heavy duty).

Today, many designers choose alkaline manganese batteries. These batteries provide a much higher energy output which is needed for the fast growing demand for portable power.

Rayovac has played an important role in this battery history. Founded in 1906, Rayovac is an international manufacturer and marketer of alkaline, and heavy duty batteries.

Alkaline batteries provide the longest service life for high drain devices. They will last more than twice as long as heavy duty batteries in certain applications. Alkaline batteries get their long life from their unique construction and the purity of the materials used.

The alkaline cathode is a mixture of manganese dioxide, graphite, and electrolyte. This mixture is granulated, aged in storage, and then compacted into a pressed cylindrical assembly. This mixture is inserted into a steel can. The steel can and the mixture become the cathode of the alkaline battery. An indentation is made near the top of the can and sealant is placed just above it. These two steps help safeguard the battery against leakage.

Diagram 1

Outaway of an Alkaline Battery
If the cathode and anode come in contact with each other, a very active chemical reaction would occur. A barrier must be between the two. A paper separator soaked with an electrolyte that promotes ionic or electrolytic conductivity is used as this barrier. The anode portion is a gel made up of zinc powder and several other materials. The anode is then inserted into the steel can against the paper separator.

To insure a long shelf life, the battery must be sealed. The seal is made of a brass nail (which acts as the current collector), a plastic gasket, a steel washer and metal endcap. The four items are preassembled and inserted into the middle of our steel can up against the indentation (which was formed earlier). A top plate is welded to the other end of the can to provide the positive polarity safety feature.

The batteries are then stored, given another voltage test and a decorative, insulating outer label is applied. Rayovac has further developed the alkaline system and introduced Rechargeable Alkaline® Batteries. (Refer to OEM Designer's Guide OEM-150)

**Zinc Chloride**

Heavy duty zinc chloride batteries are the result of technological advances in zinc carbon battery manufacturing.

The type and purity of the mix ingredients is why a zinc chloride battery lasts up to twice as long as the older zinc carbon formulations. (Diagram 2)

A powdery mix serves as the cathode component of the zinc chloride battery. The mix is made of manganese dioxide (the active ingredient), carbon black (for electrical conductivity and moisture absorption), and zinc chloride electrolyte (which assists the chemical reaction).

**Chemical System**

<table>
<thead>
<tr>
<th>Alkaline</th>
<th>Heavy Duty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical System</td>
<td>Alkaline Manganese</td>
</tr>
<tr>
<td>Features</td>
<td>Best for high drain applications</td>
</tr>
<tr>
<td>Applications</td>
<td></td>
</tr>
<tr>
<td>– CD Players</td>
<td>– Portable Radios</td>
</tr>
<tr>
<td>– Camera Flash</td>
<td>– Smoke Detectors</td>
</tr>
<tr>
<td>– Calculators</td>
<td>– Calculators</td>
</tr>
<tr>
<td>– Cassette Players</td>
<td>– Clocks</td>
</tr>
<tr>
<td>– Flashlights</td>
<td>– Toys</td>
</tr>
<tr>
<td>– Toys</td>
<td>– Remote Control Units</td>
</tr>
</tbody>
</table>

**Table 1**
The mix is then inserted in the can. A compression washer is placed on top and a carbon rod is inserted through the mix. This carbon rod serves as the current collector for the battery and provides the outside contact.

Next, the top of the zinc can is curled inward. The battery is placed inside a paper tube that has a metal bottom plate. A seal washer is placed on top of the carbon rod. Finally, this entire assembly is placed inside a protective outer shell.

The paper tube acts as an electrical insulator, keeping the negative and positive ends of the battery from contacting the outside protective shell. The shielded battery is then sealed which keeps the internal components of our battery fresh.

Finally, a metal cap (the positive contact of our battery) is embedded on top of the battery and the metal shell is curled over the cap.

