

# CRITICAL ITEMS LIST

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REFERENCE DESIGNATOR:

NAME/QUANTITY: Battery Pack, LiBCX "D" Size

DRAWING REFERENCE: SDD15550258 (Cell MNR 31910-XA)

PROJECT: SLE-1

LRU NAME/QUANTITY: Minioscilloscope

LRU PART NUMBER: SDD15550349-301

SUBSYSTEM: Minioscilloscope

EFFECTIVITY: All Orbiters

FAILURE MODE NUMBER Mini-01	CRITICALITY 1/1	FAILURE EFFECT	RETENTION RATIONALE
<b>FUNCTION</b> Power source for the minioscilloscope.		<b>END ITEM</b> Minioscilloscope does not function.	1. Design Features to Minimize Failure Mode. a. The LiBCX cells use lithium (Li) as the anode and thionyl chloride (SOCl <sub>2</sub> ) with 18 percent bromine chloride (BrCl) as the catholyte reacting on an inert carbon cathode to produce an open circuit voltage of 3.9 volts. The normal operating temperature range for the LiBCX cell is -40°F to 160°F. b. A fiberglass separator material between the positive and negative electrodes is designed to provide ion conduction while insulating against internal shorts. c. The cell contents are contained in an approximately 1 mm thick 304 stainless steel case with a welded metal lid. d. Redundant diodes are in parallel with each cell to inhibit cell reversal/overdischarge. e. As of February 1987, the "D" cell design has been modified to resist leaking and venting at temperatures up to 149°C (300°F) (Report NAS 9-17701 and ISC 22940, "LiBCX D-Cell Delta Qual").  2. Test or Analysis to Detect Failure Mode. <u>Acceptance:</u> a. Vendor cell lot certification (acceptance) tests (ISC-EP5-B3-G25E). A certified lot is defined as a set of cells which has been consecutively made within 2 consecutive calendar days using a single batch of electrolyte mix. Additionally, the cells are made from one batch of anode, cathode, and separator material. To certify a lot, a sample (20 percent minimum) of a lot is subjected to the following tests performed by the vendor:  (1) <u>Capacity Discharge</u> - one sample (6 percent) of cells is discharged through a 20 ohm load at 70°F until reaching a cutoff voltage of 2 volts. <u>Pass/Fail Criterion</u> - average capacity must be greater than 13 ampere hours. <u>Fuse Check</u> - 3 ampere fuse must blow within 15 seconds at 6 amperes. <u>Overdischarge Tolerance</u> - 3 weeks after the discharge test, the cells are overdischarged at low current for 16 hours at 160°F. <u>Pass/Fail Criterion</u> - no venting or rupture of cell material.  (2) <u>High Temperature Exposure</u> - a second sample (6 percent) is plated in an oven at 200°F for 2 hours. <u>Pass/Fail Criterion</u> - no venting or leakage.
<b>FAILURE MODE AND CAUSE</b> A) Mode: Internal short resulting in venting/explosion. B) Cause: <ul style="list-style-type: none"> <li>• Excessive vibration or shock.</li> <li>• Defective separator membrane (manufacturing defect.)</li> </ul>		<b>MISSION</b> Possible reassessment of the mission.	
		<b>CREW/VEHICLE</b> Possible injury to or loss of crewmember because of toxic venting/explosion.	
<b>REDUNDANCY SCREENS</b>  A - N/A B - N/A C - N/A	<b>REMAINING PATHS</b>  N/A	<b>INTERFACE</b>  None.	
<b>MISSION PHASE</b>  Flight	<b>TIME TO EFFECT</b>  Immediate	<b>TIME TO CORRECT</b>  None	

# CRITICAL ITEMS LIST

REFERENCE DESIGNATOR:  
 NAME/QUANTITY: Battery Pack, LiBCX "D" Size  
 DRAWING REFERENCE: SDD75550250 (Cell Pin 381910-XA)

PROJECT: 543-F  
 IRU NAME/QUANTITY: Minioscilloscope  
 IRII PART NUMBER: SDD75550249-101

