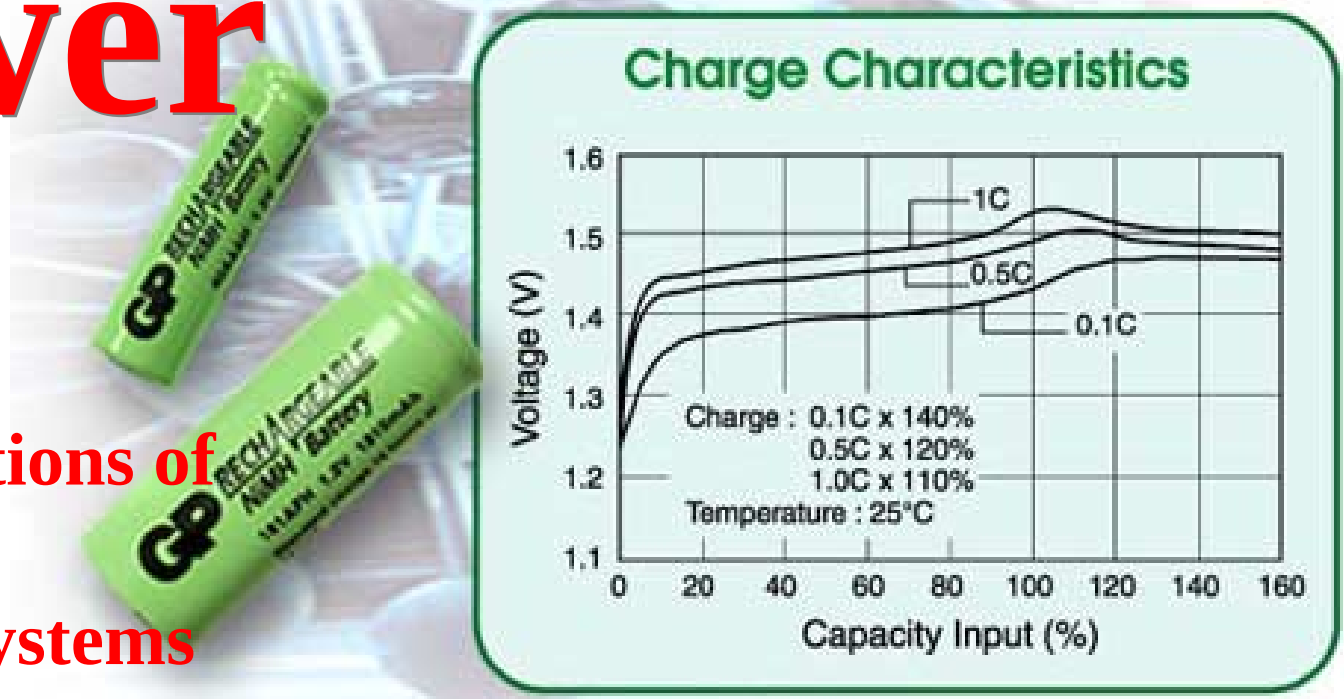
Power



Teleoperations of Aerospace Payload Systems

Week 04

Rechargability

Batteries operate on the principle of converting chemical energy into electrical energy on demand. There are a wide range of battery types, with different chemical make-ups. These can be classified into two main types:

Primary Cells:

Batteries that *cannot* be recharged are *primary* cells.

Secondary Cells:

Batteries that can be recharged are *secondary* cells.

Characteristics

Energy Density: The maximum amount of energy per unit mass that a particular battery is able to store. Usually, this is measured in units of Watt-hours per kilogram. Alternately, it may be represented in units of energy per unit volume.

Capacity: The total amount of energy stored in a cell. This is usually represented in the practical units of Amp-hours or milliamp-hours.

Voltage: The voltage produced by a single cell is characteristic of the chemical composition. The voltage can also be affected by the state of charge of the cell (i.e., is it new or partially drained).

