

CRITICAL ITEMS LIST

ASSY NOMENCLATURE: LIBCX D & C Battery Cells

SYSTEM: TBD

REVISION: A

ASSY P/N: TBD

SUBSYSTEM: TBD

PAGE 1 OF 4

FMEA		NAME, QTY & DRAWING REF DESIGNATION	QNTY	FAILURE MODE AND CAUSE	FAILURE EFFECT ON ITEM	RATIONALE FOR ACCEPTANCE
REF	REV					
7		Battery Cell Lithium-Bromine-Complex (LIBCX) "D" and "C" size 3B21/3B464	1/1	<p>Mode: Internal short resulting in rapid venting/explosion</p> <p>Cause: <ul style="list-style-type: none"> • Excessive vibration or shock • Mechanical failure of separator membrane • Defective separator membrane (manufacturing defect) </p>	Possible loss of and item, mission, vehicle, or crewmember	<p>1. Design Features to Minimize Failure Mode.</p> <ul style="list-style-type: none"> a. The LIBCX cell uses lithium (Li) as the anode and thionyl chloride (SOCl₂) with 16 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 -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 3 mm thick 304 stainless steel case with a welded metal lid d. As of February 1987, the cell design has been modified to resist leaking and venting at temperatures up to 149°C (300°F) (Report NAS 9-17701). <p>2. Test or Analysis to Detect Failure Mode.</p> <p><u>Acceptance:</u></p> <ul style="list-style-type: none"> a. Vendor cell lot certification (acceptance) tests (JSC EPL-87 D25). 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 (16 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 (6 percent) of cells are 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> - 1 week 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 placed in an oven 200°F for 2 hours. <u>Pass/Fail Criterion</u> - no venting or leakage.

PREPARED BY: J. C. Gausepohl, E. England

SUPERSEDING DATE: 2-8-87

APPROVED BY: R. J. Brown, C. Darity

DATE: 2/25/87

CRITICAL ITEMS LIST

ITEM NOMENCLATURE: *LiBCK D & C Battery Cells*

SYSTEM: *TBD*

REVISION: *A*

ASSY P/N: *TBD*

SUBSYSTEM: *TBD*

PAGE 2 OF 4

FMEA		NAME, QTY & DRAWING REF DESIGNATION	CRITY	FAILURE MODE AND CAUSE	FAILURE EFFECT OR CONDITION	RATIONALE FOR ACCEPTANCE																
REF	REV																					
1		Battery Cell Lithium-Bromine-Complex (LiBCK) "D" and "C" size 382173B464	1/3	<p>Mode: Internal short resulting in rapid venting/explosion</p> <p>Cause: a Excessive vibration or shock b Mechanical failure of separator membrane c Defective separator membrane (manufacturing defect)</p>	Possible loss of end item, mission, vehicle, or crewmember	<p>(3) <u>Short Circuit Tolerance</u> - a third sample (4 percent) is electrically shorted through a load equal to or less than 50 millivolts. Pass/Fail Criterion - no venting or leakage.</p> <p>b. NASA Cell Acceptance Test (TTA-t-2p137, 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 delivered to NASA are subjected 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 border="0"> <tr> <td>FREQUENCY (Hz)</td> <td>LEVEL</td> </tr> <tr> <td>20 to 80</td> <td>+3 db/octave</td> </tr> <tr> <td>80 to 350</td> <td>.64 g²/Hz</td> </tr> <tr> <td>350 to 2000</td> <td>-3db/octave</td> </tr> </table> <p>The OCV is monitored during testing and a load test is performed after vibration testing is complete.</p> <p><u>CERTIFICATION:</u></p> <p>During cell certification (JSC-EP5-81-008), the LiBCK cell was evaluated over a variety of performance and off limits test conditions in order to meet the three basic requirements for certification:</p> <ol style="list-style-type: none"> Capacity performance. Venting temperature under off limits testing. Vibration. <p>(1) 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 for the duration of 300 seconds in each of 3 axes:</p> <table border="0"> <tr> <td>FREQUENCY (Hz)</td> <td>LEVEL</td> </tr> <tr> <td>20-100</td> <td>.106 - 210 g²/Hz</td> </tr> <tr> <td>100-400</td> <td>.210 g²/Hz</td> </tr> <tr> <td>400-2000</td> <td>210 - .156 g²/Hz</td> </tr> </table>	FREQUENCY (Hz)	LEVEL	20 to 80	+3 db/octave	80 to 350	.64 g ² /Hz	350 to 2000	-3db/octave	FREQUENCY (Hz)	LEVEL	20-100	.106 - 210 g ² /Hz	100-400	.210 g ² /Hz	400-2000	210 - .156 g ² /Hz
FREQUENCY (Hz)	LEVEL																					
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FREQUENCY (Hz)	LEVEL																					
20-100	.106 - 210 g ² /Hz																					
100-400	.210 g ² /Hz																					
400-2000	210 - .156 g ² /Hz																					

