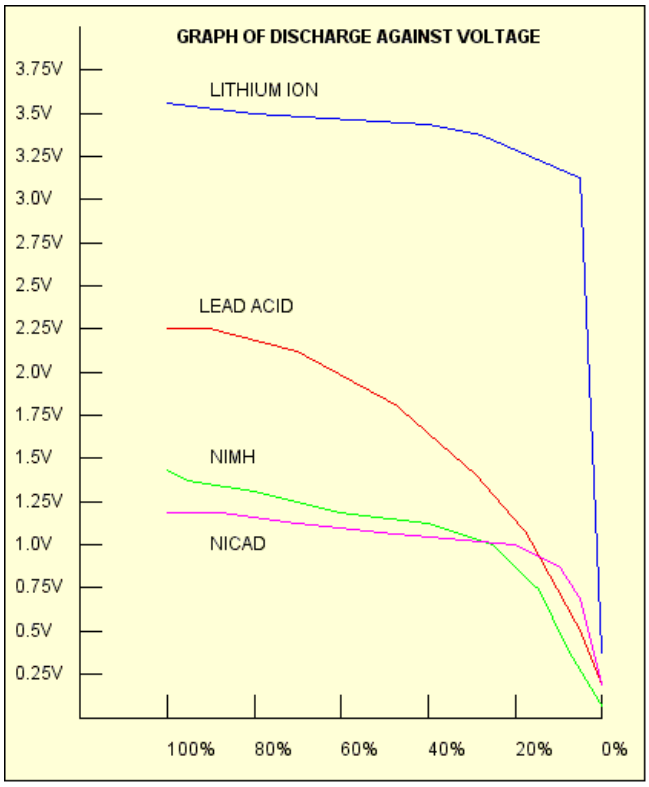
Batteries.

There are four main types of battery available for Gauge 3 locomotives. They are Lithium Ion, Sealed Lead Acid, Nickel Metal Hydride, and Nickel Cadmium. The available voltage from them at various points during their discharge cycle is shown by the graph below. This shows the voltage across a 20 Watt rated 10 Mega Ohm Resistor as the battery discharges over the course of several hours. This should be taken as the best possible case.



NOTE:

Lithium Ion batteries should not be fully discharged as this **WILL** damage the cells -possibly to point of ruin.

Sealed Lead Acid (SLA) batteries can deliver up to **45%** of their storage capacity in a one hour load. Always charge SLA in a vertical position as the gas vent is at the top. The plates are at the bottom. For proper Centre of Gravity matter s place the plates towards the middle of the loco.

Larger NiMH and NiCd cells such as “**C**” and “**D**” sizes can sustain a higher drain rate than “**AA**” or “**AAA**” cells due to the larger plate sizes. The charging current for NiCd should never be more than 10% of the rating i.e. If the battery has 1Ah then the charging current should not exceed 0.1A. NiMH cells get quite hot whilst charging -ensure some form of cooling fan while charging in a loco for example.

Sizes of battery

NiMH and NiCd cells are easily available in the following sizes:

AAA	44.5mm x 10.5mm Ø
AA	50.5mm x 14.5mm Ø
C	50.0mm x 26.2mm Ø
D	61.5mm x 34.2mm Ø

It is recommended that if the loco requires a specific battery pack making up then TAGGED cells are purchased. These are easier to assemble and the heat from the soldering iron will not damage the cells. Fitting tags to untagged cells can be dangerous and requires specific equipment to spot weld them to the cells.

The following is the technical specifications for a std rechargeable Lithium Ion battery that may be grouped together into battery packs.

Nominal Voltage:	3.7V
Capacity:	2600 mAh
Chemistry:	Rechargeable Lithium Ion
Max Charging current:	2.6A
Max Discharging current:	4.3A
Tabs:	Spot Welded on Both Ends
Length:	65 mm
Diameter:	18 mm
Weight:	46.5 grammes

Note:

Lithium Ion Batteries may **explode** if you do not charge or discharge them properly. Users must have knowledge on how to charge and discharge Lithium Ion batteries before making Lithium Ion battery packs. Use only the recommended charger for your Lithium batteries.

DO NOT charge Lithium Ion batteries in chargers designed for Lithium Polymer batteries. The result will be a ruined set of batteries and a “blown” charger.

Assembly.

There are several sources of battery tubes made of soft polystyrene that may be glued together to produce a lattice or honeycomb that the tagged cells are fitted to. Care should be taken that the linking cable is of high enough current rating to not burn out during discharge.

(See EU_cable.doc)

Common Sealed Lead Acid battery sizes and capacities are listed below

Voltage	Amp Hours	Dimensions (mm)			Weight (Kg)
		L	W	H	
6V	1.3	97	25	51	0.3
6V	4.5	70	48	101	0.9
6V	10.0	151	51	94	1.8
6V	12.0	151	51	94	1.9
12V	1.3	97	43	52	0.6
12V	2.2	178	34	60	1.0
12V	3.3	134	67	60	1.3
12V	4.2	90	70	100	1.6
12V	7.2	151	65	95	2.5
12V	12.0	151	99	96	4.0

Battery Power Pack considerations.

This may seem an odd statement(!) But, if you are running a battery powered locomotive or a steam locomotive with power servos, then you should be aware of the conditions that your battery pack is going to operate in. It may seem an obvious statement that a battery pack is going to get hot near a steam boiler -but the same is true of an electric motor. Large motors often incorporate cooling fans at the rear of the armature -thus the motor is self cooling. Conversely the motor now acts as a small “fan heater” -added to this there is a the heating effect of the current flowing through the wires them selves. This is the square of the current flowing times the resistance of the wire. Good copper wire has a low resistance thus the heating effect is quite low -but in the cramped confines of a locomotive running over the course of say an hour...

So, mount (or design) your battery pack to be in a nice cool part of the locomotive -or to have a good breeze across it.