Matsushita Electric Industrial Co., Ltd.
Matsushita Battery Industrial Co., Ltd.

SPECIFICATIONS OF
SEALED NICKEL METAL HYDRIDE BATTERIES

FOR MESSRS : PIE

MODEL : HHR−210AB18

DATE : 11. JUN. 2004

SPECIFICATION No. : S4061173

SENT ON
14. JUN. 2004
ALKALINE STORAGE BATTERY DIV.

	AMENDMENT	DATE OF ISSUE

Drawn	[signature]
Checked	[signature]
Checked	M. Tamura
Approved	H. KAIYA

APPROVED BY	SIGNATURE	DATE

FORM No. : EAAE06

MH

SPECIFICATIONS

1. APPLICATION

This specification applies to the Sealed Nickel-Metal Hydride rechargeable cell or battery :

Model HHR-210AB18

for ____________

2. RATINGS

○IEC Designation	HR17/50	
○Nominal voltage	1.2	V
○Rated (Minimum) capacity *1	2100	mAh
○Average capacity(for reference only)	2200	mAh
○Standard charge rate	210	mA × 16 h
○Rapid charge rate	2100	mA (with the following charge condition)*2
Value of dT/dt (for reference only)	1 to 2	℃/min
Value of −ΔV per cell	5 to 10	mV
Value of Tco	55	℃
Trickle current	63 to 105	mA (Need timer)
○Discharge cut-off voltage	(n×1.0)V	(n=1∼6)
	[(n−1)×1.2]V	(n=7∼10)
	(n:cell number)	
○Maximum continuous discharge current (single cell)	4200	mA (at 20 ℃)

○Operating temperature range (Humidity : +65 %±20 %)

Standard charge	0 to +45 ℃ (32 to 113 °F)
Rapid charge	0 to +40 ℃ (32 to 104 °F)
Discharge	−10 to +65 ℃ (14 to 149 °F)

○Storage temperature range (Humidity : +65 %±20 %)

within 1 year *3	−20 to +35 ℃ (−4 to 95 °F)
within 6 months	−20 to +45 ℃ (−4 to 113 °F)
within 1 month	−20 to +55 ℃ (−4 to 131 °F)
within 1 week	−20 to +65 ℃ (−4 to 149 °F)

*1 Rated capacity figures are based on single cell performance.
*2 All rapid charge systems should be discussed with our engineer.
*3 We recommend cells or batteries are charged at least once every 6 months.

When operation falls outside these parameters please contact our engineer.

3. ASSEMBLY & DIMENSIONS

as per attached drawing

drawing number C21213213

4. PERFORMANCE

4-1. TEST CONDITIONS

All tests are carried out on new cells or batteries. (within one month after delivery)

Ambient conditions :

Temperature	+20 ℃±5 ℃
Humidity	+65 %±20 %

4-2. TEST METHOD & PERFORMANCE

4-2-1. Outer appearance :

Cells and batteries shall be free from any stains, scratches or deformations which may reduce the commercial value of the product when visually inspected.

4-2-2. Capacity :

Following a 16hour charge period at 210 mA, the cell shall be stored for a period of 1hour. The discharge duration shall exceed 5 hour(s) 00 min(s) when discharged at 420 mA down to a terminal voltage of 1.0 V. The capacity returned may not initially attain the specified value following the first charge - discharge cycle. In this event, the test may be repeated a further two or three times to attain the specified value.

4-2-3. Open circuit voltage : (O.C.V.)

Following a 16hour charge period at 210 mA, the open circuit voltage of the cell or battery shall be checked within 1hour. The O.C.V. shall exceed 1.25 V per cell.

4-2-4. Closed circuit voltage : (C.C.V.)

Following a 16hour charge period at 210 mA, the closed circuit voltage of the cell or battery shall be checked with a 0.50 Ω per cell load within 1hour. The C.C.V. shall exceed 1.2 V per cell within 1sec.

4-2-5. Internal impedance :

Following a 16hour charge period at 210 mA, the Internal impedance of the cell or battery shall be checked at 1000 Hz within 1hour. The internal impedance shall be less than 25 mΩ per cell.

4-2-6. High rate discharge :

Following a 16hour charge period at 210 mA, the cell or battery shall be stored for a period of 1hour. The discharge duration shall exceed 48 min(s) when discharged at 2100 mA.

4-2-7. Low temperature discharge :

Following a 16hour charge period at 210 mA, the cell or battery shall be stored for a period of 24hours at 0 ℃±2 ℃. The discharge duration shall exceed 3 hour(s) 30 min(s) when discharged at 420 mA at ambient temperature of 0 ℃±2 ℃.