III. Recommended Usage of Chemical Systems

Rayovac offers top performing, quality built alkaline, and heavy-duty batteries enabling you to meet every power requirement you have. Table 1 describes the features and applications of these two systems.

![Figure 1](attachment://AA_Cell_Discharge_Relative_Service_Moderate_Current.png)

### IV. Technical Data

<table>
<thead>
<tr>
<th></th>
<th>Alkaline</th>
<th>Heavy Duty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Voltage/Cell</td>
<td>1.5 volts</td>
<td>1.5 volts</td>
</tr>
<tr>
<td>Maximum Continuous Current</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Maximum Pulse Current</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>-30°C to 55°C (-20°F to 130°F)</td>
<td>-20°C to 55°C (0°F to 130°F)</td>
</tr>
<tr>
<td>Capacity Retention</td>
<td>Greater than 97% after 12 months @ 21°C (70°F) Greater than 85% after 5 years</td>
<td>Greater than 90% after 12 months @ 21°C (70°F) Greater than 85% after 4 years</td>
</tr>
</tbody>
</table>

Table 2
V. Rayovac Batteries and The Environment

All Rayovac batteries, alkaline, and heavy duty, use a no Mercury added formulation. Rayovac alkaline and zinc chloride batteries do not contain Cadmium as an active ingredient.

Rayovac Alkaline and Heavy Duty batteries are recognized by the U.S. Environmental Protection Agency (EPA) as standard, household waste. Worldwide regulations vary from country to country. Contact Rayovac’s Environmental and Safety Department or the OEM/Technical products group for the latest environmental updates and legislation.

VI. Storage

Batteries depend on internal chemical reactions to produce power. Chemical reactions are accelerated by high temperatures and retarded by low temperatures. Therefore, to minimize power loss during storage, batteries should ideally be stored at a maximum temperature of 77°F (25°C). Refrigerated storage is neither necessary nor recommended.

The following storage procedures should be observed to assure maximum battery power.

1. Rotate inventory stock. Make sure your customer receives the freshest possible product by rotating your stock on a “first in - first out” basis.

2. Avoid storage in high temperature areas. Make sure that batteries are stored away from radiators, hot air vents, motors, and equipment that generates heat. Do not store batteries near windows where sunlight could heat up the batteries.

VII. Handling and Shipping

Batteries are vulnerable to short circuiting if not handled properly. Those battery types which have their “+” and “−” terminations in close proximity to each other are particularly susceptible to short circuiting. Examples of these battery types are the Rayovac A1604, and D1604 batteries. Rayovac packaging engineers design all packaging to assure that Rayovac batteries can be shipped and stored in their original cartons without damage.

To avoid potential short circuit and shipping damage situations:

1. Always store the batteries in the trays and/or cartons in which they were shipped.

2. Whenever possible, re-ship the batteries in their original trays and/or cartons.

3. Broken package shipments of Rayovac batteries can be safely made by putting each battery in a sealed plastic bag.

4. General precautions:
   A. Never place or dump batteries on conductive surfaces, such as metal tables or shelves.
   B. Never ship batteries in anti-static bags or conductive foam as these materials will short out the battery.
   C. Insulate metal micrometers and calipers with non-conductive tape to avoid short circuiting batteries during dimensional checks.

If you have any questions please contact your Rayovac sales representative.
VIII. Dimensional Specifications

A. Alkaline

a. AAA Size Alkaline Battery

Rayovac No.: 824
Nominal Voltage: 1.5 volts
System: Primary Alkaline
ANSI/NEDA No.: 24A (AAA)
IEC No.: LR03
Approximate Volume: 0.2 cu. in. (3.3 cu. cm.)
Approximate Weight: 0.4 oz. (11 gm.)
Terminals: Flashlight
Shell: Plastic
Environmental: Meets Environmental Protection Agency (EPA) requirements for landfill disposal. No mercury added formulation.

