BATTERY INFORMATION

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Ampere-Hours (Ah)
One ampere-hour is equal to a current of one ampere flowing for one hour. A unit-quantity of electricity used as a measure of the amount of electrical charge that may be obtained from a storage battery before it needs recharging.

Battery
A device that transforms chemical energy into electric energy. The amp hour (Ah) of a battery times the voltage gives the power available in watt hours (Wh).

Capacity
The electrical content of a battery as expressed in ampere-hours.

Charge
The process of restoring the electrical charge in a rechargeable battery.

Cycle
A single charge and discharge of a rechargeable battery.

Cycle Life
The number of cycles a battery provides before it is no longer usable. A battery is non-usable if its capacity falls below 60% to 80%.

Discharge Rate
The discharge rate of a battery is the relationship of its voltage level to the amount of time it has been discharging. In most primary batteries, the voltage will drop steadily as it is used. When used in a flashlight, for example, the brightness will decrease steadily over time. Secondary batteries, such as the NiCd and Lithium-ion, will maintain their rated voltage level for approximately two-thirds of the discharge cycle and shortly after that point is reached the voltage will drop to zero.

Electrode
Conducting element within a cell in which an electrochemical reaction occurs. It includes active materials plus conductive and supportive elements.

Electrolyte
A non-metallic conductor of electricity (typically liquid) between the positive and negative electrodes of a battery. The current is produced by physical movement of ions from one electrode to the other through the electrolyte.

Energy
Voltage multiplied by current and is expressed in watts.

Energy Density
The amount of energy a battery contains. Gravimetric energy is the watt-hours a battery is capable of producing per given weight, and volumetric energy is the watt-hours per given physical size of the battery.

Fast Charge
Fast charge time for a NiCd battery is 1 to 3 hours. The fast-charger detects the state-of-charge and switches to trickle charge when full charge is reached.

Intrinsically Safe Battery
Contains built-in protection circuitry for use in explosive environments. These environments include oil refineries, mines, grain elevators and fuel handling at airports which are typically serviced by two-way radios. Intrinsically safe batteries prevent high heat and electric spark on equipment failure. Their cost is two to three times the cost of a similar battery that is not rated "intrinsically safe".

Memory
Reversible capacity loss in NiCd, and to some extent NiMH batteries. The physical process that causes the memory effect is formation of potassium-hydroxide crystals inside the battery cells. This build up of crystals interferes with the chemical process of generating electrons during the next battery-use cycle.

This condition is caused by repeatedly discharging the battery to only, for example, 50% of its capacity. The battery "remembers" this discharge point and superficially "needs" a charge whenever it is discharged to the 50% level. This condition may be overcome by discharging the battery completely and charging it fully. It may take several cycles for the battery to attain maximum capacity. (See Recondition).

Overcharge
Charging a battery after it reaches full charge. The battery can no longer absorb a charge and it heats up excessively. Prolonged high temperatures can damage the battery.

Passivation Layer
A resistive layer that forms in some cells after prolonged storage. This layer must be broken to enable proper operation which can be done by cycling the battery several times.

Primary Battery
A battery that is designed to be cycled (fully discharged) only once then discarded. Primary batteries have a higher energy density than secondary batteries. As an example, a primary alkaline battery provides 50% more power than a lithium-ion battery of similar size.

Recondition
A deep discharge causing a change to the molecular structure of the cell and a rebuilding of its chemical composition. Recondition helps break down large crystals to a more desirable small size, often restoring the battery to its full capacity. Applies to nickel-based batteries.

Secondary Battery
Commonly known as a rechargeable battery. The electromechanical action is reversible so that the battery may be recharged by passing current through the cells in the opposite direction to that of the discharge. Usually designed to have a lifetime of between 100 and 1000 recharge cycles, depending on the composite materials. Secondary batteries are generally more cost effective over time than primary batteries since they can be recharged and reused. A single discharge cycle of a primary battery, however, will provide more current for a longer period of time than a single discharge cycle of an equivalent secondary battery.

Self-Discharge
Capacity loss during storage due to the internal leakage between the positive and negative cell plates. The self-discharge rate will vary with battery type.

Shelf-Life
The amount of time a battery can be stored without a significant loss in energy capacity. Aging is subject to storage temperature and state-of-charge. While primary batteries have a shelf life of up to 10 years, lithium-based batteries are good for 2 to 3 years whether used or not. Cool storage at a 40% charge level prolongs longevity. Nickel- based batteries are good for 5 years or longer but require priming to regain performance after long storage.

TYPES OF BATTERIES

PRIMARY (Non-Rechargeable)

Alkaline Battery
Zinc-Manganese Dioxide Alkaline batteries can have a useful life of five to six times that of the older zinc-carbon batteries. Alkaline batteries have a high rated capacity, but they can only deliver their full capacity if the power is used slowly. Shelf life is up to 7 years. Self discharge rate is around 5% per year.