4-2-8. Self discharge :

Following a 16hour charge period at 210 mA, the cell or battery shall be stored on open circuit for a period of 28 days. The subsequent discharge duration shall exceed 3 hour(s) 15 min(s) when discharged at 420 mA.

4-2-9. Storage :

The cell shall be stored on open circuit for a period of 12months at discharged state. Following completion of the storage period, the cell shall be charged for 16hours at 210 mA. The subsequent discharge duration shall exceed 4 hour(s) 15 min(s) when discharged at 420 mA. The test may be repeated a further two or three times to reach the specified capacity.

4-2-10. Over-charge # 1 :

Following a 48hour continuous overcharge period at 210 mA, the cell or battery shall be stored for a period of 1hour. The subsequent battery discharge duration shall exceed 5 hour(s) 00 min(s) when discharged at 420 mA. The cell or battery shall not be externally deformed and no leakage of electrolyte in liquid form shall be observed.

4-2-11. Life time (Based on IEC) :

Based on 50 charge -discharge cycles as outlined in the table below, the discharge time of the 50th, 100th, 150th, 200th, 250th, 300th, 350th, 400th, 450th and 500th shall exceed 3 hour(s) 00 min(s). (Ambient temperature is 20 ℃±5 ℃)

Test condition :

Cycle number	Charge	Rest	Discharge
1	210 mA for 16 hours	none	525 mA for 2.33hours
2~48	525 mA for 3.17hours	none	525 mA for 2.33hours
49	525 mA for 3.17hours	none	525 mA to 1.0 V per cell
50	210 mA for 16 hours	1-4h	420 mA to 1.0 V per cell

4-2-12. Life time (Rapid charge) :
For the 300th cycle the cell or battery shall supply more than 36 min(s) under the following test conditions.
Test conditions :

charge	using the rapid charge condition specified in clauses "2.RATINGS"
discharge	2100 mA to 1.0 V per cell

4-2-13. Humidity :
No leakage of electrolyte in liquid form shall be observed during 14days of storage under the following storage conditions :
33 ℃±3 ℃ (91.4 °F±5.4 °F) Relative humidity of 80 %±5 %. (Salting is permitted)

4-2-14. Vibration :
Following vibration tests over an amplitude of 4 mm (0.1575 inches) at a frequency of 16.7 Hz (1000 cycles per minute) and repeated through any axes during 60mins, the discharge duration shall exceed 5 hour(s) 00 min(s) when discharged at 420 mA and the cell or battery shall not be externally deformed and no leakage of electrolyte in liquid form shall be observed.

4-2-15. Free falling : (Drop)
Following a drop test from 450 mm(17.717 inches)on to a hard-wood board in a vertical axis 2 times on each of 2 mutually perpendicular axes, the discharge duration shall exceed 5 hour(s) 00 min(s) when discharged at 420 mA and the cell or battery shall not be externally deformed and no leakage of electrolyte in liquid form shall be observed.

4-2-16. Short :
The cell or battery shall not explode during or at the end of a 1hour short-circuit test. However, leakage of electrolyte, external deformation or outer sleeve cracking is permitted.

4-2-17. Incorrect polarity charging :
The cell or battery shall not explode during or at the end of a 1hour period of incorrect polarity charging at 2100 mA. However, leakage of electrolyte, external deformation or outer sleeve cracking is permitted.

4-2-18. Over charge # 2 :
The cell or battery shall not explode during or at the end of a 5hour charging period at 2100 mA. However, leakage of electrolyte, external deformation or outer sleeve cracking is permitted.

