

OVR(TI28)



# ENERGY SYSTEMS TEST AREA (ESTA) BATTERY CAPABILITIES

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## Slide 1

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**OVR(TI27** Add the month & year of the presentation (September 2014)

Oliva, Vladenka R. (JSC-KA)[Jacobs Technology, Inc.], 9/15/2014

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# TYPES OF BATTERY OPERATIONS



- **Battery Fabrication & Rework**
- **Performance Testing:**
  - Electrochemical Testing
  - Functional Testing
  - Internal Resistance
  - Rate Capability at Different Temperatures
  - Environment Testing for Flight Levels:
    - Vibration
    - Thermal
    - Vacuum
- **Safety Evaluation Testing:**
  - Evaluation of Limits:
    - Overcharge      - External Short-Circuit      - Gas Analysis (FDIR),
    - Over-Discharge      - Internal Short-Circuit      - Thermal Propagation Testing
    - Heat -to-Vent      - Vent & Burst      - Electrolyte Analysis
- **Vehicle Interface Verification Testing:**
  - ISS, Orbiter, CEV IVA, EVA Verification Testing



# BATTERY FABRICATION/REWORK



## ➤ Machine Shop:

- Disk Sander
- Drill Press
- Band Saw
- Grinder
- Vice



## ➤ Spot Welding:

- Can spot-weld tabs onto batteries



# CYCLING CAPABILITIES



## ➤ Automated Battery Test Stands:

- 10 systems ranging from low current/voltage to high current/voltage
- Off-the-shelf units (Arbin, Maccor, PEC)
- NASA-constructed units (Labview)
- Each channel is independent of the other
- Can record voltage, current, & temperature
- Constant voltage, current, & power modes



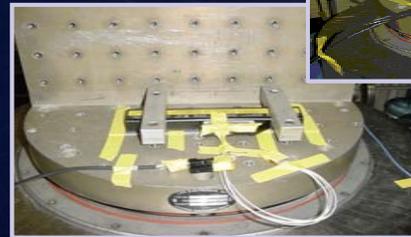
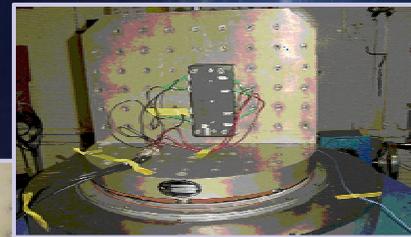
# BATTERY DEFECT SCREENING



## ➤ **Vibration:**

- Vibration levels during take-off
- Determine if there is poorly constructed battery prone to internal short
- Screening of all batteries before flight
- Vibrate in the x, y, & z axes to a defined spectrum
- Cells & batteries undergo charge & discharge cycling before & after testing

## ➤ **Shock Testing is Also Performed**



# THERMAL ENVIRONMENTS



## ➤ Thermal Chambers:

- Various chambers ranging from 2 ft<sup>3</sup> to 8 ft in diameter
- Many have Cryogenic capabilities
- Some chambers can reach to 500°F (260°C)
- Precise humidity control
- Unattended operation



# PRESSURE ENVIRONMENTS



➤ **Pressure:**

- 100 psig

➤ **Vacuum:**

- 10<sup>-4</sup> Torr
- 2-ft to 8-ft chambers

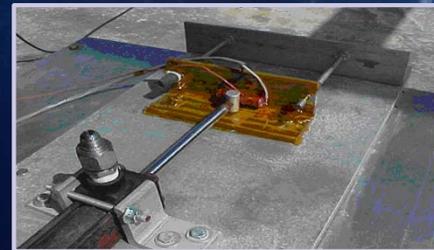


# INTERNAL SHORT SIMULATION



## ➤ Crush Test:

- Simulates an internal short
- Causes deformation without penetration
- Can measure pressure of hydraulic cylinder & calculate force
- Monitors OCV & temperature

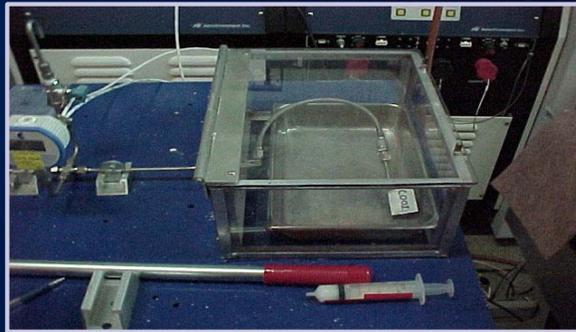


# VENT AND BURST SIMULATION



## ➤ Vent/Burst Test Stand:

- Can apply water pressure to battery & measure the pressure the battery vents
- Can block vent hole & measure the pressure of the battery bursts
- Can test up to MAWP 2500 psig



