BATTERIES

WHENEVER HANDLING A LITHIUM BATTERY

THERE IS ALWAYS A POTIENTIAL FOR A FIRE

- COLD TEMPERATURES INCREASE THE INTERNAL RESISTANCE AND DECREASE THEIR CAPACITY
- COLD BATTERIES PRODUCE LESS POWER BECAUSE OF SLOWER CHEMICAL REACTIONS
- COLD BATTERIES ARE UNABLE TO RETAIN THEIR REGULAR FULL CHARGE
- WARM/HOT BATTERIES SHOULD NOT BE CHARGED UNTIL COOLED
- HOT BATTERIES MAY PUFF

LITHIUM BATTERIES

- THE TERM LITHIUM ION BATTERY DOES NOT REALLY IDENTIFY THE CHEMISTRY
- THERE ARE MANY DIFFERENT TECHNOLOGIES:

LITHIUM – COBALT – OXYDE	LCO
LITHIUM – NICKLE - COBALT – ALUMINUM	NCA
LITHIUM – NICKLE – MANGANESE – COBALT	NMC
LITHIUM – IRON – PHOSPHATE	LiFePO4 or LFP
AND MANY MORE ….	

- THE TECHNOLOGY REFERRED TO AS LITHIUM ION IS USUALLY: LCO, NCA or NMC
- LCO, NCA, AND NMC ARE VERY DANGEROUS WHEN HANDLED
- LFP ARE RELATIVLY SAFE

LiON BATTERY STORAGE

- BATTERIES NEED TO BE STORED BETWEEN 40º AND 70º F
- DO NOT STORE BATTERIES AT 100% OR 0% OF CAPACITY
- IDEAL STORAGE CHARGE IS 50% OR ABOUT 3.8 v PER CELL
- TEMPERATURES TOO COLD OR TOO HOT CAN DAMAGE THEM
- THEY NEED TO BE KEPT OUT OF DIRECT SUNLIGHT OR FROM HOT SURFACES OR CONTAINERS
- DON’T STORE THEM IN A TOOLBOX OR YOUR POCKET
- STORE THEM IN A FIRESAFE BAG OR NON-FLAMABLE CONTAINER
- THE STORAGE CONTAINER SHOULD NOT HAVE SHARP EDGES

CHARGING AND DISCHARGING

- CHARGE ONLY ON A NON-FLAMABLE SURFACE
- MONITOR BATTERIES WHILE UNDER CHARGE
- MOST COMMON ERRORS WHILE CHARGING ARE:
  - CHARGING AT THE WRONG RATE
    - 3S BATTERY CHARGED AT A 4S RATE
  - CHARGING WITH THE WRONG CHEMISTRY SETTING
    - LIPO BATTERY CHARGED WITH NICAD RATE
  - SERIES CHARGING AN UNBALANCED MULTI CELL PACK
    - CHARGE OR MONITOR EACH CELL THROUGH THE BALANCE PORT
- SAFE CHARGING IS NORMALLY AT A 1C RATE BASED UPON CAPACITY

LiON BATTERY PUFFING

- PUFFING IS USUALLY DUE TO EXCESSIVE HEAT
- MOST COMMONLY CAUSED BY OVER CHARGING, OVER DISCHARGING, PHYSICAL DAMAGE, OR OLD AGE
- WHEN A BATTERY IS STRESSED BEYOND ITS NORMAL LIMITS THE ELECTROLITE SUFFERS DECOMPOSITION RELEASING GASSES
- PUFFED BATTERIES MAY SUFFER DECREASED CAPACITY
- PUFFED BATTERIES ARE NOT CONSIDERED SAFE AND SHOULD BE DISPOSED OF PROPERLY

OR

- PUFFED BATTERIES, IF NOT PHYSICALLY DAMAGED, CAN BE USED UNTIL THEY CAN NO LONGER HOLD A CHARGE

WHY DO THEY PUFF?