SUBSYSTEM: Minioscilloscope  
 EFFECTIVITY: All Orbiters

FAILURE MODE NUMBER Mini-01	CRITICALITY 1/1	FAILURE EFFECT	RETENTION RATIONALE								
<b>FUNCTION</b> Power source for the minioscilloscope.		<b>END ITEM</b> Minioscilloscope does not function.	<p>(3) <u>Short Circuit Tolerance</u> - a third sample (4 percent) is electrically shorted through a load equal to or less than 50 milliohms. Pass/Fail Criterion - no venting or leakage.</p> <p>(4) A sample of one "D" cell lot is also tested to 300°F for 15 minutes. It must not leak or vent during this period.</p> <p>(5) A sample of four cells per lot are subjected to random vibration for 15 minutes prior to being discharged for capacity information. The random vibration testing is identical to that for NASA acceptance in "b (2)" below.</p> <p>b. NASA Cell Acceptance Test (TTA 1-2p 109, revision B)</p> <p>(1) Visual and open circuit voltage (OCV) tests are performed on 100 percent of delivered cells.</p> <p>(2) A sample from each lot of the cells is tested to the following spectrum by the vendor or are delivered to NASA who subjects them to acceptance vibration test for 15 minutes in each of three mutually perpendicular axes, according to the following spectrum, before being discharged for capacity information.</p> <table style="width: 100%; border: none;"> <tr> <td style="text-align: center;">FREQUENCY (Hz)</td> <td style="text-align: center;">LEVEL</td> </tr> <tr> <td style="text-align: center;">20 to 80</td> <td style="text-align: center;">+ 3 dB/octave</td> </tr> <tr> <td style="text-align: center;">80 to 350</td> <td style="text-align: center;">0.1g<sup>2</sup>/Hz</td> </tr> <tr> <td style="text-align: center;">350 to 2000</td> <td style="text-align: center;">-3 dB/octave</td> </tr> </table> <p>The OCV is monitored during testing and a load test is performed after vibration testing is complete.</p> <p><b>CERTIFICATION:</b>                      During cell certification (JSC-EP5-81-008, JSC-EP5-027, and JSC-23940), the LiBCX cell was evaluated over a variety of performance and off-limits test conditions in order to meet the three basic requirements for certification:</p> <ul style="list-style-type: none"> <li>a. Capacity performance</li> <li>b. Venting temperature under off limits testing</li> <li>c. Vibration/shock</li> </ul>	FREQUENCY (Hz)	LEVEL	20 to 80	+ 3 dB/octave	80 to 350	0.1g <sup>2</sup> /Hz	350 to 2000	-3 dB/octave
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20 to 80	+ 3 dB/octave										
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350 to 2000	-3 dB/octave										
<b>FAILURE MODE AND CAUSE</b> A) Mode: Internal short resulting in venting/explosion. B) Cause: <ul style="list-style-type: none"> <li>• Excessive vibration or shock.</li> <li>• Defective separator membrane (manufacturing defect)</li> </ul>		<b>MISSION</b> Possible reassessment of the mission.									
<b>REUNDANCY SCREENS</b> A - N/A B - N/A C - N/A		<b>CREW/VEHICLE</b> Possible injury to or loss of crewmember because of toxic venting/explosion.									
<b>REMAINING PATHS</b> N/A		<b>INTERFACE</b> None.									
<b>MISSION PHASE</b>	<b>TIME TO EFFECT</b>	<b>TIME TO CORRECT</b>									
Flight	Immediate	None									

PREPARED BY:

REVISION:

PERSEDING DATE:

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# CRITICAL ITEMS LIST

REFERENCE DESIGNATOR:  
 NAME/QUANTITY: Battery Pack, LiBCK "D" Size  
 DRAWING REFERENCE: CDTR II-001-007 (Cell PM 381910-XA)

PROJECT: SLF-1  
 LRU NAME/QUANTITY: Minioscilloscope  
 LRU PART NUMBER: SD15550249-301

SUBSYSTEM: Minioscilloscope  
 EFFECTIVITY: All Orbiters

FAILURE MODE NUMBER Mini-Q1	CRITICALITY 1/1	FAILURE EFFECT	RETENTION RATIONALE								
<b>FUNCTION</b> Power source for the minioscilloscope.		<b>END ITEM</b> Minioscilloscope does not function.	<p>The lithium "D" battery cell was subjected to the following vibration tests conducted at Ames Research Center. Although the vibration levels were higher than the specification requirement, the battery cells did not experience any failures to the duration of 300 seconds in each of 3 axes.</p> <table style="margin-left: 40px;"> <tr> <td style="text-align: center;">FREQUENCY</td> <td style="text-align: center;">LEVEL</td> </tr> <tr> <td style="text-align: center;">20-100</td> <td style="text-align: center;">10G- 210 g<sup>2</sup>/Hz</td> </tr> <tr> <td style="text-align: center;">100-400</td> <td style="text-align: center;">210 g<sup>2</sup>/Hz</td> </tr> <tr> <td style="text-align: center;">400-2000</td> <td style="text-align: center;">210- 150 g<sup>2</sup>/Hz</td> </tr> </table> <p>Shock: 20g's sawtooth with 11 ms rise once in each axis for 6 shock pulses</p> <p><b>TURNAROUND:</b>                      After a cell configuration has been certified, each cell is useable for flight for 1 year from date of manufacture. This nonrechargeable cell may be reflowed as long as it was not activated during flight. Once a cell has had any use (no matter how limited) during a flight, it is removed from inventory and submitted for disposal. Unused cells are subjected to a visual inspection, DCV, and load test and returned to flight status, provided the 1 year shelf life has not expired.</p> <p>3. Inspection.</p> <p><b>MANUFACTURING:</b>                      During vendor cell manufacturing/acceptance test (JSC EPS-83-0258 and Boeing TE Spec. PS28/ATP-08001), 100 percent of the cells are manufactured under on site Defense Contract Administration Services (DCAS) delegation</p> <ol style="list-style-type: none"> <li>a. Electrode plates and separator material are checked for burrs and misalignment.</li> <li>b. Ohmic resistance across the dry cell terminal is checked.</li> <li>c. Each cell is identified by a serial number.</li> <li>d. Prior to filling the cell with electrolyte, each cell is x-rayed in two directions to examine this assembled internal configuration.</li> </ol>	FREQUENCY	LEVEL	20-100	10G- 210 g <sup>2</sup> /Hz	100-400	210 g <sup>2</sup> /Hz	400-2000	210- 150 g <sup>2</sup> /Hz
FREQUENCY	LEVEL										
20-100	10G- 210 g <sup>2</sup> /Hz										
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400-2000	210- 150 g <sup>2</sup> /Hz										
<b>FAILURE MODE AND CAUSE</b> A) Mode: Internal short resulting in venting/explosion. B) Cause: <ul style="list-style-type: none"> <li>• Excessive vibration or shock.</li> <li>• Defective separator membrane (manufacturing defect.)</li> </ul>		<b>MISSION</b> Possible reassessment of the mission.									
		<b>CREW/VEHICLE</b> Possible injury to or loss of crewmember because of toxic venting/explosion.									
<b>REDUNDANCY SCREENS</b> A - N/A B - N/A C - N/A	<b>REMAINING PATHS</b> N/A	<b>INTERFACE</b> None.									
<b>MISSION PHASE</b>	<b>TIME TO EFFECT</b>	<b>TIME TO CORRECT</b>									
Flight	Immediate	None									

