CRITICAL ITEMS LIST

ASSY NOMENCLATURE: *EMU LIGHT ASSEMBLY* SYSTEM *EMU* REVISION: A

ASSY P/N: *10161-10061* SUBSYSTEM *EMU LIGHT ASSEMBLY* PAGE 1 OF 4

FMEA REF	FMEA REV	NAME, QTY & DRAWING REF DESIGNATION	CRIT'Y	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
2A		Battery Assy., (1) ILC P/N 10161-20001 (Cell P/N 381910-XA)	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	**1. Design Features to Minimize Failure Mode.** a. The LiBCX cell uses lithium (Li) as the anode and thionyl chloride ($SOCl_2$) 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 short. c. The cell contents are contained in an approximately 1 mm thick 304 stainless steel case with a welded metal lid. d. 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 JSC 22940, "LiBCX D-Cell Delta Qual"). **2. Test or Analysis to Detect Failure Mode.** Acceptance: a. Vendor cell lot certification (acceptance) tests (JSC-EPS-83-0258). 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) Capacity Discharge - one sample (6 percent) of cells are discharged through a 20 ohm load at 70°F until reaching a cutoff voltage of 2 volts. Pass/Fail Criterion - average capacity must be greater than 13 ampere hours. Fuse Check - 3 ampere fuse must blow within 15 seconds at 6 amperes. Overdischarge Tolerance - 3 weeks after the discharge test, the cells are overdischarged at low current for 20 hours at 160°F. Pass/Fail Criterion - no venting or rupture of cell material. (2) High Temperature Exposure - a second sample (6 percent) is placed in an oven 200°F for 2 hours. Pass/Fail Criterion - no venting or leakage.

PREPARED BY *J.C. Gausepohl/H. E. England* SUPERSEDING DATE *2/25/88* APPROVED BY *B. J. Bragg/F. C. Darcy* DATE *3/15/89*

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CRITICAL ITEMS LIST

ASSY NOMENCLATURE: *EMU LIGHT ASSEMBLY* | SYSTEM: *EMU* | REVISION: A

ASSY P/N: *10161-10061* | SUBSYSTEM *EMU LIGHT ASSEMBLY* |

FMEA REF	FMEA REV	NAME, QTY & DRAWING REF DESIGNATION	CRIT'Y	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
2A		**Battery Assy., (1)** **ILC P/N 10161-20001** **(Cell P/N 3B1910-XA)**	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	(3) Short Circuit Tolerance - 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. (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 (5) A sample of four cells per lot are 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 "b (2)" below b NASA Cell Acceptance Test (TTA-1-2p109, revision B) (1) Visual and open circuit voltage (OCV) tests are performed on 100 percent of delivered cells (2) A sample from each lot of the cells are 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 FREQUENCY (Hz) — LEVEL 20 to 80 — +3 db/octave 80 to 350 — 0.1 g²/Hz 350 to 2000 — -3db/octave The OCV is monitored during testing and a load test is performed after vibration testing is complete CERTIFICATION: During cell certification (JSC-EPS-B1-008), 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: a Capacity performance b Venting temperature under off limits testing c Vibration

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S40208N
ATTACHMENT 1
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CRITICAL ITEMS LIST

ASSY NOMENCLATURE: *EMU LIGHT ASSEMBLY* SYSTEM: *EMU* REVISION: *A*

ASSY P/N: *10161-10061* SUBSYSTEM: *EMU LIGHT ASSEMBLY*

FMEA REF	FMEA REV	NAME, QTY & DRAWING REF DESIGNATION	CRIT'Y	FAILURE MODE AND CAUSE	FAILURE EFFECT On END ITEM	RATIONALE FOR ACCEPTANCE
2A		Battery Assy., (1) (LCP/N 10161-20001 (Cell P/N 381910-XA)	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	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 FREQUENCY (Hz) — LEVEL 20 - 100 — .106 - .210 g^2/Hz 100-400 — .210 g^2/Hz 400-2000 — .210 - .150 g^2/Hz 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 3. Inspection. MANUFACTURING: During vendor cell manufacturing/acceptance test (JSC-EPS-83-025), 100 percent of the cells are manufactured under on site defense contract administration services (DCAS) delegation 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 the assembled internal configuration e The cells are put in an oven at 160°F for 2 hours followed by: (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

PREPARED BY *J. C. Gauspohl/H. S. England* SUPERSEDING DATE: *2/25/88* APPROVED BY: *B. J. Bragg/E. C. Darcy* DATE *3/15/89*

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SK0208N
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CRITICAL ITEMS LIST

ASSY NOMENCLATURE: *EMU LIGHT ASSEMBLY* | SYSTEM: EMU | REVISION: A

ASSY P/N: *10161-28061* | SUBSYSTEM: *EMU LIGHT ASSEMBLY* |

FMEA REF	FMEA REV	NAME, QTY & DRAWING REF DESIGNATION	CRIT'Y	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
2A		Battery Assy., (1) ILC P/N 10161-28061 (Cell P/N 381918-XA)	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	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 NOTE Visual and OCV inspections are done on 100 percent of the delivered cells. All the tests conducted in part 2 and inspection 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. 4. Failure History. None reported. As of February 1989, 595 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 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). 5. Operational Use. a. Operational Effect of Failure: Possible loss of crewmember. b. Crew Action: None identified. c. Crew Training: The crew will be trained to perform a preuse visual and subjective temperature checkout of the battery cells when possible. d. Mission Constraints: None identified. e. In Flight Checkout: A preuse visual and subjective temperature checkout of the battery cells will be performed when possible.

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