5. OTHERS

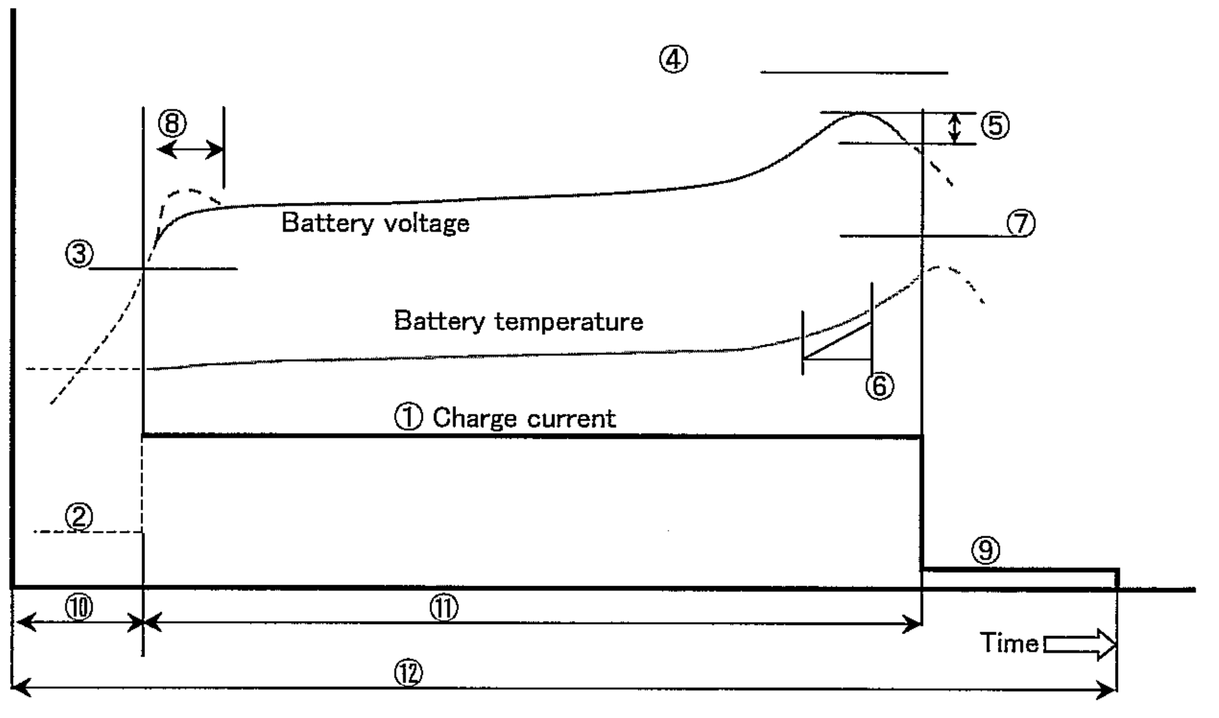
5-1. The cell or battery shall be charged state at shipping.
5-2. Cut-off voltage :
○We recommend a cut-off voltage of 1.0 to 1.1 V per cell.
○If the cut-off voltage is above 1.1 V per cell, the battery may be underutilized resulting in insufficient use of the available capacity.
○If the cell voltage drops below 1.0 V per cell, the battery may become over discharged or reverse charged.
* In case of over 2C mA discharge a cut-off voltage should be 0.8 V per cell.

Specification can be changed upon mutual agreement between
P I E
and Matsushita Battery Industrial Co., Ltd.

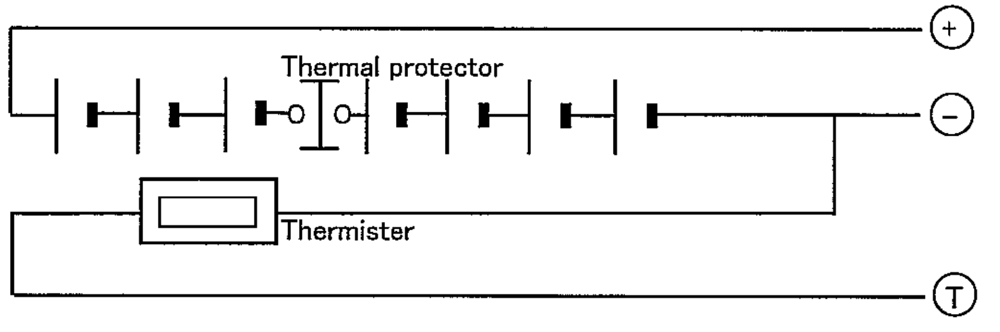
Ni–MH Battery ; Example on rapid charge system

1. Basic charge system

① Rapid charge current	: 0.5C to 1.0C mA
② Charge current to voltage for rapid charge	: 0.2C to 0.3C mA
③ Start voltage of rapid charge	: above 0.8 V per cell
④ Upper limit voltage (to trickle charge)	: 1.8 V per cell
⑤ Value of minus delta V (−ΔV)	: 5 to 10 mV per cell
⑥ Temperature increase rate (dT/dt)	: 1 to 2 ℃/min
⑦ Upper limit temperature (Tco)	: 55 ℃
⑧ Initial non–detection timer of minus delta V(−ΔV)	: 5 to 10 min
⑨ Trickle charge current	: 1/20C to 1/30C mA
⑩ Transfer timer to rapid charge	: 60 min
⑪ Total rapid charge timer	: 1.5 h
⑫ Total charge timer	: 10 to 20 h
⑬ Ambient temperature for rapid charge	: 0 to 40 ℃