PREPARED BY: *J. C. Gustafson/H. S. England*

SUPERSEDING DATE: *7-8-87*

APPROVED BY: *E. J. BRADY, C. DREY*

DATE: *1/25/88*

EMU TV-2

S40209L
 ATTACHMENT
 Page 4 of 4

CRITICAL ITEMS LIST

ASSY NOMENCLATURE: LBCY D & C Battery Cells

SYSTEM: TBD

REVISION: A

ASSY P/N: TBD

SUBSYSTEM: TBD

PAGE 3 OF 4

FMEA		NAME, QTY & DRAWING REF DESIGNATION	CRITY	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE								
REF	REV													
1		Battery Cell Lithium-Iron-Complex (LIBCO) "D" and "C" size 3021/30464	1/1	Mode: Internal short resulting in rapid venting/explosion Cause: • Excessive vibration or shock • Mechanical failure of separator membrane • Defective separator membrane (manufacturing defect)	Possible loss of end item, mission, vehicle, or crewmember	<p>(2) The lithium "C" battery cell was subjected for a duration of 15 minutes in each of 3 axes to the following vibration tests conducted at JSC:</p> <table border="0"> <tr> <td>FREQUENCY (Hz)</td> <td>LEVEL</td> </tr> <tr> <td>20-80</td> <td>+ 6 dB/OCT to 0.1 g²/Hz</td> </tr> <tr> <td>80-350</td> <td>0.1 g²/Hz</td> </tr> <tr> <td>350-2000</td> <td>-3db/oct</td> </tr> </table> <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 reflown 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, OCV, 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 test (JSC-EP5-83-075), 100 percent of the cells are manufactured under on site defense contract administration services (DCAS) delegation.</p> <ol style="list-style-type: none"> Electrode plates and separator material are checked for burrs and misalignment. Ohmic resistance across the dry cell terminal is checked. Each cell is identified by a serial number. Prior to filling the cell with electrolyte, each cell is x-rayed in two directions to examine this assembled internal configuration. The cells are put in an oven at 180°F for 2 hours followed by: <ol style="list-style-type: none"> OCV test - must be greater than 3.85 volts. Load test - must be greater than 3.5 volts Size and weight check to verify no swelling or venting occurred. 	FREQUENCY (Hz)	LEVEL	20-80	+ 6 dB/OCT to 0.1 g ² /Hz	80-350	0.1 g ² /Hz	350-2000	-3db/oct
FREQUENCY (Hz)	LEVEL													
20-80	+ 6 dB/OCT to 0.1 g ² /Hz													
80-350	0.1 g ² /Hz													
350-2000	-3db/oct													

PREPARED BY: J. C. Gautepohm, S. England

SUPERSEDING DATE: 2-8-87

APPROVED BY: A. A. Bragg, C. Darty

DATE: 1/29/86

EMU TV-3

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Page 5 of 6

CRITICAL ITEMS LIST

CONVINCLOATURE: LIBCK D & C Battery Cells

SYSTEM: TBD

REVISION: A

ASSY P/N: TBD

SUBSYSTEM: TBD

PAGE 4 OF 6

FMEA		NAME, QTY & DRAWING REF DESIGNATION	CRIT'Y	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
REF	REV					
1		Battery Cell Lithium-Bromine-Complex (LiBCX) "D" and "C" size 3821/38466	1/1	Mode: Internal short resulting in rapid venting/ explosion Cause: • Excessive vibration or shock • Mechanical failure of separator membrane • Defective separator membrane (manufacturing defect)	Possible loss of end item, mission, vehicle, or crewmember	<p><u>TUNAROUND:</u></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><u>NOTE</u></p> <p>Visual and DCV 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 April 1987, 571 LiBCX 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 ISC. In fact, no internal shorts have been reported for all the D cells delivered in a 5-year history of the vendor (which includes the production of approximately 500,000 cells, 100,000 of which are D cells).</p> <p>5. Operational Use.</p> <p>a. <u>Operational Effect of Failure:</u> Possible loss of crewmember.</p> <p>b. <u>Crew Action:</u> None identified.</p> <p>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.</p> <p>d. <u>Mission Constraints:</u> None identified.</p> <p>e. <u>In-Flight Checkout:</u> A preuse visual and subjective temperature checkout of the battery cells will be performed when possible.</p>

PREPARED BY: J. C. Gentry/LEN. S. England

SUPERSEDING DATE: 2-8-82

APPROVED BY: E. J. BRADY, C. DICKY

DATE: 2/25/88

EMU TV-4

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ATTACHMENT
PAGE 6 OF 6