# CRITICAL ITEMS LIST

REFERENCE DESIGNATOR:  
 NAME/QUANTITY: Battery Pack, LiBCK "D" Size  
 DRAWING REFERENCE: SDD15550250 (Cell PIN 101910-XA)

PROJECT: SL-1  
 LRU NAME/QUANTITY: Minioscilloscope  
 LRU PART NUMBER: SDD15550249-101

SUBSYSTEM: Minioscilloscope  
 EFFECTIVITY: All Orbiters

FAILURE MODE NUMBER Mini-01	CRITICALITY 1/1	FAILURE EFFECT	RETENTION RATIONALE
<b>FUNCTION</b> Power source for the minioscilloscope.		<b>END ITEM</b> Minioscilloscope does not function.	<p>e. After filling, all the cells are put in an oven at 160°F for 2 hours followed by:</p> <ul style="list-style-type: none"> <li>(1) OCV test - must be greater than 3.85 volts</li> <li>(2) Load test - must be greater than 3.5 volts</li> <li>(3) Size and weight check to verify no swelling or venting occurred</li> </ul> <p><b>TURNAROUND</b></p> <p>Cells not used during a mission can be reused after a visual inspection and verification that all have not passed their 1 year shelf life</p> <p><b>NOTE:</b></p> <p>Visual and OCV inspections are done on 100 percent of the delivered cells. All the tests conducted in part 2 and inspections in part 3 serve to prevent the occurrence of internal shorts in flight cells by product quality control during manufacturing and by parametric screening during cell acceptance testing.</p> <p>4. Failure History:</p> <p>None reported. As of February 1989, 595 LiBCK cells have been flown in the Shuttle Orbiter without a hazardous event occurring. No internal shorts have been detected in more than 4,000 cells at JSC. In fact, no internal shorts have been reported for all the D cells delivered in a 7-year history of the vendor (which includes the production of approximately 1,000,000 cells, 220,000 of which are D cells)</p> <p>5. Operational Use.</p> <ul style="list-style-type: none"> <li>a. <u>Operational Effect of Failure.</u> Possible loss of crewmember</li> <li>b. <u>Crew Action.</u> None identified</li> <li>c. <u>Crew Training.</u> The crew will be trained to perform a preuse visual and subjective temperature checkout of the battery cells when possible.</li> <li>d. <u>Mission Constraints.</u> None identified</li> <li>e. <u>In-Flight Checkout.</u> A preuse visual and subjective temperature checkout of the battery cells will be performed when possible.</li> </ul>
<b>FAILURE MODE AND CAUSE</b>		<b>MISSION</b>	
<p>A) Mode: Internal short resulting in venting/explosion.</p> <p>B) Cause:</p> <ul style="list-style-type: none"> <li>• Excessive vibration or shock.</li> <li>• Defective separator membrane (manufacturing defect.)</li> </ul>		Possible reassessment of the mission.	
<b>REDUNDANCY SCREENS</b>		<b>CREW/VEHICLE</b>	
<p>A - N/A</p> <p>B - N/A</p> <p>C - N/A</p>		Possible injury to or loss of crewmember because of toxic venting/explosion.	
<b>REMAINING PATHS</b>		<b>INTERFACE</b>	
N/A		None.	
<b>MISSION PHASE</b>	<b>TIME TO EFFECT</b>	<b>TIME TO CORRECT</b>	
Flight	Immediate	None	

PREPARED BY:

REVISION:

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SUPERSEDING DATE:

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