2. Basic pack circuit



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Commercial Tolerance	Sym.	Date	Revision	Drawn	Checked	Approved
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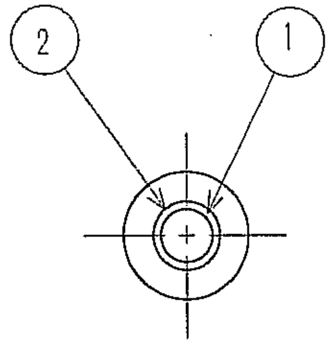

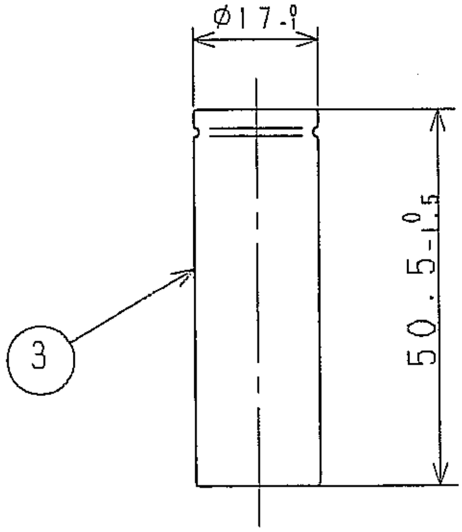

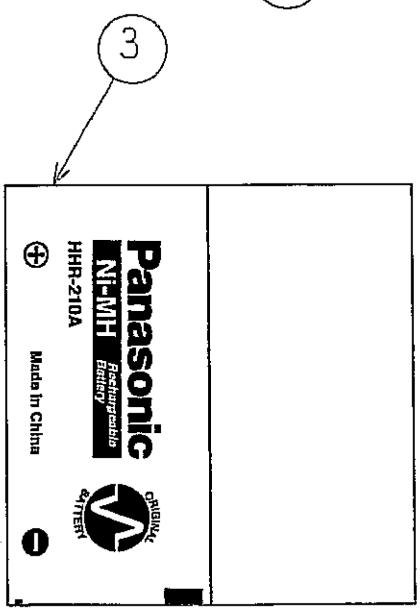

Nominal voltage 1.2 V
Rated capacity 2100mAh
(minimum)
Averege Capacity 2200mAh
(for reference only)
Approx.weight 38g

Sym	Item or Code No.	Material & Size	ol.	Process	Remark
3	Jacket	P.V.C tube	1		
2	Insulation ring	Paper	1		
1	Battery	HHR-210A	1	Charged	Made in China

Scale	Designed	Drawn	Checked	Approved
1/1	TERADARU 08.Apr.2004	TERADARU 08.Apr.2004	[signature]	M. Tamura

Name	Sealed Nickel Metal Hydride Battery HHR-210AB18
No.	C21213213

<<Sealed Type Nickel-Cadmium Rechargeable Battery / Nickel-Metal Hydride Rechargeable Battery>>

· Cautions concerning the use of the batteries and the design of battery-operated products

- When using these batteries and when designing battery-operated products, please pay particular attention to the following points in order to take full advantage of the batteries' characteristics, and to prevent problems due to improper use.
  Panasonic assumes no responsibility for quality problems or troubles resulting from use that does not conform to the "Cautions concerning the use of the batteries and the design of battery-operated products" shown below.

________________Please pay particular attention to underlined text.

1. Charging

1－1 Charging temperature

① Charge batteries within an ambient temperature range of 0℃ to +40℃.

② The ambient temperature during charging affects the charging efficiency. Since the charging efficiency is best within a temperature range of +10℃ to +30℃, whenever possible place the charger (battery pack) in a location within this temperature range

③ At temperatures below 0℃, the gas absorption reaction is not adequate, causing the gas pressure inside the battery to rise, which can activate the safety vent and lead to leakage of alkaline gas and deterioration of the battery performance.

④ The charging efficiency drops at temperatures above +40℃.
This can impact the full charging and lead to deterioration in performance and battery leakage.

1－2 Parallel charging of batteries

- When charging batteries connected in parallel, sufficient attention should be paid to the design of the charger, including temperature variations depending on the number of batteries charged.
Consult Panasonic when parallel charging is required.