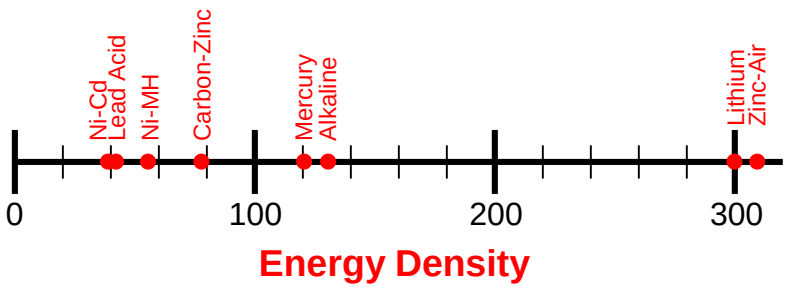
Internal Resistance: When being used, the maximum amount of current a battery may deliver is related to its internal resistance (**Discharge Rate**). This parameter increases as the battery discharges.

Shelf Life: Batteries lose charge even when there is no external load.

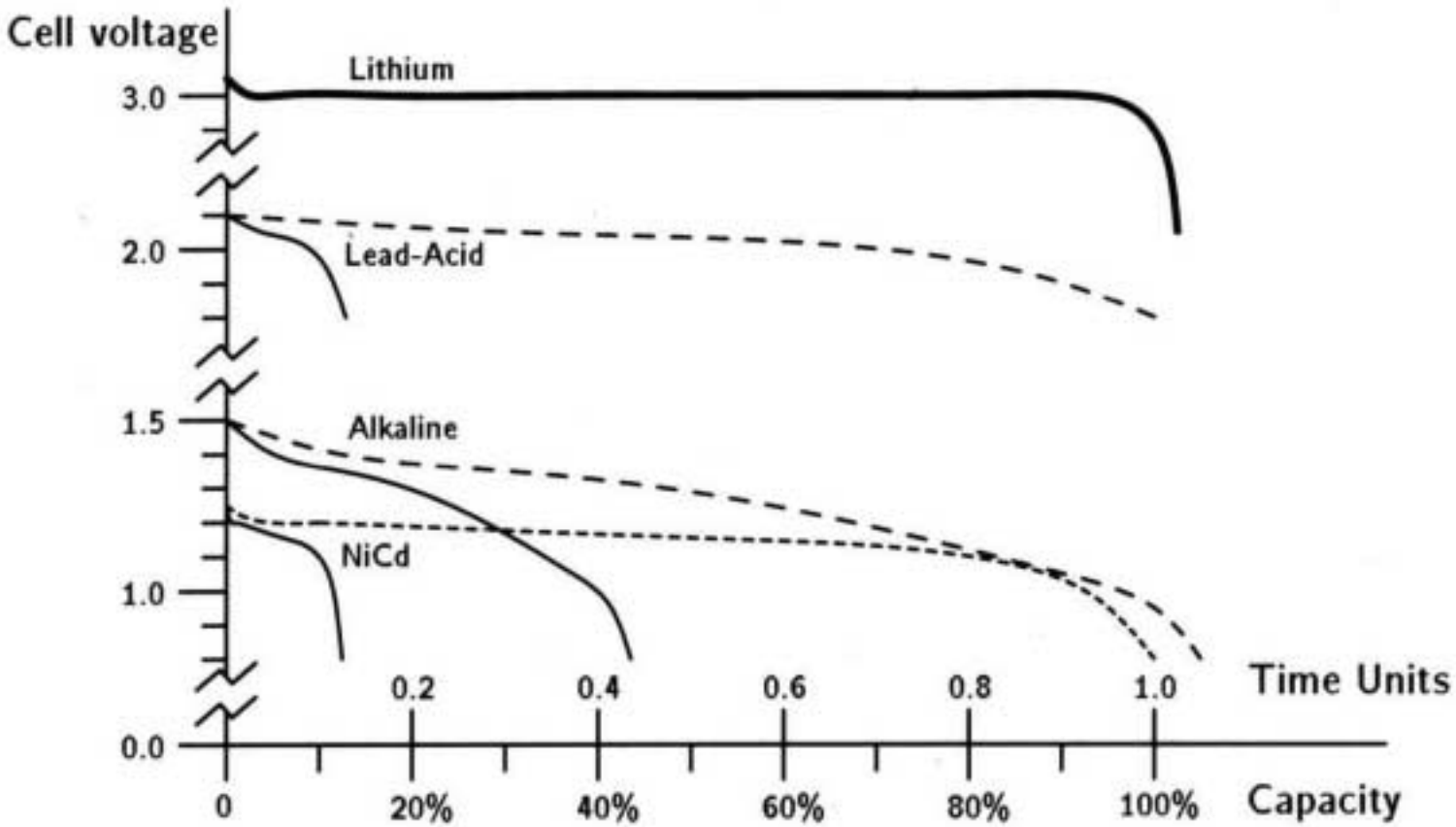
Temperature Dependence: Most battery properties, especially shelf life and available capacity are affected by temperature.

