WHOI OBS Battery Systems

Alan Gardner, Woods Hole Oceanographic Institution

Diversity of batteries in WHOI OBS

- Many factors lead to a proliferation of battery models

Diversity of batteries in WHOI OBS

- Function of battery:

Main

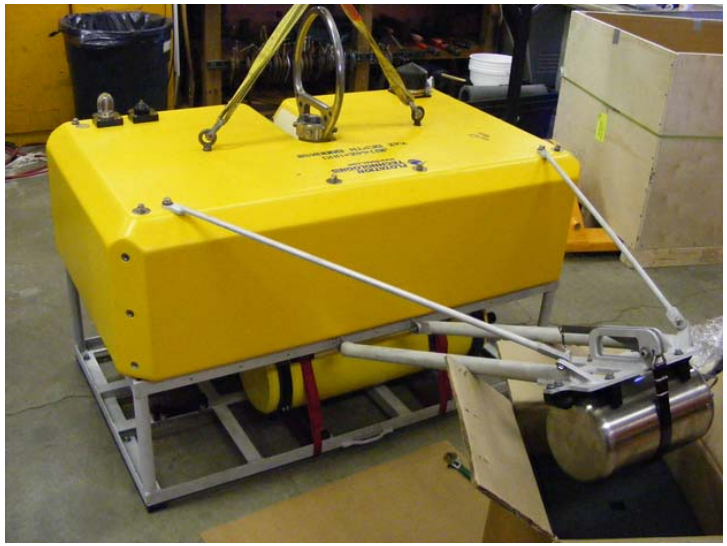
Acoustic release

Clock keep-alive

Recovery aids

Diversity of batteries in WHOI OBS

- Form factor of instrument:



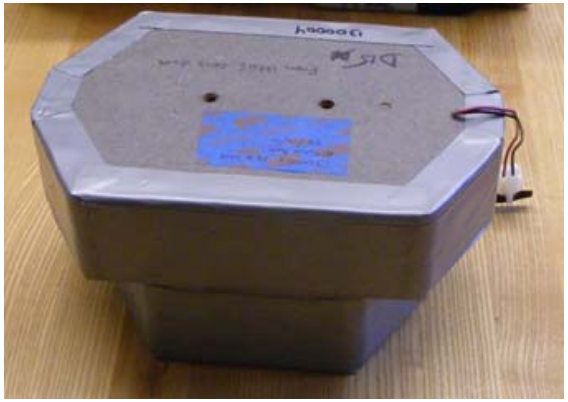
7” ID pressure tube

17” glass spheres

12” glass spheres

Diversity of batteries in WHOI OBS

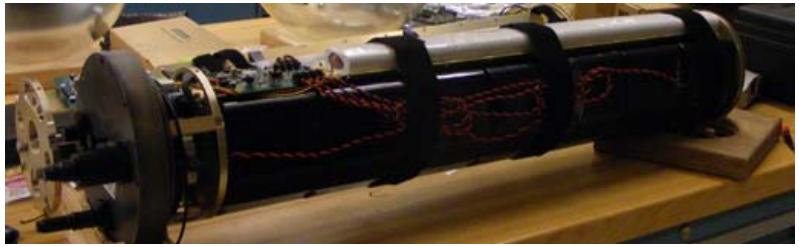
- Experiment duration and sensor load



72 days with geophone

7.5 months with geophone

1 year with Guralp 3T and Episensor (14 individual batteries)



1 year with Trillium Compact (7 individual batteries)

Diversity of batteries in WHOI OBS

- Battery chemistry

Lithium Primary (LiSO2Cl2)

Lithium Primary (LiSOCl2)

Alkaline

Comparison of lithium chemistries

Tadiran

- Lithium Thionyl Chloride (LiSOCl2)
- Uses “Hybrid Layer Capacitors” for pulse handling and passivation
- Light weight
- Less expensive

Electrochem

- Lithium Sulfuryl Chloride (LiSO2Cl2)
- High intrinsic current capability
- Prone to passivation
- Heavy
- More expensive

Comparison of lithium chemistries

Tadiran

- More energy per cell
- Higher specific energy density
- Very long lead times
- UN Testing charges
- Difficult design process

Electrochem

- Less energy per cell
- Lower specific energy density
- ~1 month lead times
- Typically no UN Testing charges
- Easy to work with

