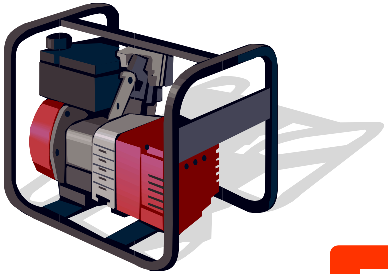
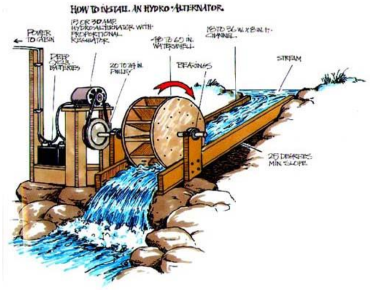


Emergency Power

Are you prepared ?

Rev 2.0



January 2016

Jack Tiley AD7FO

What Do You Need?

- **What equipment do you plan to operate?**
- **How long will you need to operate it?**
- **What is my equipment power requirement?**
- **How will you get your equipment to the operating site?**
- **What location will you be operating it from?**
- **Is it a fixed or moving Location?**
- **Location access (How far will yoo need to transport the radio and power source)?**
- **What is the availability of alternate power?**

How Much Emergency Power is Needed?

- **What is your anticipated standby current requirement (non Transmitting)?**
- **What is your anticipated operating current when transmitting at the planed transmit power output level?**
- **What is your anticipated transmit duty cycle?**

Calculating Power Requirements

- **Determine Receive Current in amperes:**
  - For a 2meter /70 cm mobile Radio in the receive mode the typical current will be 0.5 amperes (500 MA)
- **Determine Transmitter current in amperes for the power setting you will use you will be using:**
  - For a 2 meter /70 cm mobile Radio the typical transmit current will be 10 amperes at 50 watts , 5 amperes at 25 watts and 3 amperes for 20 watts.
- **Determine transmit duty cycle (Typical):**
  - 35% for net control
  - 10% for net participant

Calculating Power Requirements

At a 50 watt transmit power for a net control station the power requirement in ampere hours will be:

Required AH= (Transmit current x .35) + (receive current x . 65)

Required AH= (10 amperes x .35) + (0.5 x . 65) or 3.83 Ampere Hours

This means an 80 ampere hour deep cycle battery could run the station for approximately 21 hours.

A 17 ampere hour Gel Cell battery could run your station for approximately 4-1/2 hours.

Reducing the power used to transmit will lengthen your operation time.

Calculating Power Requirements

A 5 watt hand held will draw 0.150 amperes in receive mode and 1.5 Amperes in 5 watt transmit mode.

As a net participant the transmit duty cycle will be 10%.

Required AH= (Transmit current x 0.10) + (receive current x . 0.90)
Required AH= (1.5 amperes x .10) + (0.150 x . 90) or 0.29 Ampere Hours

With a 1400 Milliampere Hour battery pack you can operate for approximately

4.8 Hours.

Calculating Power Requirements

- **An HF Transceiver will draw approximately 1.6 amperes in receive mode and in the 100 watt transmit mode it will draw approximately 22 Amperes.**
- **A typical 100 watt SSB HF Rig requires about 22 *peak* amperes when transmitting at 100% modulation.**
- **When transmitting Digital modulation you will typically only be transmitting 40-50 watts.**

Calculating Power Requirements

- **At 100 watt transmit power for an HF net control station the power requirement in ampere hours will be:**

Required AH= (Transmit current x .35) + (receive current x .65)

Required AH= (22 amperes x .35) + (1.6 x .65) or 8.8 Ampere Hours

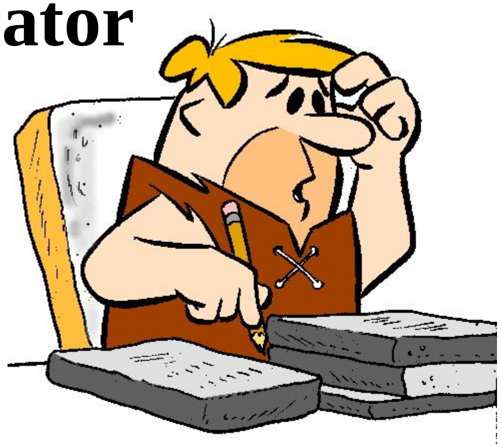
Since SSB is not 100% duty cycle the average power required will be less and dependent on you voice peaks.