1－3 **Reverse charging**

- **Never carry out reverse charging.**
Charging with reversed polarities can cause a reversal in a battery's polarity, causing the gas pressure inside the battery to rise, which can activate the safety vent and cause a rapid deterioration in battery performance, even battery swelling and battery rupture.

1－4 **Overcharging**

- **Avoid overcharging.**
Repeated overcharging can lead to deterioration in battery performance.
(Overcharging means charging a battery when it is already fully charged.)

1－5 **Rapid charging**

- **To charge batteries rapidly, use the specified charger (or charging method recommended by Panasonic) and follow the correct procedures.**

1－6 Trickle charging (continuous charging)

① When adopting trickle charging as the standard charging method, use the H or O type batteries.
Charge the batteries at a current from 1/30 ItmA to 1/20 ItmA.

② When adopting trickle charging as a supplementary charging method after rapid charging, carry out trickle charging at a current from 1/30 ItmA to 1/20 ItmA.
To avoid the deterioration of a battery's performance due to overcharging, use a timer that measures the total charging time including trickle charging.

* Note: "ItmA"

During charging and discharging, ItmA is a value indicating current and expressed as a multiple of nominal capacity. Substitute "It" with the battery's nominal capacity when calculating.
For example, for a 1500mAh battery of 1/30 ItmA, this value is equal to 1/30 × 1500, or roughly 50mA.

2. Discharging

2－1 Discharging temperature

① Discharge batteries within an ambient temperature range of -10℃ to +65℃.
② The level of the discharge current (i. e., the current at which a battery is discharged) affects the discharging efficiency. The discharging efficiency is satisfactory within a current range of 1/10 ItmA to 1/2 ItmA.
③ Discharging batteries at temperatures below -10℃ or above +65℃ can lead to the deterioration in the battery's performance.
④ Even at the maximum discharge current or lower, discharging may be impossible at a low temperature.

2－2 Overdischarging (deep discharge)

- **Because overdischarging (deep discharging) damages the battery and causes electrolyte leakage, do not forget to turn off the switch when discharging, and do not leave the battery connected to the equipment for long periods of time. Also, avoid shipping the battery installed in the equipment.**

2－3 High-current discharging

① When discharging at a high current, use the P or X type batteries.
② Because high-current discharging can lead to heat generation and decreased discharging efficiency, consult Panasonic before attempting continuous discharging or pulse discharging at currents greater than 2 ItmA.

3. Storage

3－1 Storage temperature and humidity (short-term)

① Store batteries in a dry location with low humidity, no corrosive gases, and a temperature range of -20℃ to +45℃.
② Storing batteries in a location where humidity is extremely high or temperatures fall below -20℃ or rise above +45℃ leads to the rusting of metallic parts and battery leakage due to expansion or contraction in parts composed of organic materials.

3－2 Long-term storage (1 year, -20℃ to +35℃)

① Long-term storage may cause the deterioration of various characteristic.
Therefore, it is desirable to store the batteries at as a low temperature as much as possible.
② When charging for the first time after long-term storage, deactivation of reactants may have led to increased battery voltage and decreased battery capacity. Restore such batteries to their original performance through repeated several cycles of charging and discharging.
③ When storing batteries for more than 1 year, charge once every six months or at least once a year to prevent leakage and deterioration in performance due to self-discharging.

4. Service life of batteries

4－1 Cycle life

- The life of a battery is 500 cycles or more of operation under the durability test conditions specified by JIS.
  A significantly reduced service time in spite of proper charging means that the life of the battery has been exceeded.
  Also, at the end of service life, an unusual increase in internal resistance, or an internal short-circuit failure may occur. Chargers and charging circuits should therefore be designed to ensure safety in the event of heat generated upon battery failure at the end of service life. (if any points are unclear, contact Panasonic.)

4 − 2 Service life with long-term use

- As batteries are chemical products involving internal chemical reactions, performance deteriorates not only with use, but also during prolonged storage.
  Normally, a battery will last 2 to 3 years (or 500 cycles) if used under proper conditions and not overcharged or overdischarged. Note that failure to satisfy the proper conditions concerning charging, discharging, temperature, and other factors during actual use can cause electrolyte leakage, leading to the deterioration of a battery's performance or damage to products, and shorten the battery's service life (or cycle life).

5. Design of products which use batteries

5 − 1 **Connecting batteries and products**

① **Never solder a lead wire or other connecting materials directly to the battery, because doing so will damage the battery's internal safety vent, separator, and other parts made of organic materials.**
To connect a battery to a product through soldering, solder the lead wire to a contact piece (tab) made of nickel or nickel-plated steel, and then spot-weld the tab to the battery.