Dimensions shown are ANSI/IEC standards.
b. AA Size Alkaline Battery

<table>
<thead>
<tr>
<th>Application &amp; Duty Cycle</th>
<th>Load Current Capacity (mA at 1.2V)</th>
<th>Radiocut Voltage (1.929&quot;–1.988&quot;)</th>
<th>Overall Diameter (13.5–14.5MM)</th>
<th>Overall Height (49.0–50.5MM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio (4 Hrs/Day)</td>
<td>43</td>
<td>28</td>
<td>59</td>
<td>69</td>
</tr>
<tr>
<td>Cassette (1 Hr/Day)</td>
<td>10</td>
<td>120</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>Toy/Game (1 Hr/Day)</td>
<td>3.9</td>
<td>308</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Flashlight (Continuous)</td>
<td>3.9</td>
<td>308</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Photo (15 Sec/Min – 24 Hrs/Day)</td>
<td>1.8</td>
<td>667</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Quality Systems Certification:
c. C Size Alkaline Battery

Rayovac No.: 814
Nominal Voltage: 1.5 volts
System: Primary Alkaline
ANSI/NEDA No.: 14A (C)
IEC No.: LR14
Approximate Volume: 1.6 cu. in. (26.2 cu. cm.)
Approximate Weight: 2.5 oz. (70 gm.)
Terminals: Flashlight
Shell: Plastic
Environmental: Meets Environmental Protection Agency (EPA) requirements for landfill disposal. No mercury added formulation.

<table>
<thead>
<tr>
<th>Application &amp; Duty Cycle</th>
<th>Load (ohms)</th>
<th>Current (mA at 1.2V)</th>
<th>Estimated Average Service At 70°F (Hours)</th>
<th>Approx. mAh Capacity to 0.9V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio (4 Hrs/Day)</td>
<td>20</td>
<td>60</td>
<td>79 96 108 117</td>
<td>7245</td>
</tr>
<tr>
<td>Cassette (1 Hr/Day)</td>
<td>6.8</td>
<td>176</td>
<td>18 28 33 36</td>
<td>6365</td>
</tr>
<tr>
<td>Flashlight (4 Min/Hr – 8 Hrs/Day)</td>
<td>3.9</td>
<td>308</td>
<td>8 14 19 20</td>
<td>6133</td>
</tr>
<tr>
<td>Toy/Game (1 Hr/Day)</td>
<td>3.9</td>
<td>308</td>
<td>7 13 17 20</td>
<td>5822</td>
</tr>
<tr>
<td>Flashlight (Continuous)</td>
<td>3.9</td>
<td>308</td>
<td>5 11 16 19</td>
<td>5539</td>
</tr>
</tbody>
</table>

Dimensions shown are ANSI/IEC standards.
d. D Size Alkaline Battery

Rayovac No.: 813  
Nominal Voltage: 1.5 volts  
System: Primary Alkaline  
ANSI/NEDA No.: 13A (D)  
IEC No.: LR20  
Approximate Volume: 3.4 cu. in. (55.7 cu. cm.)  
Approximate Weight: 5.0 oz. (144 gm.)  
Terminals: Flashlight  
Shell: Plastic  
Environmental: Meets Environmental Protection Agency (EPA) requirements for landfill disposal. No mercury added formulation.

Dimensions shown are ANSI/IEC standards.

### Application & Duty Cycle

<table>
<thead>
<tr>
<th>Application &amp; Duty Cycle</th>
<th>Load (ohms)</th>
<th>Current (mA at 1.2V)</th>
<th>Estimated Average Service At 70°F (Hours)</th>
<th>Approx. mAh Capacity to 0.9V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1.2V</td>
<td>1.1V</td>
<td>1.0V</td>
</tr>
<tr>
<td>Radio (4 Hrs/Day)</td>
<td>10</td>
<td>120</td>
<td>80</td>
<td>101</td>
</tr>
<tr>
<td>Cassette (1 Hr/Day)</td>
<td>3.9</td>
<td>308</td>
<td>21</td>
<td>32</td>
</tr>
<tr>
<td>Toy/Game (1 Hr/Day)</td>
<td>2.2</td>
<td>545</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Flashlight (4 Min/Hr - 8 Hrs/Day)</td>
<td>2.2</td>
<td>545</td>
<td>9</td>
<td>16</td>
</tr>
<tr>
<td>Flashlight (Continuous)</td>
<td>2.2</td>
<td>545</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Flashlight, K2 Krypton Bulb</td>
<td>1.5</td>
<td>800</td>
<td>3</td>
<td>7</td>
</tr>
</tbody>
</table>
e. 9-Volt Alkaline Battery