This means an 80 ampere hour automotive or deep cycle battery would run a 100 watt station for a minimum of 9 hours. Reducing the power used to transmit will lengthen your operation time

Emergency Power

Choosing your emergency power source

- **Emergency Power requires understanding the requirement and pre-planning before the need:**
  - **What type of power source?**
  - **Storage/maintenance needed to insure readiness when needed.**
  - **If emergency power is a Generator how much fuel if needed?**
  - **How close is the emergency power to the operating position?**



Stored Emergency Power

Choosing your emergency power source

- **Understand the operating environment:**
  - **Can batteries be charged during event?**
  - **Will generator or commercial power be available?**
  - **How much transmit power needed (affects operating time)?**
  - **What is the accessibility like for the operating location?**
    - **Drive in - Hike in – Other access**
  - **Anticipated duration of operation.**

Alkaline Battery Power

If you use alkaline batteries the capacity in mAh (miliampere hours) is approximately:

Size AAA – 1000 mAh*

Size AA - 2000 mAh*

Size C – 3000 mAh*

Size D - 5000 mAh*

*** Note: actual mAh ratings will vary depending on discharge rate and allowable minimum voltage at discharge.***

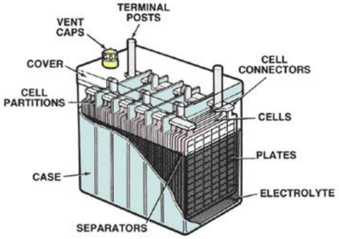
Alkaline Battery Power

(Cntinued)

- **Alkaline batteries stored at room temperature self discharge at a rate of less than two percent per year.**
- **At 85 degrees they only self discharge about 5% per year, but at 100 degrees they lose 25% per year.**
- **If you live in a very hot climate or are storing your batteries in a very hot location , it may be worthwhile for you to store your batteries in a refrigerator.**

- **Alkaline batteries are good because they have low internal resistance (needed for transmit current).**

Flooded Lead Acid Batteries



- **Designed as starter battery, momentary high energy (current) burst.**
- **Require maintenance (charging and fluid level).**
- **Will withstand high charge and discharge rates.**
- **Must be kept upright in vented area to avoid electrolyte leakage and accumulation of explosive hydrogen gas.**
- **Available in sizes from ~15 AH to ~100+ AH.**
- **Will self discharge over time at 5% per month.**
- **Charge condition measured by specific gravity of the electrolyte.**

Flooded Lead Acid Batteries

Deep Discharge/Marine Batteries

- **Must be kept upright in vented area to avoid electrolyte leakage and accumulation of explosive hydrogen gas.**
- **Can provide continuous power to a load.**
- **Deep cycle batteries allow for a deep discharge of up to 80% of the battery capacity.**
- **Better choice than an automotive battery.**
- **Charge condition measured by specific gravity of the electrolyte.**

Gelled Electrolyte Lead Acid Batteries

(SLA – Sealed Lead Acid and VRLA – Valve Release Lead Acid)

- **Thickening agent added to electrolyte.**
- **They can be mounted in any position.**
- **Sealed, no hydrogen gas release.**
- **Do not require maintenance or venting.**
- **Float charge voltage 13.5-13.8 VDC.**
- **Readily Available new and used.**
- **Available in 1AH to 80 AH or more capacity.**
- **Maintenance free.**

Absorbed Glass Mat (AGM) Batteries

- **The Electrolyte is absorbed by a very fine fiberglass mat making batteries spill proof.**
- **AGM batteries have very low internal resistance and are capable of delivering very high currents.**
- **They offer relatively long service life, even when deep-cycled.**
- **AGM batteries are maintenance free.**
- **Lighter than the flooded lead acid type.**
- **They stand up well to low temperatures.**
- **They have a low self-discharge rate.**

Absorbed Glass Mat (AGM) Batteries (continued)

- Can be charged faster than flooded cell batteries.
- Should be stored in charged state.
- an AGM can do anything a Gel-cell can, only better.
- Since they are also sealed, charging has to be controlled carefully or they can be damaged.