② **To connect the terminal of a product to the terminal of a battery pack by contact rather than using a connector, the terminal shapes and the contact pressure should be carefully designed to prevent contact failures.**

5 − 2 **Material for terminals in products using the batteries**

- **As small amounts of alkaline electrolyte can leak out from the battery seal during extended use or when the safety vent is activated during improper use, use a highly alkaline-resistant material for the product's contact terminals in order to avoid problems due to corrosion.**

5 − 3 Position and temperature of batteries in products

- As excessively high temperatures (i. e., higher than 65℃) can cause alkaline electrolyte to leak out from the battery, thus damaging the product and shorten battery life by causing deterioration in the separator or other battery parts, install the batteries far from the heat-generating parts of products. The best battery position is a battery compartment made of an alkaline-resistant material and that isolates the batteries from the product's circuitry. This prevents damage caused by slight leakages of alkaline electrolyte from the battery.

5 − 4 **Discharge end voltage**

- The basic discharge end voltage is determined by the formula given below.
  Number of batteries arranged serially
  1 to 6: (Number of batteries × 1.0) V
  7 to 10 : [(Number of batteries − 1) × 1.2] V

  The discharge end voltage should be set in accordance with the number of cells in a battery pack and the discharge current. When you require a battery pack whose discharge current is 2 ItmA or more or includes more than 10 cells, please consult Panasonic.

5 − 5 **Overdischarge (deep discharge) prevention**

- **Overdischarging (deep discharging) or reverse charging deteriorates a battery's performance, leading to electrolyte leakage or deterioration of product performance. To avoid these problems, make sure to provide the product with a mechanism to prevent overdischarging (deep discharging).**
  Further, minimize the leakage current from the product to the battery to several microamperes or less.

6. Restrictions regarding battery handling in order to ensure safety

6－1 Disassembly

- Never disassemble a battery, as the electrolyte inside is strong alkaline and can damage skin and clothes.

6－2 Short-circuiting

- Never attempt to short-circuit a battery. Doing so can damage the product and generate heat that can cause burns.

6－3 Throwing batteries into a fire or water

- Disposing of a battery in fire can cause the battery to rupture. Also avoid placing batteries in water, as this damages battery functions.

6－4 Soldering

- Never solder anything directly to a battery. This can destroy the safety features of the battery by damaging the safety vent inside the cap.

6－5 Inserting the batteries with their polarities reversed

- Never insert a battery with the positive and negative poles reversed, as this can cause the battery to swell or rupture.

6－6 Overcharging at high currents and reverse charging

① Never carry out reverse charging or overcharging with high currents (i. e., higher than rated). Doing so causes rapid gas generation and increased gas pressure, thus causing batteries to swell or rupture.

② Charging with an unspecified charger or a specified charger that has been modified can cause batteries to swell or rupture.

☆ Be sure to indicate this safety warning clearly in all operating instructions as a handling restriction for ensuring safety.

6－7 Installation in equipment (with a sealed construction)

① Always avoid incorporating batteries into a product with a sealed construction. In some cases, gases (oxygen, hydrogen) may be generated, and there is a danger of the batteries bursting or rupturing in the presence of a source of ignition (sparks generated by a motor, switch, etc.).

6－8 Use of batteries for other purposes

- Do not use a battery for an appliance or purpose for which it was not intended. Differences in specifications can lead to damage to the battery or appliance.

6－9 Short-circuiting of battery packs

- Take special care to prevent battery packs from short-circuiting. There is a possibility that cassette type battery packs may be inserted in a reverse direction depending on the shape of the product or battery. In addition, some shapes of product terminals are more likely to cause short-circuiting. Therefore, special care should be taken.

6－１０ Using old and new batteries together

- Avoid using old and new batteries together. Also avoid using these batteries with ordinary dry-cell batteries, Ni-Cd batteries or with another manufacturer's batteries.
  Differences in the characteristics can damage the batteries or the product.

7. Other precautions

7－1 Charging before use

- Batteries should always be charged prior to use. Be sure to charge them correctly.

8. Requests

※ **Battery performance and service life vary largely with usage.**
When you design a battery-operated product, please consult Panasonic regarding the charging and discharging specifications and the product structure to ensure safety.

Panasonic assumes no responsibility for quality problems or troubles resulting from use that does not conform to the "Cautions concerning use and the design of battery-operated products" shown above.

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