Smackdown by the numbers

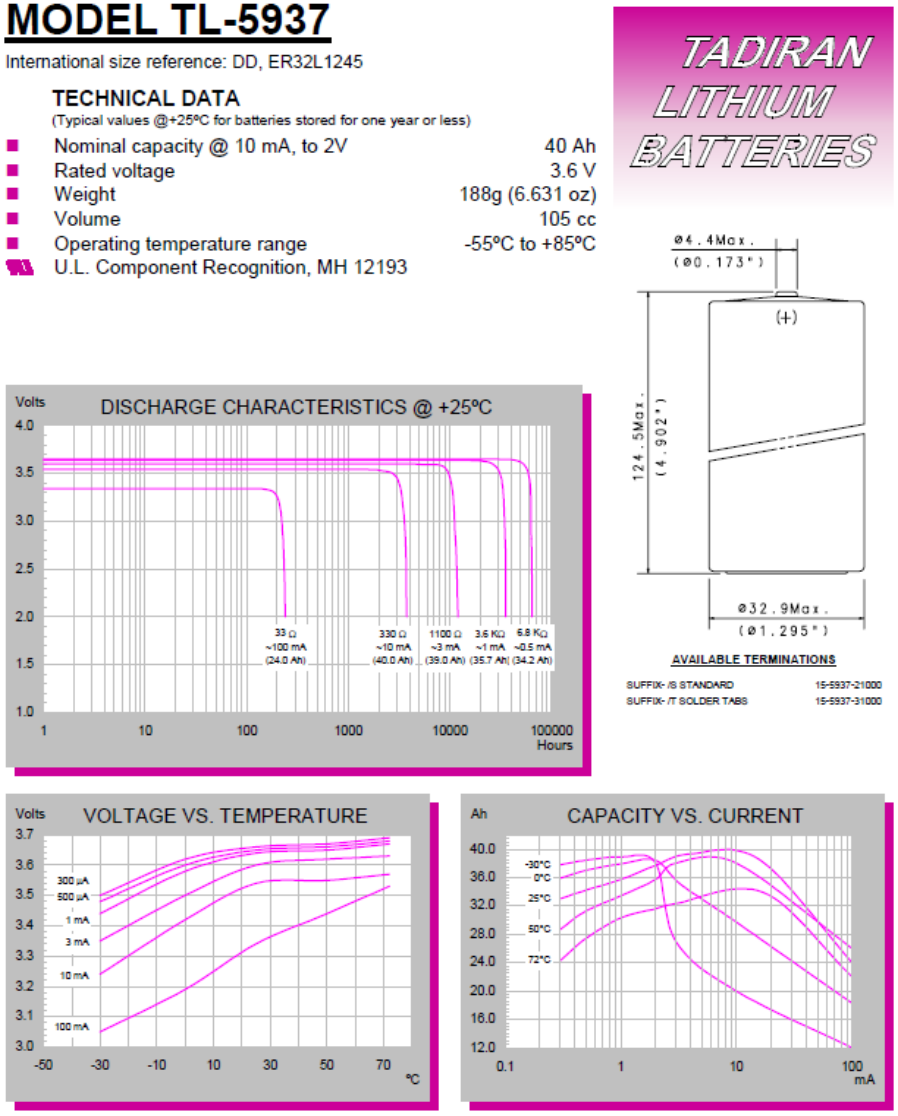
	Tadiran	Electrochem	
Energy	100	87.5	W-Hr
Length	124.5	111.4	mm
Diameter	32.9	33.5	mm
Weight	195	213	g
Volume	108	98	cc
Cost	42	65	USD
Energy Density	0.926	0.893	W-Hr/cc
Specific E.D.	0.513	0.411	W-Hr/g
Energy to Cost	2.38	1.35	W-Hr/USD

Energy based on conservative reading of datasheets, extensive conversation with manufacturers, and decades of on bottom time

Tadiran weight and volume include 1/3 HLC

Be careful with capacities

- Wow! 40Ah * 3.6V = 144 Wh!
- Well, not really
- Check actual discharge currents and temperature
- Be conservative!