Nickel Cadmium Batteries

- **One of the most rugged and forgiving batteries.**
- **High self discharge rate (10% per month).**
- **High energy storage capacity vs size and weight.**
- **The sealed *nickel-cadmium* cell can be stored in the charged or discharged state without damage. They can be restored for service by recharging with several charge/discharge cycles.**
- **Charge at 1/10 the battery rating (200 ma for 2 AH battery).**

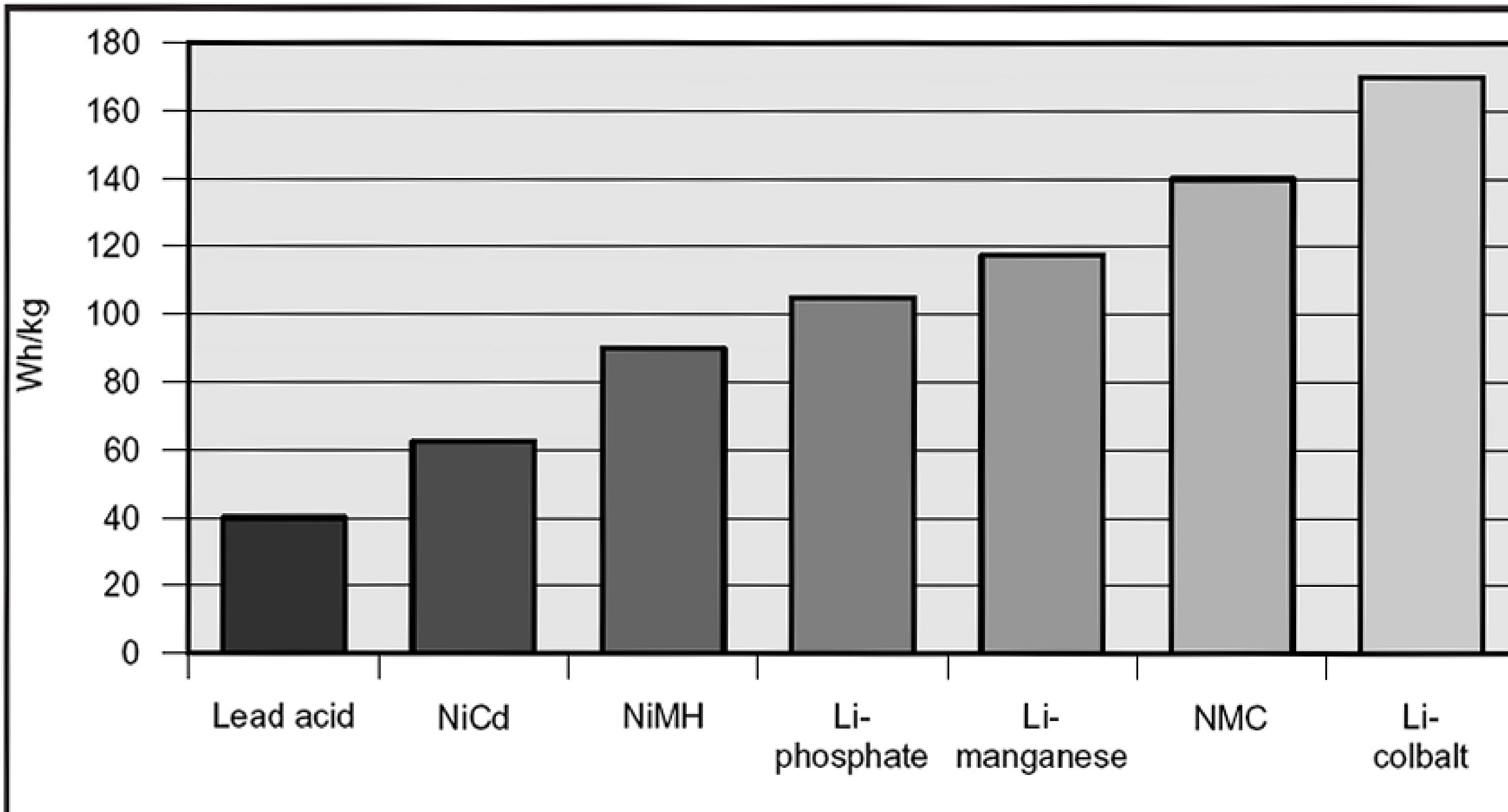
Lithium ION Batteries

- **High energy storage capacity vs. size and weight**
- **More expensive.**
- **Good charge/discharge efficiency: 80–90%.**
- **One regular charge for new batteries.**
- **Relatively low self-discharge - self-discharge is less than half that of nickel-based batteries.**
- **Low Maintenance - no periodic discharge is needed; there is no memory.**
- **Requires protection circuit to maintain voltage and current within safe limits.**