Battery Characteristics

Battery Chemistry	Rechargable	Energy Density (Whr/kg)	Cell Voltage	Typical Capacity (mAh)	Internal Resistance (ohms)	Comments
Alkaline	No	130	1.5	AA 1400 C 4500 D 10000	0.1	Most common primary battery
Lead-Acid	Yes	40	2	1200-12000	0.006	Avail in wide range of sizes
Lithium	No	300	3	A 1800 C 5000 D 14000	0.3	Excellent energy densit High unit cost
Mercury	No	120	1.35	coin 190	10	
NiCd	Yes	38	1.2	AA 500 C 1800 D 4000	0.009	Low internal resistance Widely available
NiMH	Yes	57	1.3	AA 1100 4/3A 2300		Better energy den. than NiCd More expensive than NiCd
Silver	No	130	1.6	coin 180	10	
Zinc-Air	No	310	1.4			High en. den. Uncommon
Carbon-Zinc	No	75	1.5	6000		Inexpensive but obsolete



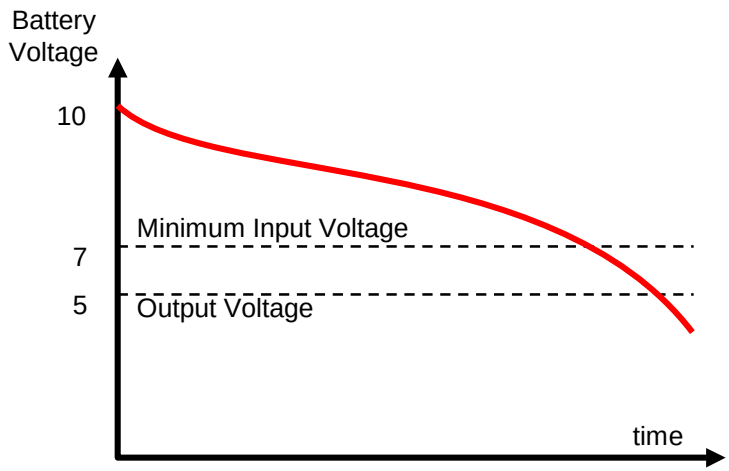
Discharge Characteristics

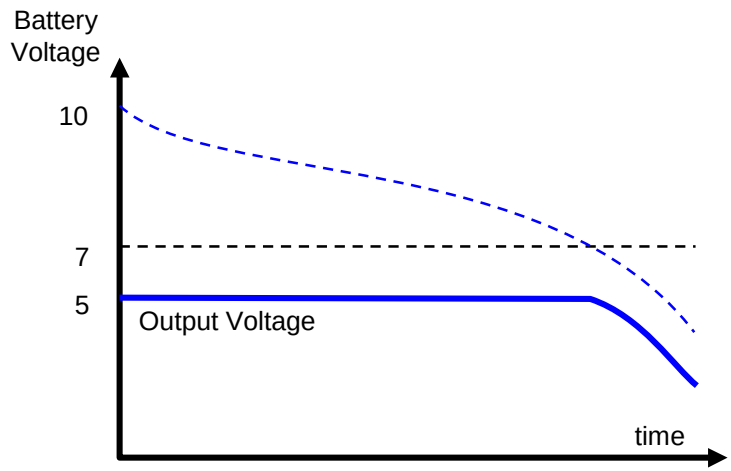


The discharge characteristics of common battery types. The dashed lines shows output voltage vs. battery capacity consumed. The solid lines show voltage vs. time (au).