- BATTERIES CONSIST OF 3 MATERIALS:

  ANODE (+), CATHODE (-) AND THE ELECTROLITE
- WHEN CHARGING OR DISCHARGING, ELECTRONS MOVE BETWEEN THE ANODE AND THE CATHODE THROUGH THE ELECTROLITE
- THE LOWER THE INTERNAL RESISTANCE THE LESS HEAT IS DEVELOPED
- THE HIGHER THE CHARGE OR DISCHARGE RATE THE MORE HEAT IS DEVELOPED
- EXCESSIVE HEAT OXIDIZES THE ELECTROLITE CAUSING THE GASSING (THE GAS CONSISTS OF CO2, AND CO)
- GASSING CAN ALSO BE CAUSED BY NATURAL DETERIORATION DUE TO OLD AGE (THE GAS CONSISTS OF OXYGEN)

PUFFED CELLS CAN NOT BE REPAIRED

SAFE DISPOSAL

- DISPOSE OF BATTERIES WHEN THEY CAN NO LONGER HOLD A CHARGE OR THEY DROP BELOW 80% OF THEIR CAPACITY
- BEFORE DISPOSING OF A BATTERY IT SHOULD BE DISCHARGED
- IF THE BATTERY IS DAMAGED, OR PUFFED, DON’T DISCHARGE (SKIP STRAIGHT TO THE SALT WATER)
- AFTER DISCHARGING SUBMERGE THE BATTERY INTO SALT WATER
- THE SALT WATER SHOULD CONSIST OF ONE CUP OF SALT TO ONE GALLON OF WATER
- LEAVE THE BATTERY IN THE WATER FOR ABOUT TWO WEEKS
- TAKE THE DISCHARGED BATTERY TO A RECYCLE CENTER (LOWES OR HOME DEPOT) DON’T THROW THEM INTO THE TRASH

LiON BATTERY FIRES

THE FIRE TRIANGLE: HEAT, FUEL, OXIDIZER or COOL, STARVATION, SMOTHERING

A TYPICAL LITHIUM ION BATTERY CONTAINS ABOUT 7% LITHIUM BY WEIGHT

- **LiON** AND **LiPO** BATTERIES ARE PHYSICALLY DIFFERENT. LiON CELLS ARE INCLOSED IN A METAL CASE, WHILE LiPOs ARE INCLOSED IN A POLYMER POUCH
- LiON BATTERIES, **IF NOT PUNCHURED**, CAN BE EXTINGUISHED WITH A STANDARD CLASS ABC FIRE EXTINGUISHER OR WITH WATER
- LITHIUM FIRES ARE METAL FIRES AND CAN ONLY BE EXTINGUISHED WITH CLASS D FIRE EXTINGUISHERS OR WITH AN INERT GAS SUCH AS ARGON
- USING A CLASS ABC FIRE EXTINGUISHER, OR WATER, ON A LITHIUM FIRE ONLY INCREASES THE FLAME MAKING IT BURN OUT FASTER
- IF YOU HAVE A LITHIUM FIRE AND ONLY AN ABC FIRE EXTINGUISHER USE IT TO CONTROL PERIPHIAL DAMAGE. LET THE FIRE BURN ITSELF OUT
- LARGE AMOUNTS OF SAND, BAKING SODA, OR DRY CONCRETE CAN HELP TO REDUCE OR CONTAIN THE FIRE
- DROPPING A BURING LITHIUM BATTERY INTO A BUCKET OF WATER WON’T PUT OUT THE FIRE BUT WILL REDUCE THE RISK OF THE FIRE SPREADING

LiFePO4 BATTERIES

- LITHIUM IRON PHOSPHATE BATTERIES ARE COMMONLY CALLED: LiFe, LITHIUM IRON,OR LFP
- LFP BATTERIES ARE SAFE IF OVER CHARGED, UNDERCHARGED, OR PUNCHURED - THEY DON'T BURN
- THEY WILL SELF DISCHARGE OVER TIME, BUT THEY CAN BE REVIVED
- THEY ARE BEST USED WITHIN A NARROW TEMPERATURE RANGE OF 32^{O} TO 113^{O} F AND CAN BE DESTROYED IF CHARGED AT OR BELOW 32^{O} F
- LFP BATTERIES HAVE A MUCH LONGER LIFETIME ALLOWING MORE THAN 4000 CHARGE CYCLES
- THEY HAVE LIMITED ENERGY DENSITY, HIGHER COST, LOWER DISCHARGE RATE (3C MAX), AND LIMITED TEMPERATURE RANGE. HOWEVER FASTER CHARGING RATE (10% TO 80% IN 10 MINUTES)
- OPERATING VOLTAGE: 3.6v CHARGED - 3.2v NOMINAL - 2.5v DISCHARGED

FINAL THOUGHTS

- REPLACING A LIPO BATTERY IS CHEAP AS COMPARED TO HAVING A FIRE
- ONLY CHARGE THEM IN A SAFE AREA
- MONITOR BATTERIES UNDER CHARGE
- ANY SIZE LITHIUM BATTERY CAN BURN IF MISHANDLED
- IF IN DOUBT, THROW THEM OUT (RECYCLE)