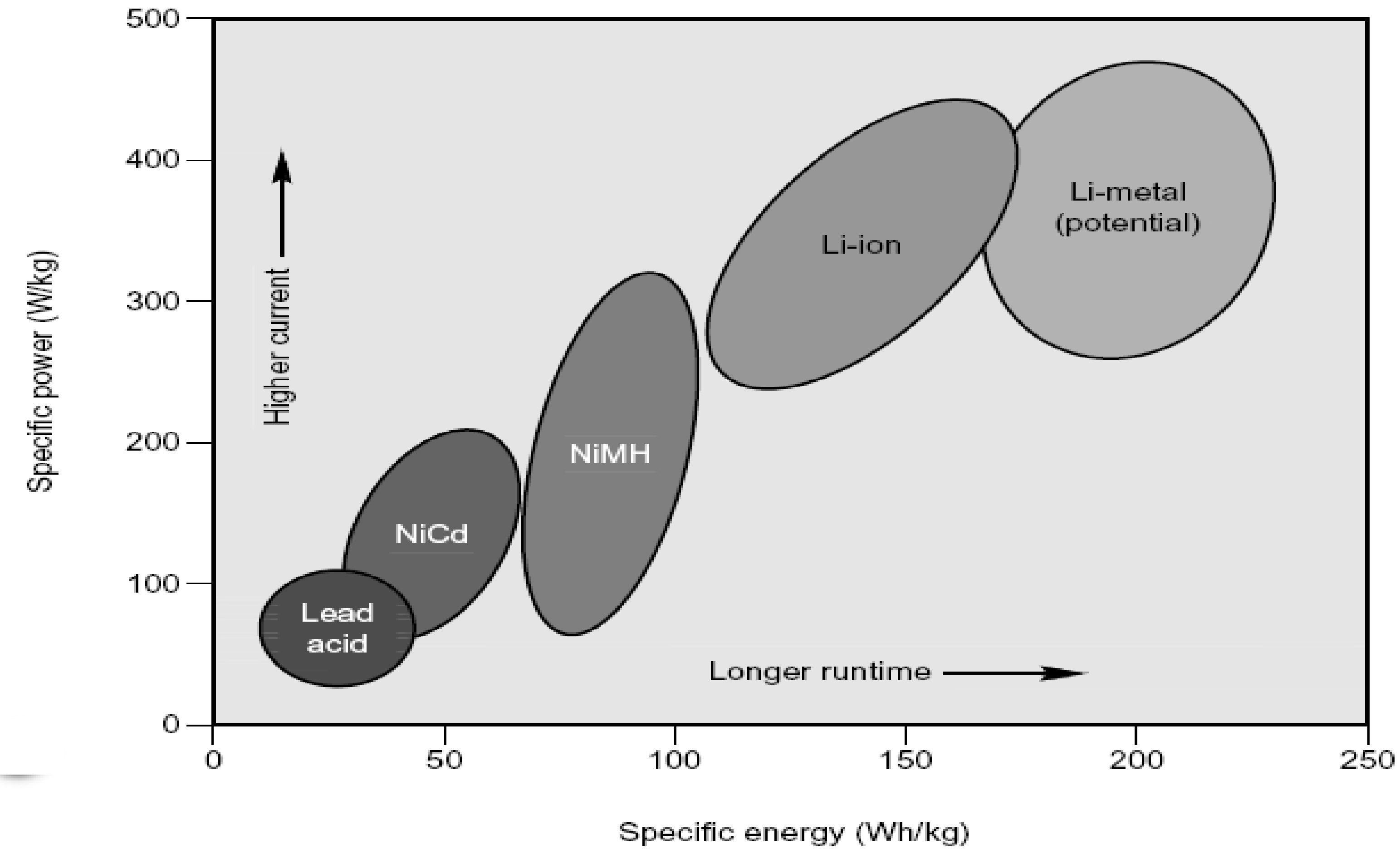
Nickel Metal Hydride Batteries

- **A NiMH battery is smaller/heavier than a Li-Ion battery.**
- **NiMH batteries suffer from memory effect. It's necessary to fully discharge and charge a new battery.**
- **They can be completely discharged and recharged.**
- **Have a slower recharge Time. NiMH batteries can be safely charged at an average of 10 hours.**
- **They are Safer with less toxic metals.**
- **High self discharge rate. They lose 5% the 1st week after a full charge.**

Typical Energy Densities of lead, Nickel and Lithium-Based Batteries



Rechargeable Batteries



Commonly Used Rechargeable Batteries

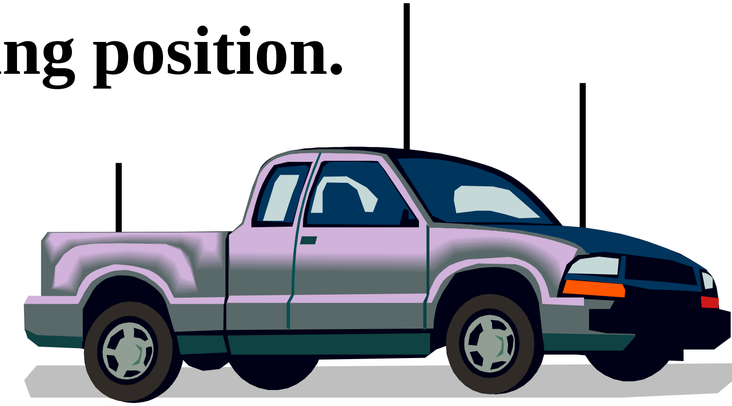
Characteristics of Commonly Used Rechargeable Batteries

Specification	*Lead Acid*	*NiCd*	*NiMH*	*Li-ion Cobalt*	*Li-ion Manganese*	*Li-ion Phosphate*
Specific energy (Wh/kg)	30-50	45-80	60-120	150-190	100-135	90-120
Internal resistance[1] (mΩ)	<100 12 V pack	100-200 6 V pack	200-300 6 V pack	150-300 7.2 V	25-75[2] per cell	25-50[2] per cell
Cycle life[4] (80% DoD)	200-300	1000[3]	300-500[3]	500-1000	500-1000	1000-2000
Fast-charge time	8-16 h	1 h typical	2-4 h	2-4 h	1 h or less	1 h or less