Rayovac No.: A1604
Nominal Voltage: 9 volts
System: Primary Alkaline
ANSI/NEDA No.: 1604A (9v)
IEC No.: 6LR61
Approximate Volume: 1.2 cu. in. (19.7 cu. cm.)
Approximate Weight: 1.6 oz. (45.4 gm.)
Terminals: Snap
Shell: Steel
Environmental: Meets Environmental Protection Agency (EPA) requirements for landfill disposal. No mercury added formulation.

<table>
<thead>
<tr>
<th>Application &amp; Duty Cycle</th>
<th>Load (ohms)</th>
<th>Current (mA at 7.2V)</th>
<th>Estimated Average Service At 70°F (Hours)</th>
<th>Cutoff Voltage</th>
<th>Approx. mAh Capacity to 4.2V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Rate (Continuous)</td>
<td>6000</td>
<td>1</td>
<td>251</td>
<td>62</td>
<td>662</td>
</tr>
<tr>
<td>Radio (2 h/d)</td>
<td>620</td>
<td>12</td>
<td>12</td>
<td>48</td>
<td>609</td>
</tr>
<tr>
<td>Toy/Game (1 h/d)</td>
<td>270</td>
<td>27</td>
<td>3</td>
<td>20</td>
<td>569</td>
</tr>
<tr>
<td>Calculator (30 m/d)</td>
<td>180</td>
<td>40</td>
<td>2</td>
<td>13</td>
<td>551</td>
</tr>
</tbody>
</table>

Dimensions shown are ANSI/IEC standards.

Quality Systems Certification:
B. Heavy Duty

a. AAA Size Heavy Duty Battery

Rayovac No.: 3AAA
Nominal Voltage: 1.5 volts
System: Zinc Chloride
ANSI/NEDA No.: 24D (AAA)
IEC No.: R03
Approximate Volume: 2 cu. in. (3.3 cu. cm.)
Approximate Weight: 3 oz. (9 gm.)
Terminals: Flashlight
Shell: Plastic
Environmental: Meets Environmental Protection Agency (EPA) requirements for landfill disposal. No mercury added formulation.

Dimensions shown are ANSI/IEC standards.
b. AA Size Heavy Duty Battery

Rayovac No.: 5AA  
Nominal Voltage: 1.5 volts  
System: Zinc Chloride  
ANSI/NEDA No.: 15D (AA)  
IEC No.: R6  
Approximate Volume: 0.48 cu. in. (7.87 cu. cm.)  
Approximate Weight: 0.65 oz. (18.4 gm.)  
Terminals: Flashlight  
Shell: Steel  
Environmental: Meets Environmental Protection Agency (EPA) requirements for landfill disposal. No mercury added formulation.

<table>
<thead>
<tr>
<th>Application &amp; Duty Cycle</th>
<th>Load Current Capacity (mA at 1.2V)</th>
<th>Estimated Average Service At 70°F (Hours)</th>
<th>Approx. mAh Capacity to 0.9V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio (4 Hrs/Day)</td>
<td>43</td>
<td>28</td>
<td>27</td>
</tr>
<tr>
<td>Cassette (1 Hr/Day)</td>
<td>10</td>
<td>120</td>
<td>4.2</td>
</tr>
<tr>
<td>Toy/Game (1 Hr/Day)</td>
<td>3.9</td>
<td>256</td>
<td>0.4</td>
</tr>
<tr>
<td>Photo (15 Sec/Min – 24 Hrs/Day)</td>
<td>18</td>
<td>667</td>
<td>—</td>
</tr>
</tbody>
</table>

