

CRITICAL ITEMS LIST

REFERENCE DESIGNATOR:
 NAME/QUANTITY: Battery Pack, LiBCX "C" Size
 DRAWING REFERENCE: 15405 (C/N) P/N 20464

PROJECT: Life Sciences
 LRU NAME/QUANTITY: Ultrasonic Limb Plethysmograph
 LRU PART NUMBER: 15416

SUBSYSTEM: ULP
 EFFECTIVITY: All Orbiters

FAILURE MODE NUMBER ULP-01	CRITICALITY 1/1	FAILURE EFFECT	RETENTION RATIONALE
FUNCTION Power source for the ULP.		END ITEM The ULP does not function.	1. Design Features to Minimize Failure Mode. <ul style="list-style-type: none"> a. The LiBCX cells use lithium (Li) as the anode and thionyl chloride (SOCl₂) with 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. 2. Test or Analysis to Detect Failure Mode. <p><u>Acceptance:</u></p> <ul style="list-style-type: none"> a. Vendor cell lot certification (acceptance) tests (Boeing-EPCC Spec P528/A TP 08001). 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. <ul style="list-style-type: none"> (1) <u>Capacity Discharge</u> - one sample (5 percent) of cells is discharged through 5 ohm load at 70°F until reaching a cutoff voltage of 2 volts. <u>Pass/Fail criteria</u> - average capacity must be greater than 6.5 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 with bypass diodes. <u>Pass/Fail Criterion</u> - no venting or rupture of cell material. (2) <u>High Temperature Exposure</u> - a second sample (5 percent) is placed in an oven 200°F for 2 hours. <u>Pass/Fail Criterion</u> - no venting or leakage.
FAILURE MODE AND CAUSE A) Mode: Internal short resulting in venting/explosion. B) Cause: <ul style="list-style-type: none"> • Excessive vibration or shock. • Defective separator membrane (manufacturing defect.) 		MISSION Possible reassessment of the mission.	
REDUNDANCY SCREENS A - N/A B - N/A C - N/A		CREW/VEHICLE Possible injury to or loss of crewmember because of toxic venting/explosion.	
REMAINING PATHS N/A		INTERFACE None.	
MISSION PHASE	TIME TO EFFECT	TIME TO CORRECT	
All	Immediate	None	

CRITICAL ITEMS LIST

REFERENCE DESIGNATOR:
 NAME/QUANTITY: Battery Pack, LIBOX "C" Size
 DRAWING REFERENCE: ISS05 (Cell PIN 30464)

PROJECT: Life Sciences
 LRU NAME/QUANTITY: Ultrasonic Limb Plethysmograph
 LRU PART NUMBER: FS416

SUBSYSTEM: ULP
 EFFECTIVITY: All Configs

FAILURE MODE NUMBER ULP-01	CRITICALITY 1/1	FAILURE EFFECT	RETENTION RATIONALE								
FUNCTION Power source for the ULP.		END ITEM The ULP 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) AQ sample of four cells per lot is subjected to random vibration for 15 minutes/axis prior to being discharged for capacity information. The random vibration testing is identical to that for NASA acceptance in "6 below.</p> <p>(5) Visual and open circuit voltage (OCV) tests are performed on 100 percent of delivered cells.</p> <p>(6) 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="margin-left: 40px; border: none;"> <tr> <td style="text-align: right;">FREQUENCY (Hz)</td> <td style="text-align: left;">LEVEL</td> </tr> <tr> <td style="text-align: right;">20 to 80</td> <td style="text-align: left;">+ 3 dB/octave</td> </tr> <tr> <td style="text-align: right;">80 to 350</td> <td style="text-align: left;">0 1g²/Hz</td> </tr> <tr> <td style="text-align: right;">350 to 2000</td> <td style="text-align: left;">-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>CERTIFICATION: During cell certification (JSC-EP5-01-014), the LIBOX cell was evaluated over a variety of performance and pH limits test conditions in order to meet the three basic requirements for certification:</p> <ol style="list-style-type: none"> a. Capacity performance b. Venting temperature under off limits testing c. Vibration/shock 	FREQUENCY (Hz)	LEVEL	20 to 80	+ 3 dB/octave	80 to 350	0 1g ² /Hz	350 to 2000	-3 dB/octave
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FAILURE MODE AND CAUSE A) Mode: Internal short resulting in venting/explosion. B) Cause: <ul style="list-style-type: none"> • Excessive vibration or shock. • Defective separator membrane (manufacturing defect.) 		MISSION Possible reassessment of the mission.									
		CREW/VEHICLE Possible injury to or loss of crewmember because of toxic venting/explosion.									
REDUNDANCY SCREENS A - N/A B - N/A C - N/A	REMAINING PATHS N/A	INTERFACE None.									
MISSION PHASE	TIME TO EFFECT	TIME TO CORRECT									
All	Immediate	None									

PREPARED BY:

REVISION:

SUPERSEDING DATE:

DATE:

CRITICAL ITEMS LIST

REFERENCE DESIGNATOR:
 NAME/QUANTITY: Battery Pack, Li/Co "C" Size
 DRAWING REFERENCE: 15695 (Cell PIN 3B464)

PROJECT: Life Sciences
 LRU NAME/QUANTITY: Ultrasonic Limb Plethysmograph
 LRU PART NUMBER: 15916

SUBSYSTEM: ULP
 EFFECTIVITY: All Orbiters

FAILURE MODE NUMBER ULP-01	CRITICALITY 1/1	FAILURE EFFECT	RETENTION RATIONALE								
FUNCTION Power source for the ULP.		END ITEM The ULP does not function.	<p>The lithium battery cell was subjected to the following vibration tests conducted by EP&TTA. The battery cells did not experience any failures for the duration of 15 minutes 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- 80 Hz</td> <td style="text-align: center;">+ 3dB/octave</td> </tr> <tr> <td style="text-align: center;">80-350 Hz</td> <td style="text-align: center;">0.1 g²/Hz</td> </tr> <tr> <td style="text-align: center;">350-2000 Hz</td> <td style="text-align: center;">0.1 g²/Hz</td> </tr> </table> <p>Shock: Testing was according to MIL-STD-810C, Method 516.2, procedure I; 20g peaks, 11ms r/ba, 1 ms decay.</p> <p>TURNAROUND: 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 reflighted 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>MANUFACTURING: During vendor cell manufacturing/acceptance testing, 100 percent of the cells are manufactured under on site Defense Contract Administration Services (DCA5) delegation.</p> <ol style="list-style-type: none"> a. Electrode plates and separator material are checked for burrs and misalignment. b. Ohmic resistance across the dry cell terminal is checked. c. Each cell is identified by a serial number. d. Prior to filling the cell with electrolyte, each cell is x-rayed in two directions to examine this assembled internal configuration. 	FREQUENCY	LEVEL	20- 80 Hz	+ 3dB/octave	80-350 Hz	0.1 g ² /Hz	350-2000 Hz	0.1 g ² /Hz
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FAILURE MODE AND CAUSE A) Mode: Internal short resulting in venting/explosion. B) Cause: <ul style="list-style-type: none"> • Excessive vibration or shock. • Defective separator membrane (manufacturing defect.) 		MISSION Possible reassessment of the mission.									
		CREW/VEHICLE Possible injury to or loss of crewmember because of toxic venting/explosion.									
REDUNDANCY SCREENS A - N/A B - N/A C - N/A		INTERFACE None.									
REMAINING PATHS N/A											
MISSION PHASE All	TIME TO EFFECT Immediate	TIME TO CORRECT None									

CRITICAL ITEMS LIST

REFERENCE DESIGNATOR:
 NAME/QUANTITY: Battery Pack LIBOX "C" Size
 DRAWING REFERENCE: 15695 (Cell PIN 30460)

PROJECT: Life Sciences
 LRU NAME/QUANTITY: Ultrasonic Limb Plethysmograph
 LRU PART NUMBER: 15416

SUBSYSTEM: ULP
 EFFECTIVITY: All Orbiters

FAILURE MODE NUMBER ULP-01	CRITICALITY 1/1	FAILURE EFFECT	RETENTION RATIONALE
FUNCTION Power source for the ULP.		END ITEM The ULP does not function.	e. After filling all the cells are put in an oven at 160°F for 2 hours followed by: <ol style="list-style-type: none"> (1) OCV test - must be greater than 3.85 volts. (2) Load test - must be greater than 3.5 volts (3) Size and weight check to verify no swelling or venting occurred <p>TURNAROUND: 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>NOTE: 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. None reported. As of May 1990, 691 LIBOX cells have been flown in the Shuttle Orbiter without a hazardous event occurring. no internal shorts have been detected in more than 4,350 cells at JSC.</p> <p>5. Operational Use.</p> <ol style="list-style-type: none"> a. <u>Operational Effect of Failure:</u> Possible loss of crewmember. b. <u>Crew Action:</u> None identified. 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. d. <u>Mission Constraints:</u> None identified. e. <u>In-Flight Checkout:</u> A preuse visual and subjective temperature checkout of the battery cells will be performed when possible.
FAILURE MODE AND CAUSE A) Mode: Internal short resulting in venting/explosion. B) Cause: <ul style="list-style-type: none"> • Excessive vibration or shock. • Defective separator membrane (manufacturing defect.) 		MISSION Possible reassessment of the mission.	
		CREW/VEHICLE Possible injury to or loss of crewmember because of toxic venting/explosion.	
REDUNDANCY SCREENS A - N/A B - N/A C - N/A	REMAINING PATHS N/A	INTERFACE None.	
MISSION PHASE	TIME TO EFFECT	TIME TO CORRECT	
All	Immediate	None	

PREPARED BY:

REVISION:

SUPERSEDED DATE:

DTI