Overcharge tolerance	High	Moderate	Low	Low. Cannot tolerate trickle charge	Low. Cannot tolerate trickle charge.	Low. Cannot tolerate trickle charge.
Self-discharge/month (room temp)	5%	20%[5]	30%[5]	<10%[6]	<10%[6]	<10%[6]
Cell voltage (nominal)	2 V	1.2 V[7]	1.2 V[7]	3.6 V[8]	3.8 V[8]	3.3 V
Peak load current (best result)	5C[9] (0.2 C)	20 C (1 C)	5 C (0.5 C)	>3 C (<1 C)	>30 C (<10 C)	>30 C (<10 C)
Operating temp.[10] (discharge only)	–20 to 60° C	–40 to 60° C	–20 to 60° C	–20 to 60° C	–20 to 60° C	–20 to 60° C
Maintenance requirement	3-6 months[11]	30-60 days	60-90 days	Not required	Not required	Not required
Safety requirements	Thermally stable	Thermally stable, fuse protection common	Thermally stable, fuse protection common	Protection circuit mandatory	Protection circuit mandatory	Protection circuit mandatory
In use since	Late 1800s	1950	1990	1991	1996	2006
Toxicity	Very high	Very high	Low	Low	Low	Low

Continuous Emergency Power

Vehicle Power

- An automotive battery provides high current.
- Running the engine charges the battery.
- You can charge other batteries.
- Does requires vehicle access to operation site.
- Great antenna platform.
- Provides a protected operating position.



