

Central Ohio Radio Club

TechNet Outline - Batteries

February 11, 2017

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1. SAFETY MUST BE NUMBER ONE WITH ELECTRICAL EQUIPMENT

- a. Understand the basics of the chemistry you're working with
- b. Follow all safety precautions given by battery and related equipment makers
- c. Use the right charger for the battery type and chemistry you have
- d. Use insulated tools to minimize arcs and sparks
- e. Wear safety glasses

2. Battery Books - Amazon

- a. *Handbook of Batteries* - McGraw-Hill Handbooks \$65
 - i. https://www.amazon.com/Handbook-Batteries-David-Linden/dp/0071359788/ref=sr_1_2?ie=UTF8&qid=1518380228&sr=8-2&keywords=handbook+of+batteries
- b. *Batteries in a Portable World: A Handbook on Rechargeable Batteries for Non-Engineers*
 - i. https://www.amazon.com/Batteries-Portable-World-Rechargeable-Non-Engineers/dp/0968211844/ref=sr_1_1?s=books&ie=UTF8&qid=1518380463&sr=1-1&keywords=batteries+in+a+portable+world

3. Websites

- a. Battery University
 - i. <http://batteryuniversity.com/>
- b. Summary table on lithium batteries
 - i. http://batteryuniversity.com/learn/article/bu_216_summary_table_of_lithium_based_batteries

4. To make any battery cell you must have the following basic components

- a. **Positive** electrode
- b. **Negative** electrode
- c. **Electrolyte**

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5. Battery chemistries in use in ham radio
 - a. Lead-acid – 2.0 volts for a single cell
 - b. Nickel Cadmium – 1.2 volts for a single cell
 - c. Nickel Metal Hydride – 1.2 volts for a single cell
 - d. Lithium Ion - cell voltage varies based on specific chemistry
 - i. Lithium cobalt oxide – 3.60V nominal; typical operating range 3.0–4.2V/cell
 - ii. Lithium manganese oxide – 3.70V (3.80V) nominal; typical operating range 3.0–4.2V/cell
 - iii. Lithium – iron phosphate – 3.20, 3.30V nominal; typical operating range 2.5–3.65V/cell

6. Comparison of Energy Density 1 (highest) to 4 (lowest)
 - a. Lithium Ion – 1
 - b. Nickel Metal hydride – 2
 - c. Nickel cadmium – 3
 - d. Lead-acid – 4

7. Basic Care and Charging
 - a. Heat is the biggest enemy of a battery regardless of chemistry
 - b. Store them in a cool location when possible
 - c. Never store in direct sunlight – very high self-discharge
 - d. Store batteries fully charged unless it is a lithium polymer type (LiPo)
 - i. LiPo should be charged to 3.86 vpc or discharge down to 3.85 to prevent electrode oxidation
 - e. Use chargers designed specifically for the type of battery to be charged
 - f. Lithium Ion battery charge and discharge characteristics are very specific; charging equipment, final discharge voltage and methods
 - i. **CANNOT** be float charged like other chemistries
 - ii. **Use the charger supplied with the battery**
 - iii. Do not substitute chargers
 1. Mark batteries and wall-wart chargers so they don't get mixed up

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8. Capacities of batteries – applies to Nickel and Lithium chemistries, but **not** lead-acid
 - a. Base unit of capacity is the amp-hour
 - b. Amps x hours
 - i. 2 amps for 4 hours = 8 AH
 - c. Typical ratings for radio battery packs are in milliamp-hours
 - i. Ex – 3000 mah = 3000 milliamps x 1 hour OR
 - ii. 1500 milliamps for 2 hours = 3000 milliamp-hours OR
 - iii. 750 milliamps for 4 hours – 3000 milliamps-hours
 - d. To determine run time for a given load,
 - i. Hours = battery rating (in MAH) / load current
 - ii. 3500 / 250 ma = 14 hours
 - iii. 14 hours @ 250 ma = 3500 mah

9. What about **lead-acid** batteries and capacity?
 - a. Must have the performance data sheet for the specific make and model of battery you have
 - i. See the table below that shows run time vs. load current to 1.90 volts per cell (red box)
 - ii. Note that the load current is **not** linear to the time
 - iii. You must use the table to determine run time
 1. This table is based on 77F and a final discharge voltage of 11.4V (1.90 volts per cell)

TEL12-70 RATINGS

End Point Volts/Cell	Constant Current Discharge Ratings - Amperes @ 77°F (25°C)													
	Operating Time to End Point Voltage (in hours)													
	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	10.00	12.00	20.00	24.00	72.00	100.00
1.75	46.80	27.50	19.83	15.55	12.86	11.00	9.64	8.64	7.10	6.01	3.75	3.15	1.08	0.78
1.80	44.50	26.80	19.20	14.95	12.30	10.58	9.29	8.38	6.92	5.86	3.66	3.08	1.06	0.77
1.85	41.80	25.50	18.30	14.25	11.90	10.20	9.00	8.05	6.60	5.59	3.53	2.98	1.03	0.75
1.90	39.50	24.20	17.30	13.63	11.30	9.70	8.57	7.73	6.40	5.42	3.43	2.88	0.98	0.71

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10. Buying lithium batteries and chargers
 - a. Research manufacturers
 - b. Ratings can be *very* misleading
 - c. Be suspicious of high capacity ratings and very low pricing
 - d. Beware of crazy-high capacity ratings, very low prices, no product descriptions, no manufacturer name and no review history – STAY AWAY!
 - i. Example 1 – click [HERE](#) for such an example on Amazon
 - ii. Example 2 – the well known 18650 cell (18mm diameter, 65mm length) is rated to a maximum capacity of about 3600 mah
 1. Beware of vendors touting more than this

11. Listing of Lithium battery cell physical sizes and capacities on Wikipedia
 - a. [https://en.wikipedia.org/wiki/List_of_battery_sizes#Lithium-ion_batteries_\(rechargeable\)](https://en.wikipedia.org/wiki/List_of_battery_sizes#Lithium-ion_batteries_(rechargeable))