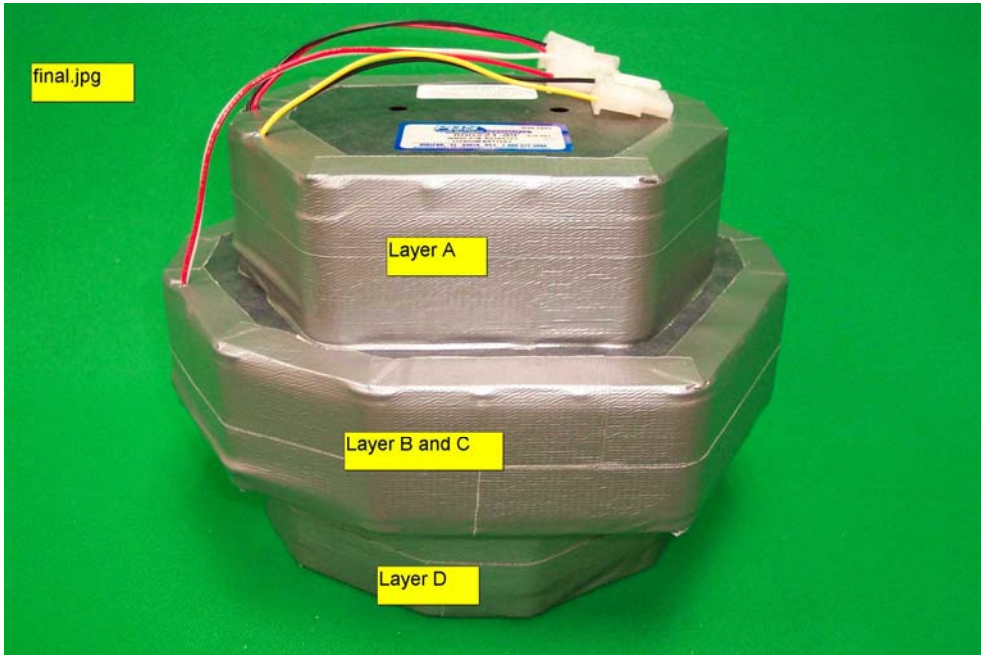
What about rechargeables?

	Tadiran	Genasun	(Gli-12-100)
Energy	100	1400	W-Hr
Length	124.5	319	mm
Diameter	32.9	266	mm
Width	N/A	175	mm
Weight	195	14000	g
Volume	108	14850	cc
Cost	42	2150	USD
Energy Density	0.926	0.094	W-Hr/cc
Specific E.D.	0.513	0.100	W-Hr/g
Energy to Cost	2.38	0.65	W-Hr/USD

Data from Genasun web page

Safety concerns with Lithium primaries

- WHOI has 11 page Lithium battery safety procedure
- All employees take biennial Battery Pack Safety course



Lithium batteries need to be treated with extreme care at all stages from design through disposal

Safety concerns with Lithium primaries

- Lithium battery safety is a big deal
- A battery pack in one of these instruments exploded on deck!

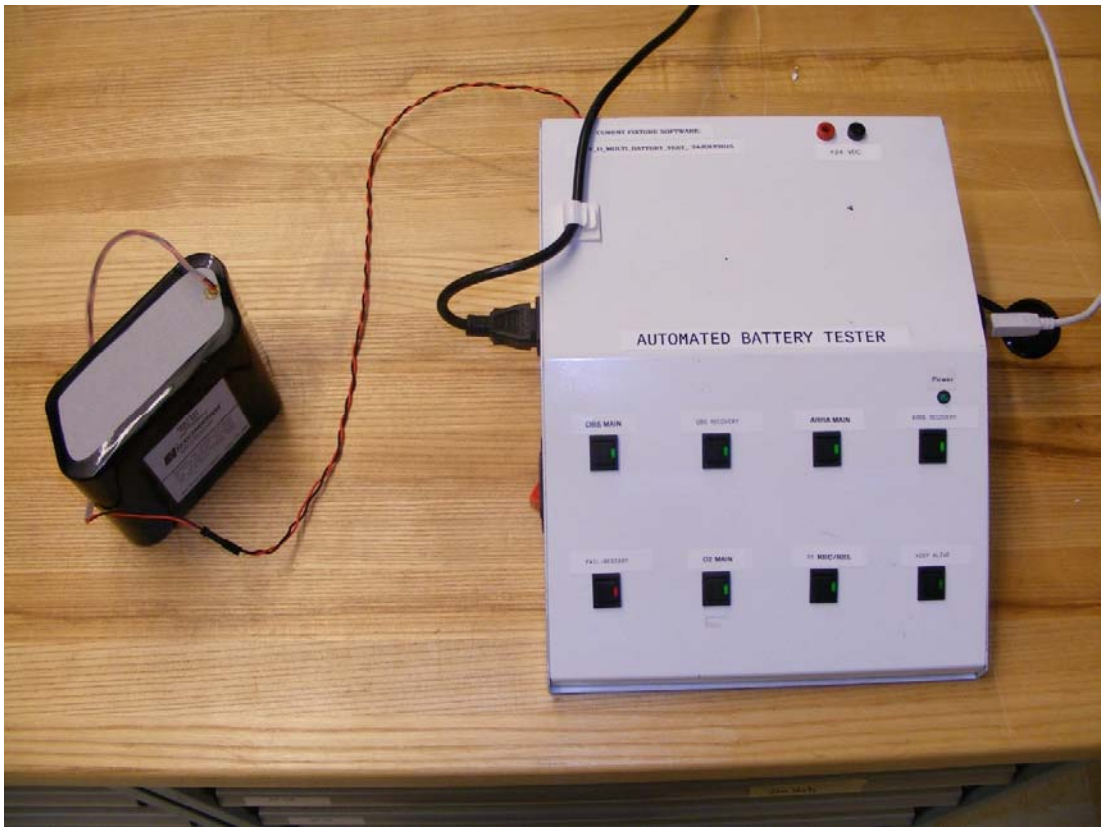
- Manufacturing fault
- Current procedures should prevent recurrence
- Fortunately no one was injured