Continuous Emergency Power

Motor Driven generator

- **Must be operated outdoors (Down wind) away from Radio operation area because of carbon monoxide emission.**
- **Requires Fuel sufficient for the duration of the emergency.**
- **Noisy (acoustical and electrical noise)**
- **Heavy and hard to transport.**

Continuous Emergency Power

Solar power

- **Good for keeping battery charge topped off or for long term charging.**
- **To produce enough power to operate a 50/100 watt radio it would take a very large Solar panel array.**
- **Generally solar power is used in conjunction with a bank of batteries.**
- **Available from Harbor Freight, RV supply stores and e-bay.**
- **Solar charge controllers available on e-bay.**

Continuous Emergency Power

Human Power Generation

- **The idea of human power is not new. This hand crank generators is from World war II era to power field radios.**
- **A stationary exercise bike could be used to turn an automotive alternator (there was an article about a Doctor who had his kids TV set powered this way to make sure they got enough exercise).**

CONTINOUS EMERGENCY POWER

Wind Power

- **Requires a wind source.**
- **Require batteries to store energy when there is no wind.**
- **Must be able to rotate to align into the wind.**
- **Must control Maximum rotation speed in high winds.**

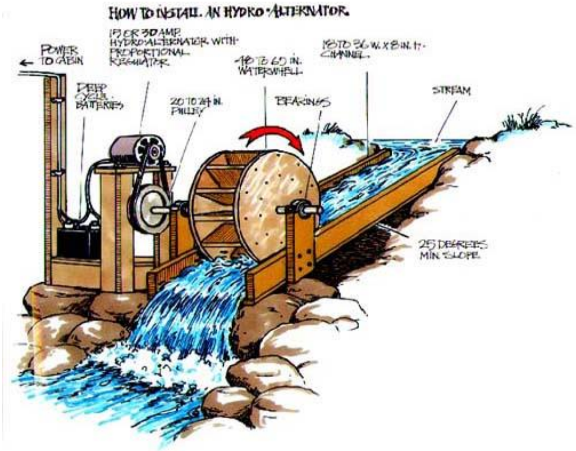
Shown is a commercially available wind generator

Sunforce model 44444, 12-Volt 400-Watt Wind Generator ~ $500

CONTINOUS EMERGENCY POWER

Water power

- Requires flowing water source.
- Line loss in wires from the generator to the shack.
- Maintenance required.
- Usually has battery or batteries to helps maintain a constant voltage.



Your Emergency Power Source

Disposable batteries:

- Need to be fresh (rotate stock).
- Need to be properly Stored (not too hot).
- For HT's a back up plan with disposable batteries.

Rechargeable Batteries

- Require re-charging to be available for use.
- Require float or smart charging.
- Require periodic charging even if not used.
- Should have spare battery pack.
- Should be tested for capacity annually.

Your Emergency Power Source

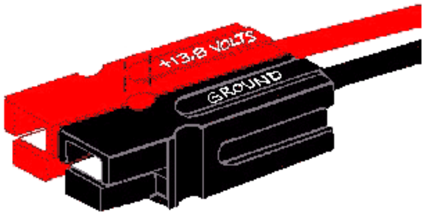
Generators

- **Need fuel.**
- **Need periodic maintenance.**
- **Need to be run frequently if not used regularly.**
- **Transportation issues.**

Use Standardized Connectors for Interoperability

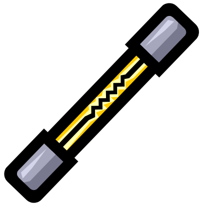
- Standardize on connectors (Anderson Power pole recommended).
- Use common polarity convention (red + black -).
- Have Anderson Connector adapters to and from common connectors.