Dimensions shown are ANSI/IEC standards.
c. C Size Heavy Duty Battery

Rayovac No.: 4C
Nominal Voltage: 1.5 volts
System: Zinc Chloride
ANSI/NEDA No.: 14D (C)
IEC No.: R14
Approximate Volume: 1.6 cu. in. (26.2 cu. cm.)
Approximate Weight: 1.5 oz. (50 gm.)
Terminals: Flashlight
Shell: Steel
Environmental: Meets Environmental Protection Agency (EPA) requirements for landfill disposal. No mercury added formulation.

Approx. Cutoff Voltage

<table>
<thead>
<tr>
<th>Application &amp; Duty Cycle</th>
<th>Load (ohms)</th>
<th>Current (mA at 1.2V)</th>
<th>1.2V</th>
<th>1.1V</th>
<th>1.0V</th>
<th>0.9V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio (4 Hrs/Day)</td>
<td>20</td>
<td>60</td>
<td>33</td>
<td>40</td>
<td>43</td>
<td>44</td>
</tr>
<tr>
<td>Cassette (1 Hr/Day)</td>
<td>6.8</td>
<td>176</td>
<td>6.7</td>
<td>10.9</td>
<td>13.7</td>
<td>14.5</td>
</tr>
<tr>
<td>Flashlight (4 Min/Hr – 8 Hrs/Day)</td>
<td>3.9</td>
<td>308</td>
<td>2.4</td>
<td>5.0</td>
<td>7.3</td>
<td>8.2</td>
</tr>
<tr>
<td>Toy/Game (1 Hr/Day)</td>
<td>3.9</td>
<td>308</td>
<td>1.7</td>
<td>4.3</td>
<td>6.6</td>
<td>7.8</td>
</tr>
</tbody>
</table>

Dimensions shown are ANSI/IEC standards.
d. D Size Heavy Duty Battery

Rayovac No.: 6D
Nominal Voltage: 1.5 volts
System: Zinc Chloride
ANSI/NEDA No.: 13D (D)
IEC No.: R20
Approximate Volume: 3.4 cu. in. (55.7 cu. cm.)
Approximate Weight: 3.3 oz. (96 gm.)
Terminals: Flashlight
Shell: Steel
Environmental: Meets Environmental Protection Agency (EPA) requirements for landfill disposal. No mercury added formulation.

<table>
<thead>
<tr>
<th>Application &amp; Duty Cycle</th>
<th>Load (ohms)</th>
<th>Current (mA at 1.2V)</th>
<th>Estimated Average Service At 70°F (Hours)</th>
<th>Approx. mAh Capacity to 0.9V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio (4 Hrs/Day)</td>
<td>10</td>
<td>120</td>
<td>36</td>
<td>6880</td>
</tr>
<tr>
<td>Cassette (1 Hr/Day)</td>
<td>3.9</td>
<td>308</td>
<td>7.8</td>
<td>6075</td>
</tr>
<tr>
<td>Flashlight, PR2 Vacuum Bulb</td>
<td>2.2</td>
<td>545</td>
<td>2.4</td>
<td>5470</td>
</tr>
<tr>
<td>Toy/Game (1 Hr/Day)</td>
<td>2.2</td>
<td>545</td>
<td>1.6</td>
<td>4725</td>
</tr>
</tbody>
</table>

Dimensions shown are ANSI/IEC standards.
### e. 9-Volt Heavy Duty Battery

- **Rayovac No.:** D1604
- **Nominal Voltage:** 9 volts
- **System:** ZINC CHLORIDE
- **ANSI/NEDA No.:** 1604D (9v)
- **IEC No.:** 6F22
- **Approximate Volume:** 1.2 cu. in. (19.7 cu. cm.)
- **Approximate Weight:** 1.5 oz. (42.5 gm.)
- **Terminals:** Snap
- **Shell:** Steel
- **Environmental:** Meets Environmental Protection Agency (EPA) requirements for landfill disposal. No mercury added formulation.

