FAILURE MODE EFFECTS ANALYSIS/CRITICAL ITEMS LIST

FMEA NUMBER: EVARM-BADGE-002	ORIGINATOR: JSC	PROJECT: EVARM	

PART NAME: EVARM Badge	LRU/ORU PART NAME: EVA Radiation Monitoring Badge.	
PART NUMBER: See Remarks	LRU/ORU PART NUMBER: See Remarks	QUANTITY: 3 badges per suit
DRAWING/REF DESIG:	LCN CONTROL NO: N/A	SYSTEM: EVARM
EFFECTIVITY/AFFECT STAGE: TBD	SUBSYSTEM: EVARM	ZONE/LOCATION: EMU

CRITICALITY

CRITICAL ITEM:	Yes	SUCCESS PATHS:	1
CRITICALITY CATEGORY:	1/1	SUCCESS PATH REMAINING:	0

END ITEM NAME: EVARM Badge

END ITEM FUNCTIONAL: Collects the radiation exposure data during an EVA.

END ITEM CAPABILITY: Collects the radiation exposure data during an EVA.

REDUNDANCY SCREENS:

1. C/O PRELAUNCH: N/A
2. C/O ON ORBIT: N/A
3. DETECTION FLIGHT CREW: N/A
4. DETECTION GROUND CREW: N/A
5. LOSS OF REDUNDANCY FROM SINGLE CAUSE: N/A

FUNCTION: This experiment badge provides the means for collecting crewmember radiation exposure data during an EVA.

FAILURE MODE CODE: 18

FAILURE MODE: Shorted (Electrical)

CAUSE: (1) Component failure (this includes battery, and all board component failures); (2) Contamination; (3) Excess humidity

REMAINING PATHS: None

EFFECT/MISSION PHASE: EVA operations

CORRECTIVE ACTION: None

PREPARED BY: K. Allen		WAIVER NUMBER: N/A	
SUPERCEDING DATE: January 16, 2002		DATE: June 18, 2002	CIL REV. 1

FAILURE EFFECTS

END ITEM/LRU/ORU/ASSEMBLY:	Electrical short would cause an increase in current flow.
SUBSYSTEM/NEXT ASSEMBLY/INTERFACE:	An increase in current flow could cause an increase in temperature inside the case. This could cause degradation of the potting, circuit board epoxy coating, and Lexan case seal materials.
SYSTEM/END ITEM/MISSION:	Degradation of the materials could cause an increase in pressure (due to out gassing), which could cause a breach in the hermetic seal allowing the internal circuitry to be exposed to the 100% oxygen environment.
CREW/VEHICLE:	Loss of EVA crewmember due to ignition of materials in a high oxygen environment.

HAZARD INFORMATION

HAZARD:	Use of electronics within EMU suit; Battery Leakage or Rupture
HAZARD ORGANIZATION CODE:	N/A
HAZARD NUMBER:	EVARM-3; EVARM-1, document #LS-71066-2

TIME TO EFFECT:	Immediate
TIME TO DETECT:	Immediate
TIME TO CORRECT:	N/A
FAILURE DETECTION:	There is no failure detection prior to the event occurring.

REMARKS

The Extra-Vehicular Activity (EVA) Radiation Monitoring (EVARM) experiment is composed of 4 sets of 3 badges (one for the head, torso and leg areas), and a badge reader. There are 10 batteries in each badge, in series, that provide 30 V power to the system. A Renata CR1025 Lithium Manganese Dioxide battery is used in the badge. It is constructed with a double separator system, which reduces the self-discharge of the cells. The electrolyte is non-aqueous using an organic solvent. The cell has a hermetic seal to protect against humidity. The nominal capacity of the cell is 30mAH.

The EVARM part numbers are:

Head Dosimeter Badge: 600-100028
Torso Dosimeter Badge: 600-100029
Leg Dosimeter Badge: 600-100030

RATIONALE FOR ACCEPTABILITY

DESIGN:

1 The badges are designed to operate in a 100% oxygen environment. They meet the requirements of NSTS 22648, sections 2 and 6.1 as well as SVHS 7800 ("Environmental Control Equipment, EMU, General Mechanical Specification."

1 The battery has been approved for flight use by EP5.

2, 3 The batteries are shrink-wrapped in sets of 2 prior to attachment to the board.

1, 2, 3 The circuit board is conformal coated.

1, 2, 3 The connector is potted and attached to the threaded Lexan housing using a silicone epoxy (Hysol). Potential ignition sources due to pin shorts are eliminated by the incorporation of 10 MΩ resistors on each pin circuit.

1, 2, 3 The badges are hermetically sealed using a cyano-acrylate adhesive. Section 5.4 of Document 101408.03: EVARM Badge Assembly Procedure dictates the procedure used for sealing the badge. First – small holes (2) are drilled in the casing, and two needles are positioned and sealed in place. A 1/16” to 1/8” gap is left between the base of the connector and the surface of the Lexan case for the tesher on the connector covers. The edges of the Lexan cover are secured together using ZAP Lexan glue. The badge is then injected with Hysol, being turned as necessary to fill the badge completely. The needles are removed and the holes are covered with clear tape. Excess hysol is wiped away. The badge is baked at 60 °C for 48 hours. A test container of similar size and shape is baked alongside the badge. After 48 hours, the test container is inspected (by being sawed in half) for Hysol hardness, and the badge returns for another 24 hours if the Hysol is not set. The tape is removed and the badges undergo functional testing according to procedure #TN101410.

1, 2, 3 The circuit board and batteries are encapsulated in Hysol by injection after the badge is sealed.

2 The EVARM is cleaned to level Visibly Clean Level 1 (Sensitive), as required by SN-C-005, Specification Contamination Control Requirements.

TESTING/ANALYSIS:

1, 2 Short circuit testing was performed by Thomson & Nielsen Electronics Ltd., Document number 101212.02. The peak current in the battery was shown to be less than 6 mA, and the maximum temperature was 28 ºC, an approximate rise of 4 ºC.

1, 2 The EVARM was Qualification and Acceptance Thermal tested per the Thermal test Plan, Document number 101423.02. Visual, functional and electrical tests all passed. No defects were seen.

1, 2 The EVARM badges were tested for extreme pressure and vibration environments per document number 101419.02 (EVARM TSP-05 Air pressure Test Plan) and 101417.02 (EVARM TSP-03 Vibration Test Plan). No failures were seen during these tests.

1, 3 The EVARM was submerged in water for 8 hours, and then the function was verified. No failures were seen.

INSPECTION:

An inspection is completed prior to delivery of the hardware for compliance to the drawing. Vendor certificate of compliance shows the hardware is built to approved drawings and parts list.

FAILURE HISTORY:

There is no documented failure history for this hardware.

OPERATIONAL:

There are no operational procedures in place to prevent failures.

MAINTAINABILITY:

There is no maintenance to be performed on this hardware.