  Open wire
  Cigarette lighter jack/plug
  Common Radio Connectors
  Binding posts
  Vehicle
  Other?



Emergency Power Considerations

Battery Safety



- **Series fuse *(A must for fire safety):***
  - **Higher rating than equipment fuses.**
  - **Located as close to battery terminals as practical.**
- **Use proper Fuse and wire size for load.**

Emergency Power Considerations

Battery Safety

- Protect battery terminals from accidental shorts:
  - The Batteries high current capability can be dangerous (delivering 100 + amperes).
- Do not exceed the battery charge ratings, Specifically:
  - Limit maximum charge & in rush current.
  - Limit maximum charge voltage.
  - Limit maximum float charge voltage.

Emergency Power Considerations

Battery Charging

- **You can use your DC power supply to float charge AGM and Gel-Cells**
  - **Current must be limited to prevent high in-rush current**
    (a 1 ohm 10 watt resistor will limit current to ~7 amps for a discharged battery)
  - **Series diode (6 amp) is used to prevent reverse current when PS is switched off with battery connected (set PS voltage to 13.8V plus an amount equal to the diode forward voltage drop (13.8 V+0.6 V) or 14.4 VDC).**

Emergency Power Considerations

Battery Charging (continued)

- **Home built chargers:**
  - **Many circuits available in the Amateur Radio Handbook, on the web and as kits.**
- **Commercial chargers – must be correct type for battery to be charged. Automotive battery chargers can not be used for Gel Cells or AGM batteries.**

Getting All The Power To The Radio

How far will the radio be from the DC Power source?

- You need to consider the voltage drop of the leads from source to the radio
- The voltage drop of 10 ft power leads can be determined by:

$V_{(drop)}$ = wire resistance per foot x Current x length x 2 (+ & - wires)

- For 20 ft of number 12 wire with a 20 amp load the loss would be:

V(d)=1.59/1000 ft x 20 ft x 20A

or *$V_{(drop)}$=.636 volts*

AWG gauge	Conductor Diameter Inches	Ohms per 1000 ft.
OOOO	0.46	0.049
OOO	0.4096	0.0618
OO	0.3648	0.0779
0	0.3249	0.0983
1	0.2893	0.1239
2	0.2576	0.1563
3	0.2294	0.197
4	0.2043	0.2485
5	0.1819	0.3133
6	0.162	0.3951
7	0.1443	0.4982
8	0.1285	0.6282
9	0.1144	0.7921
10	0.1019	0.9989
11	0.0907	1.26
12	0.0808	1.588
13	0.072	2.003
14	0.0641	2.525
15	0.0571	3.184
16	0.0508	4.016

Overcoming voltage loss

- **A Battery Booster is a switching power supply that accepts a wide range of input voltage and delivers a fixed 13.8 VDC.**
- **The Battery booster is mounted near the radio to insure it will have 13.8 VDC.**
- **Typical battery boosters will operate with inputs as low as 10 volts.**

Useful Web Sites

- Nickel Cadimum charger information
  http://www.angelfire.com/electronic/hayles/charge1.html
- Battery charging circuits and information
  http://www.discovercircuits.com/B/batt-chrg.htm
- Battery Charger Ideas
  http://www.techlib.com/electronics/battery_chargers.html
- Car Battery Charger
  http://www.aaroncake.net/circuits/charger1.htm
- Sealed Lead Acid Battery Charger
  http://www.geocities.com/vk3em/sla-charger/sla-charger.html
- Sealed Lead Acid Battery Charging Basics
  http://www.powerstream.com/SLA.htm
- Low cost solar charger for Lithium Ion AA and AAA Batteries
  http://store.l-f-l.com/cgi-bin/cp-app.cgi?pg=prod&ref=AA-SOLAR
- Frequently asked battery questions
  http://www.buchmann.ca/faq.asp
- Deep cycle battery FAQ's
  http://www.repairfaq.org/ELE/F_deep_cycle.html#DEEPCYCLE_006

As General George Patton said

"You Know What You Will Need to do"

To have emergency power when you need it

Questions?