

NAME P/N QTY	CRIT	FAILURE MODE & CAUSES	FAILURE EFFECT	RATIONALE FOR ACCEPTANCE
Battery Pack Assy. SED131D1665-301  (1)	1/1	106FM30: Internal short resulting in venting/explosion.  CAUSE: Excessive vibration, shock or impact. Defective separator membrane.	END ITEM: Explosion damaging SSA and causing suit gas leakage to ambient.  CFE INTERFACE: Rapid depressurization of SSA.  MISSION: Loss of mission.  CREW/VEHICLE: Loss of crewman.	A. Design -  The LIBCX cell uses lithium (Li) as the anode and thionyl chloride (SOCl <sub>2</sub> ) 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 is -40°F to 162°F. A fiberglass separator material between the positive and negative electrodes is designed to provide ion conduction while insulating against internal shorts. The cell contents are contained in an approximately 1 mm thick 30% stainless steel case with a welded metal lid. As of February 1987, the "D" cell design has been modified to resist leaking and venting at temperatures up to 300°F (Report NAS 9-17703 and JSC 22940, "LIBCX D-Cell Delta Qual").  B. Test -  <u>Acceptance:</u>  a. Vendor cell lot certification (acceptance) tests (JSC EP5--B3-025B). 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 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> - 3 weeks after the discharge test, the cells are overdischarged at low current for 20 hours at 160°F. <u>Pass/Fail Criterion</u> - no venting or rupture of cell material.  (2) <u>High Temperature Exposure</u> - a second (6 percent) is placed in an

NAME P/N QTY	CRIT	FAILURE MODE & CAUSES	FAILURE EFFECT	RATIONALE FOR ACCEPTANCE
--------------------	------	-----------------------------	----------------	--------------------------

Battery  
Pack Assy.  
SED13101665-301

1/1

106FM30: Internal  
short resulting in  
venting/explosion.

FAILURE EFFECT

RATIONALE FOR ACCEPTANCE

(1)

B. Test - (continued)

(3) Short Circuit Tolerance - a third sample (4 percent) is electrically shorted through a load equal to less than 50 milliohms. Pass/Fail Criterion - no venting or leakage.

(4) A sample of one "0" cell per lot is 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 (TIA-E-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 g <sup>2</sup> /Hz
350 to 2000	-3db/octave

The OCV is monitored during testing and a load test is performed after vibration testing is complete.

CIL  
CRITICAL ITEMS LIST

DOCUMENT NO. 0111-711630  
RELEASE DATE Dec 14 1955  
PAGE 39 OF 40

NAME P/N QTY	CRIT	FAILURE MODE & CAUSES	FAILURE EFFECT	RATIONALE FOR ACCEPTANCE
--------------------	------	-----------------------------	----------------	--------------------------

Battery  
Pack Assy.  
SED1101665-301

1/1

106FM30:  
Internal short  
resulting in  
venting/explosion.

(1)

B. Test - (continued)

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.

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 - .210g <sup>2</sup> /Hz
100 - 400	.210g <sup>2</sup> /Hz
400 - 2000	.210 - .150g <sup>2</sup> /Hz

TURNAROUND:

After a cell configuration has been certified, each cell is usable 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.

EMUJAHGA-7

NAME P/N QTY	CRIT	FAILURE MODE & CAUSES	FAILURE EFFECT	RATIONALE FOR ACCEPTANCE
Battery Pack Assy. SED13101665-101  (1)	1/1	106FM10: Internal short resulting in venting/explosion.		<p>C. Inspection -</p> <p>During vendor cell manufacturing/acceptance test (JSC-EP5-83-025), 100 percent of the cells are manufactured under on site defense contract administration services (DCAS) delegation.</p> <ol style="list-style-type: none"> <li>Electrode plates and separator material are checked for burrs and misalignment.</li> <li>Ohmic resistance across the dry cell terminal is checked.</li> <li>Each cell is identified by a serial number.</li> <li>Prior to filling the cell with electrolyte, each cell is x-rayed in two directions to examine this assembled internal configuration.</li> <li>The cells are put in an oven at 160°F for 2 hours followed by: <ol style="list-style-type: none"> <li>OCT Test - must be greater than 3.85 volts.</li> <li>Load Test - must be greater than 3.5 volts.</li> <li>Size and weight check to verify no swelling or venting occurred.</li> </ol> </li> </ol> <p>D. Failure History - None.</p> <p>E. Ground Turnaround - None.</p> <p>F. Operational Use - None.</p>

FMEA  
 EMU FAILURE MODE, EFFECT ANALYSIS

DOCUMENT NO. 0111-711630  
 RELEASE DATE 06/14/95  
 PAGE 24 OF 40

NAME P/N QTY	FUNCTION	FAILURE MODE & CAUSES	MISSION PHASE	FAILURE EFFECT	FAILURE DETECTION FLIGHT/GROUND	TIME TO EFFECT/ ACTIONS	CRIT	REMARKS/ HAZARD	REF
Battery Pack Assembly SED13101665 -301  (1)	Provides electrical power with over temp protection and fusing.	106FH30: Internal short resulting in venting/ explosion.  CAUSE: Excessive vibration, shock or Impact. Defective separator membrane.	PreEVA EVA PostEVA	END ITEM: Explosion damaging SSA and causing suit gas leakage to ambient.  CFE INTERFACE: Rapid depressurization of SSA.  MISSION: Loss of mission.  CREW/VEHICLE: Loss of crewman.	FLIGHT: None.  GROUND: None.	None.  TIME AVAILABLE: N/A  TIME REQUIRED: N/A	1/1	A - N/A B - N/A C - N/A	

EMU/AHGA - 9