# BATTERY ABUSE CHAMBERS



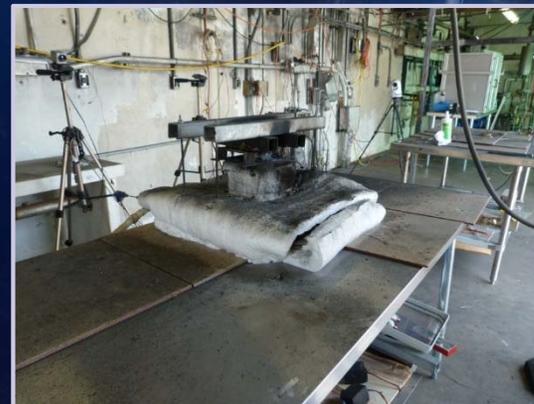
- **Overcharge & Over-Discharge Testing**
- **Short-Circuit Testing**
- **Heat-to-Vent Testing**
- **Thermal Propagation Testing**
- **4-ft Chamber:**
  - 0.1 PSI to 100 psia
  - -275C to 300C
- **All Systems Are Equipped with a Relief**
- **TNRCC-Approved for Controlled Purge of Battery Vent Products**
- **Automated Data & Control Systems**



# BATTERY ABUSE TEST CELLS



- Large Battery Open-Air Test Capabilities
- IR Cameras, Video, Remote Operations
- TNRCC-Approved for Controlled Purge of Battery Vents Products
- Automated Data & Control Systems
- Overcharge & Over-discharge Testing
- Short-Circuit Testing
- Heat-to-Vent Testing
- Thermal Propagation Testing



# BATTERY STORAGE



## ➤ Walk-In Freezer:

- Temperature range: -4°F to 80°F (-20°C to 27°C)
- Usable envelope:
  - 40-ft length x 9.5-ft height x 8-ft width
  - 8-ft entrance with 2 swing doors
- Temperature data recording
- Alarm
- Fire protection system





# PROPULSION & POWER DIVISION BATTERY TEST CAPABILITIES



### Battery Cyclers

Channel Count	Voltage Range	Current Range	Power Range	Notes
24	0 to 5VDC	-10A to 10A	50W	Channels can be paralleled up to 5V up to 120A (600W).
16	0 to 6VDC	-250A to 250A	1500W	Channels can be paralleled up to 6VDC up to 4000A (24000W).
36	0 to 10VDC	-5A to 5A	50W	Channels can be paralleled up to 10V up to 100A (1000W).
12	-5V to 15VDC	-15A to 15A	225W	Channels can be paralleled up to 15VDC up to 180A (2700W).
9	0 to 30VDC	-10A to 10A	300W	256 auxiliary channels available for cell measurements.
12	-36 to 36VDC	-12A to 12A	432W	Channels can be series or paralleled up to 216V or up to 72A (2592W).
4	0 to 50VDC	-50A to 50A	2500W	16 auxiliary channels available for cell measurements.
12	0 to 80VDC	-50A to 50A	4800W	Channels can be paralleled up to 80VDC @ 600A (48000W).
1	0V to 120VDC	-300A to 300A	30000W	Single channel system that is currently able to support large battery tests. Can be changed to used ±446VDC 300A power source.
<b>Total Channels</b>		<b>Max Voltage Range</b>	<b>Max Current Range</b>	<b>Max Power Range</b>
126		±446VDC	±4000A	30KW



### Environments for Battery Testing

Number of Chambers	Temperature Range	Humidity Range	Size	Notes
3	-73°C to 190°C	10 to 90% RH	3'x3'x3'	Fully automated thermal cycling & battery cycling using battery cyclers.
<b>Vibration Testing</b>				
<b>Vacuum Environments for Battery Testing</b>				
Number of Chambers	Vacuum Range	Size	Notes	
2	14.7psi to 0.1PSI (1 x 10 <sup>-3</sup> Torr)	2' diameter	Fully automated battery cycling up to 3 channels.	
1	14.7psi to 0.1PSI (1 x 10 <sup>-6</sup> Torr)	8' diameter	Fully automated battery cycling up to 16 channels.	



### Abuse/Safety Testing

Abuse Chambers	Voltage Range	Current Range	Size	Notes
3	0 to 600VDC	0 to 100A (7,500A short circuit)	2' diameter x 3'	Can use any battery test system or combinations of power supplies & loads for testing at various test ranges & conditions. Test include Short circuit, Over charge, over discharge, heat to vent. Chambers are capable of containing battery vent for sample analysis.
<b>Vent/Burst Systems</b>				
	Pressure Range	Notes		
2	0 to 2500 psi	Capable of supporting automated vent & burst cell testing. This test helps determine cell.		
<b>Internal Short System</b>				
	Temperature Range	Size	Notes	
1	-73°C to 190°C	2'x2'x2'	Capable of supporting cell level internal short simulation by means of crushing the cells.	
1		Outdoor System	Capable of supporting cell level internal short simulation by means of crushing the cells.	
<b>Drop Testing</b>				
	Height Range	Notes		
1	Up to 8'	Remote camera & data system.		

**Slide 13**

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**OVR(TI11** This graph is too small to read. Consider divided it among three slides instead of showing it on one.

Oliva, Vladenka R. (JSC-KA)[Jacobs Technology, Inc.], 9/10/2014



PROPULSION & POWER DIVISION  
BATTERY TEST CAPABILITIES



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