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### Application & Load Current Capacity

<table>
<thead>
<tr>
<th>Duty Cycle</th>
<th>Load (ohms)</th>
<th>Current (mA at 7.2V)</th>
<th>Estimated Average Service At 70°F (Hours)</th>
<th>Cutoff Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>7.8V</td>
<td>6.6V</td>
<td>6.0V</td>
</tr>
<tr>
<td>Low Rate (24 Hrs/Day)</td>
<td>6000</td>
<td>188</td>
<td>326</td>
<td>351</td>
</tr>
<tr>
<td>Radio (2 Hrs/Day)</td>
<td>620</td>
<td>7.7</td>
<td>25.5</td>
<td>31.3</td>
</tr>
<tr>
<td>Toy/Game (1 Hr/Day)</td>
<td>270</td>
<td>0.9</td>
<td>7.5</td>
<td>10.3</td>
</tr>
<tr>
<td>Calculator (30 Min/Day)</td>
<td>180</td>
<td>0.3</td>
<td>3.7</td>
<td>5.5</td>
</tr>
<tr>
<td>Cassette (1 Hr/Day)</td>
<td>180</td>
<td>0.3</td>
<td>3.5</td>
<td>5.5</td>
</tr>
</tbody>
</table>

---

### Dimensions

- **Overall Width:** 1.043" (26.5MM)
- **Overall Height:** 1.909"–1.945" (48.5–49.5MM)
- **Overall Depth:** 1.043" (26.5MM)
- **Min Height:** 0.490"–0.510" TERMINALS (ON CENTER) (12.45–12.95MM)
- **Max Height:** 1.831"–1.909" (46.5–48.5MM)
- **Overall Height:** 1.827" (46.4MM)
- **Min Height:** 0.070" (1.78MM)
- **Max Height:** 0.437" (11.1MM)

Dimensions shown are ANSI/IEC standards.

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### Quality Systems Certification:

![Certified ISO 9001](image)
IX. Product Availability

Rayovac batteries are available in various packaging options including bulk, carded, and multi-packs. For information, call your Rayovac representative.
Notice

This publication is furnished only as a guide. It is the user’s responsibility to determine suitability of the products described for the user’s purpose (even if the use is described herein) and to take precautions for protection against any hazards attendant to the handling and use of the products. Rayovac recommends prospective users test each application.

The battery products and arrangements described herein may be covered by patents owned by Rayovac or others. Neither this disclosure nor the sale of products by Rayovac conveys any license under patent claims covering combinations of battery products with other elements or devices. Rayovac does not assume liability for patent infringement arising from any use of the products by the purchaser.

The technical data contained herein are not designed to be the basis for specifications. Rayovac’s Quality Assurance Department can furnish data that can serve as the basis for specifications.

Worldwide Sales & Marketing Offices

RAYOVAC CORPORATION
World Headquarters
OEM Sales & Marketing
P.O. Box 44960
Madison, WI 53744-4960
Tel. (608) 275-3340
Fax (608) 275-4073

RAYOVAC CANADA INC.
5448 Timbertop Boulevard
Mississauga, Ontario L4W 1T7
Canada
Tel. (905) 629-2571
Fax (905) 629-4439

RAYOVAC UK, LTD.
Galleon House
King Street
Maidstone, Kent ME14 1BG
England
Tel. 011-44-622-688331
Fax 011-44-622-685523

RAYOVAC FAR EAST LTD.
Room 720-723, Hollywood Plaza
610 Nathan Road
Mongkok Kowloon
Hong Kong
Tel. 011-852-2782-2343
Fax 011-852-2782-4091

www.rayovac.com/oem

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