Safety concerns with Lithium primaries

- Protection diodes
- Fuses: in cell, in pack, on board
- Ensure excess pressure can vent
- Pressure sensors to watch for outgassing

Automated Battery Tester

- We test 100% of our Lithium batteries prior to installation
- Check voltage under load (functional)
- Check for diode (SAFETY!)
- No operator error



Safety concerns with Lithium primaries

Proper storage:

- Flammables cabinet in lab
- Battery storage van offsite
- Original packaging where possible

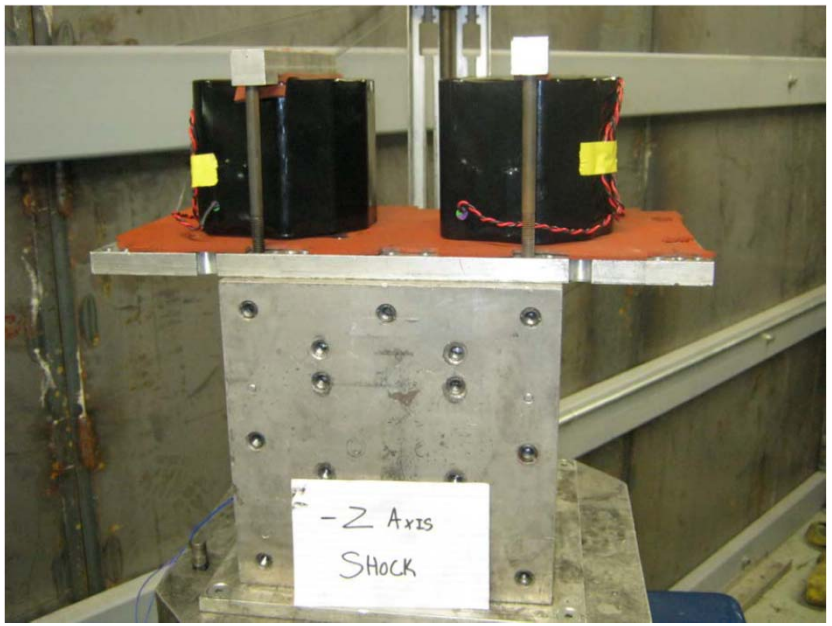
Proper disposal:

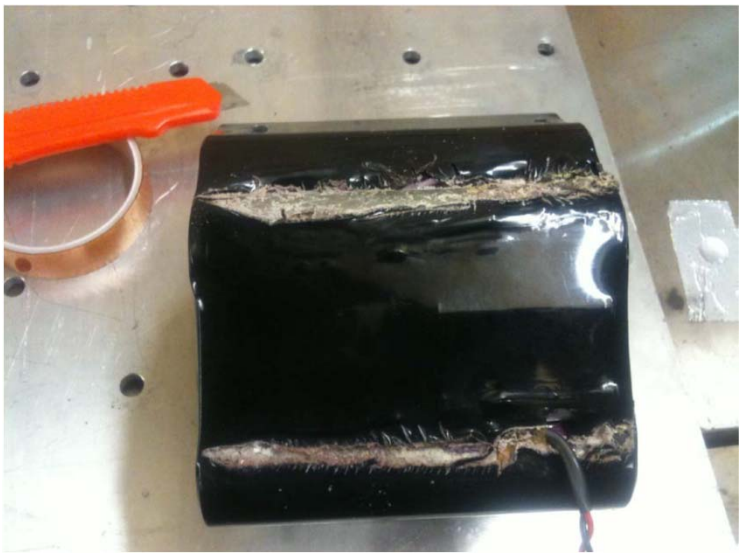
Shipping concerns with Lithium primaries

- US government regulations – 49 CFR
- International Maritime Dangerous Goods Code controls seagoing shipments
- Lithium primaries prohibited from passenger aircraft
- Limits on total Lithium content per battery
- Technically can’t ship exhausted cells

Shipping concerns with Lithium primaries

- UN testing required for all Lithium primary shipments
- 8 packs destructively tested





After short circuit test

Modular pack design

- Easier to handle
- Install more packs to increase energy without retesting
- Allows large aggregate packs to be shipped
- Requires monitoring of each pack

Monitoring individual battery packs