Voltage Regulation

Voltage regulation is used to “condition” the power supply so that electronics can have a nice and steady voltage level (which they often require).





The problem with voltage regulators is that they usually waste energy, which is bad when you are trying to conserve batteries. The efficiencies of regulators varies a lot with the type, but usually is between 50% and 90%.

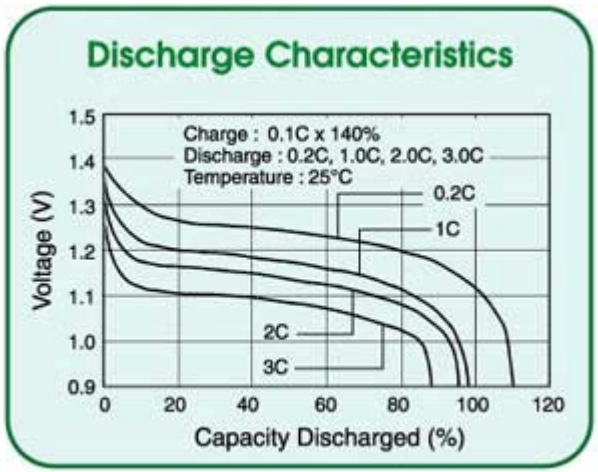
Ideally, you just choose components that can tolerate wide range of voltages, but this isn’t always possible.

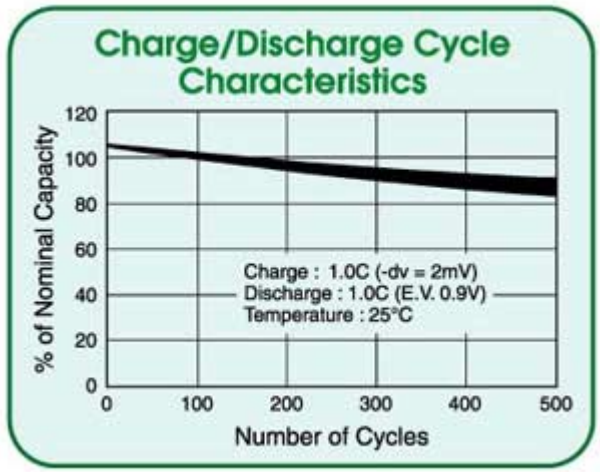
Performance Data

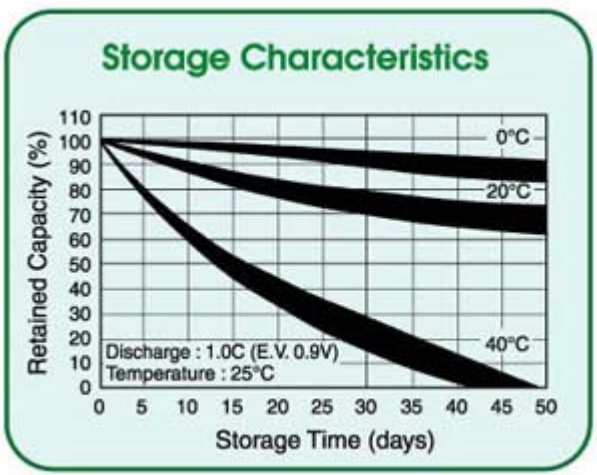
General NiMH Battery Data

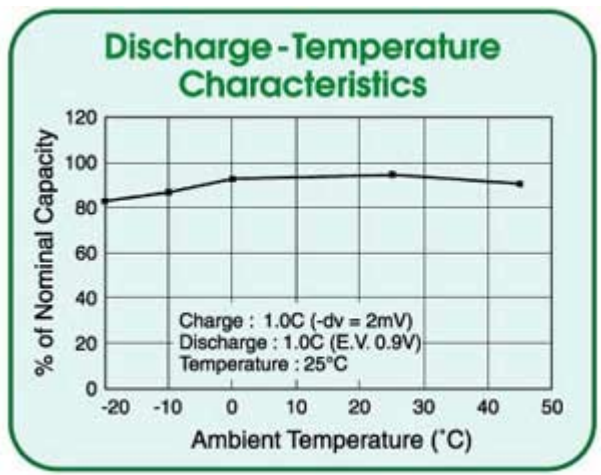
Data from Gold Peak website describing their NiMH line of products.