Lithium Battery
Lithium is a promising, fast-growing reactant in battery technology. Lithium is the lightest known metal which results in a battery weighing 33% less than alkaline. It has a shelf life of over 10 years and is the best non-rechargeable power source for heavy drain and frequent use. Primary Lithium batteries can last three times longer than alkaline batteries of the same size. Self-discharge rate is approximately 0.5% per year at room temperature. Lithium batteries must be handled with care. Lithium is highly volatile when mixed with air or water as it forms hydrogen which is explosive.

SECONDARY (Rechargeable)

Nickel Cadmium Battery. (NiCd-Pronounced NiCad)
The most widely used household rechargeable battery. They are rugged and reliable, exhibit a high-power capability, offer a wide operating temperature range and a long cycle life. May be cycled between 600 to 1000 times if maintained well. Self-discharge rate is approximately 1% per day. Life is extended if the battery is periodically discharged and charged. They suffer from "memory effect" and contain material unfriendly to the environment.

Nickel Metal Hydride (NiMH)
NiMH batteries are much lighter and offer up to 40% more energy capacity than a traditional NiCd battery of equal size. This battery is less prone to the "memory effect" of NiCds and they are environmentally friendly. Shallow rather than deep discharges are preferable and the battery's longevity is directly related to the depth of discharge. The service life is limited to 200 to 300 cycles, under heavy load, and their shelf life is only three years. Self-discharge rate is 50% higher than NiCds or 2% per day.

Lithium-Ion (Li-ion)
Lithium Ion battery is the fastest growing technology in the industry. It offers high energy density and low weight (35% less than NiMH). The high energy density is attributed to the higher voltage per cell, 3.0 to 3.5 volts, as opposed to other types of batteries which produce a maximum of 1.2 to 1.25 volts per cell. The lithium in this battery is not in metal form but in the form of lithium ions (atoms) which make them safer than the primary version. Shallow discharge cycles are no problem. Electronic protection circuits are included in the lithium-ion battery packs to limit voltage and current. Typical discharge cycles are between 300 to 500 and the shelf life is two to three years whether used or not. The self-discharge rate is approximately 5% to 10% per month. This battery is environmentally safe.

Battery Charging
Always use the charger recommended by the battery manufacturer. Batteries of different chemistries require different chargers. If too much current is applied the battery may overheat (greatly diminishing battery life), leak or explode. If not enough current is applied the battery may never become fully charged since the self-discharge rate may nullify the charging effort.

NiCd
Under normal conditions NiCd batteries prefer a constant current charge. Overcharging may cause overheating and the "memory effect" to take place. This type of battery will absorb heat (cool down) during the first 25% of the charging cycle and then generate heat until charged. Of all of the secondary batteries the NiCd will take the most abuse during use and in the charging process. The life may be prolonged by fully discharging and charging the battery once per month.

NiMH
The NiMH battery generates considerably more heat during charging and requires a more complex algorithm for full-charge detection. Most NiMH batteries are equipped with internal temperature sensing to assist in full-charge detection. They cannot accept as fast a charge as a NiCd and the charge time is double that of a NiCd.

Li-ion
Charge them often. It is very important, for safety reasons, to use the charger approved by the battery manufacturer. The Li-ion charger is typically a constant current/constant voltage charger. Fully discharging (below 2.4 volts) will cause the electrodes to corrode through a process that cannot be reversed by recharging. If this occurs, battery capacity will be lost and the cells may be completely destroyed. A discharged battery can be charged in approximately three hours. Overcharging (trickle charge) will damage this battery and may present a safety hazard.

BATTERY CARE

Store in cool dry environment. Heat and moisture decrease shelf life. Alkaline battery life may be increased by storage in the refrigerator. Low temperatures slow down the chemical process of self-discharge. Some battery manufacturers disagree.

1. Store at a charge level of 40% to 50%.

2. Do not allow any metallic device to touch the positive and negative terminals simultaneously (short circuit). This will cause overheating and damage to the battery.

3. Don't carry batteries in a pocket. Keys etc., may cause a short circuit and overheat causing damage to the battery and to the body.

4. Do not attempt to recharge primary batteries.

5. Do not dispose of batteries in a fire; explosion may occur.

6. Do not disassemble a battery. Bodily contact with battery components may cause skin irritation, burns and possible nerve damage. Acidic or alkaline electrolyte will cause skin irritations or burns; electrode materials such as cadmium are toxic; lithium, when exposed to air or water may explode.

END OF LIFE

Primary Batteries - When discharged the battery is no longer useful a must be discarded according to the manufacturers directions.

Secondary Batteries - All secondary batteries will eventually fail due to age, expended components, or physical damage. A battery, when properly maintained, will fail through gradual loss of capacity. To the user, this gradual failure will appear as a frequent need to charge the battery. Dispose of according to the manufacturer directions.