Note: The 3300 mAH products correspond to the “1C” line

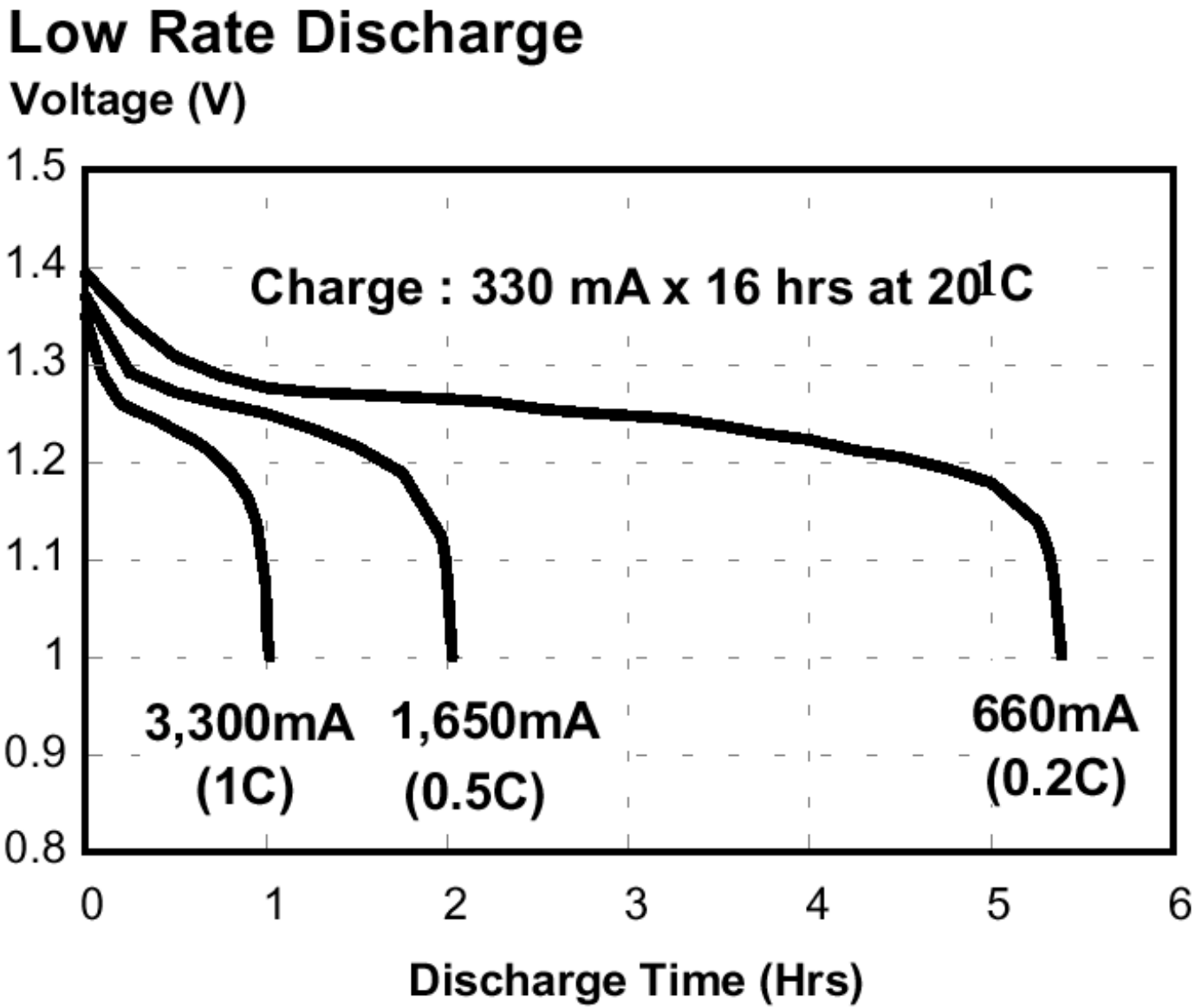




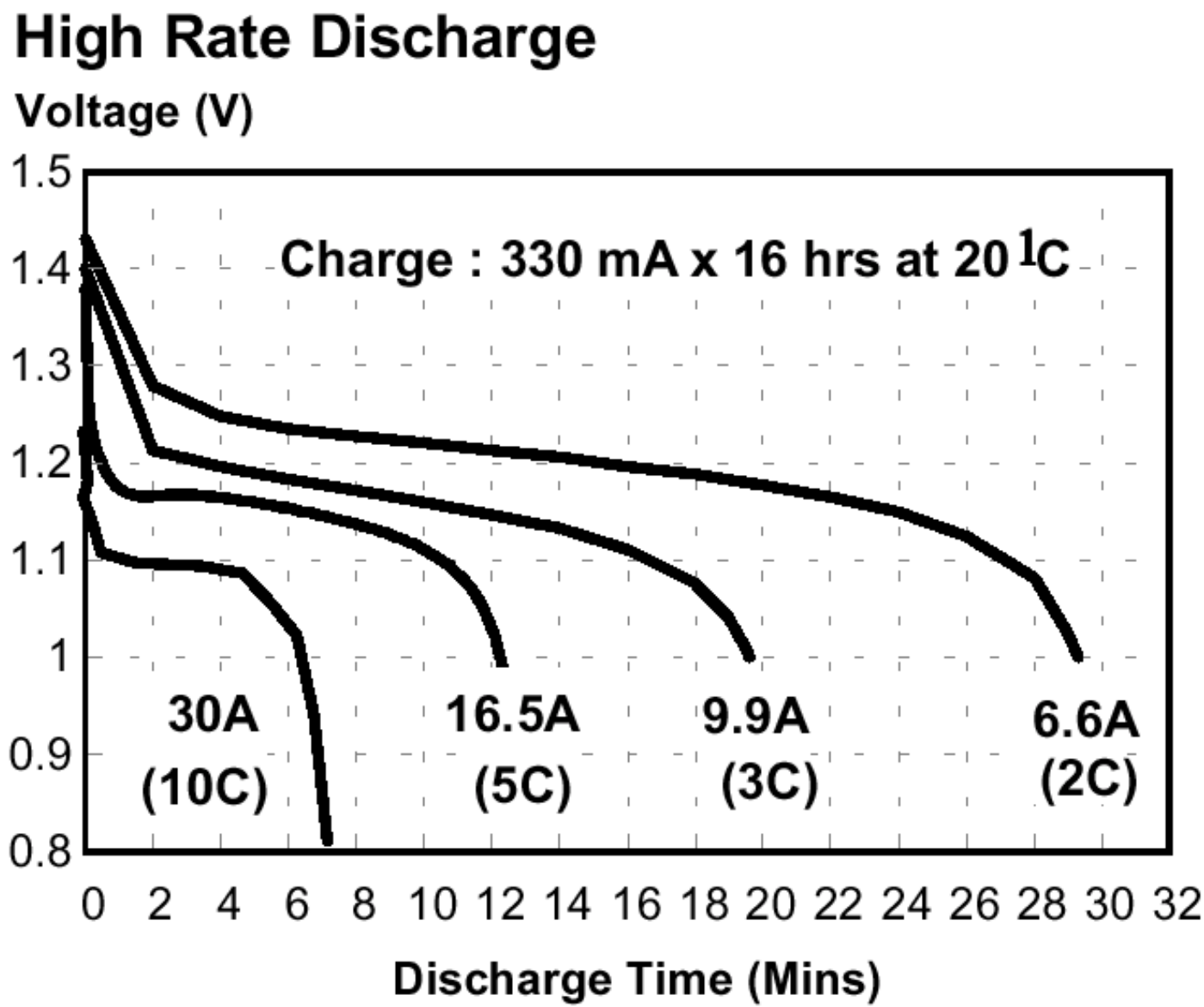




NiMH GP330SCH Sub-C Cells

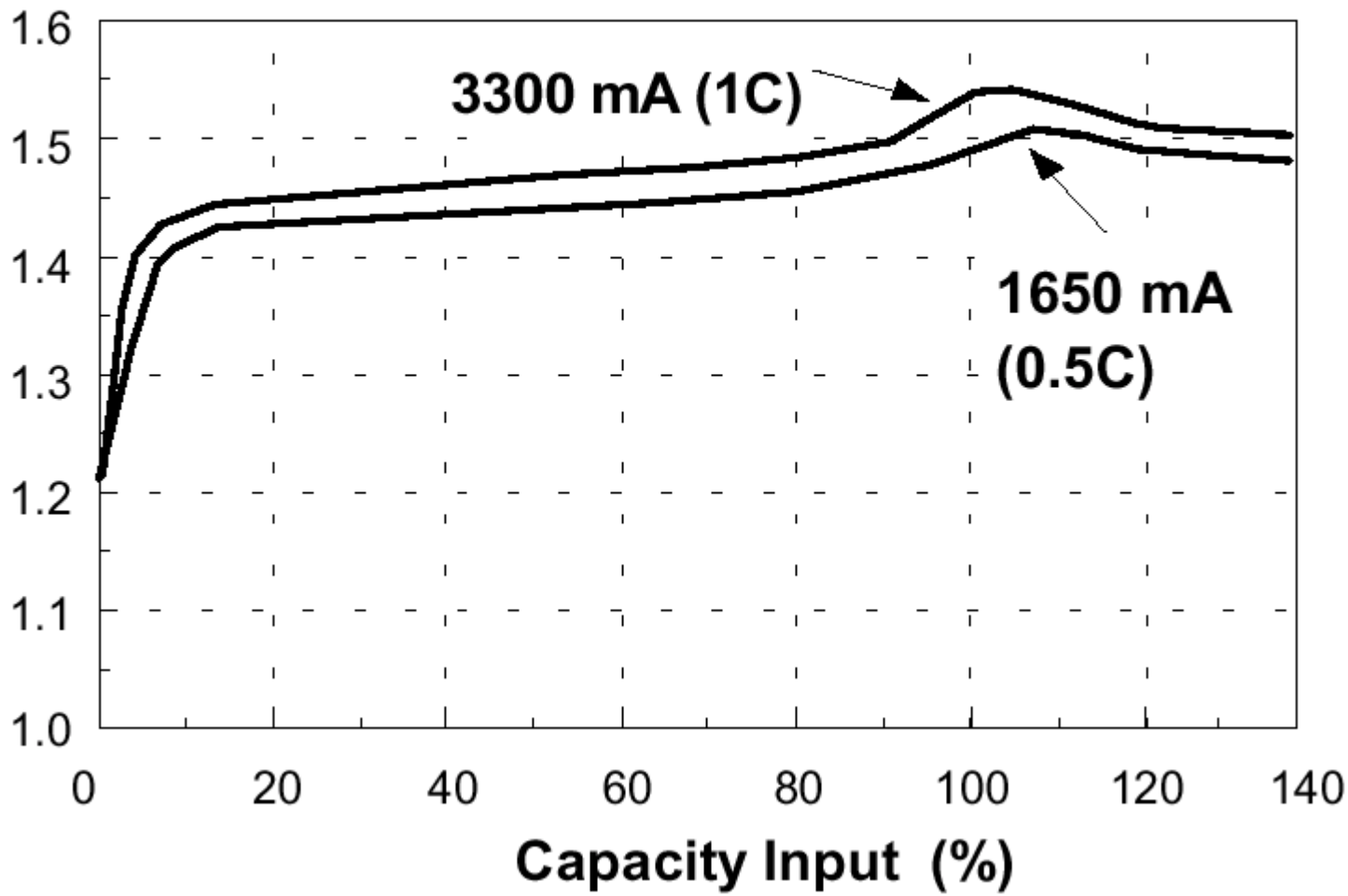


NiMH GP330SCH Sub-C Cells



NiMH GP330SCH Sub-C Cells

Fast Charge (Charge Control required)



Resources

Other Resources:

- *Mobile Robots* by Joseph Jones, Anita Flynn, and Bruce Seiger, 1999, Natick, MA, Chapter 7 (ISBN 1-56881-097-0