NAME P/N QTY	CRIT	FAILURE MODE & CAUSES	FAILURE EFFECT	RATIONALE FOR ACCEPTANCE
		102FM21		
BELLOWS ASSEMBLY, ITEM 102 (1) LEFT (1) RIGHT ---------- 0102-82438-17/18 (2)	1/1	External gas leakage beyond SOP makeup capability.	END ITEM: Suit gas leakage to ambient.	A. Design - The bellows is fabricated from a neoprene-cemented composite of neoprene-coated dacron and neoprene-coated nylon ripstop. The bellows is attached to the HUT and the gimbal via a retained bead mechanism and sealed with neoprene adhesive N-136. At the gimbal attachment, the bead is retained by a wrapping of polyester cord potted with Resi-weld adhesive. At the HUT attachment, the bead is retained by a fiberglass ring and RTV-102. Additionally the ring is held in place by two clamps with self locking screws.
		Defective Material: worn fabric. Inadequate/defec- tive bond to HTS, or Gimbal. Loss of bellows fiberglass retaining ring.	GFE INTERFACE: Depletion of primary O2 supply and SOP. Rapid depressurizatio n of SSA beyond SOP makeup capability.	Wear of the fabric material is precluded by the rolling action of the bellows and interface clearance of the HUT and the gimbal. By design, the bellows is subjected to internal SSA gas pressures only; all man loading and plug loading is carried by the gimbal pivots and, at the limits of gimbal travel, by the gimbal stop straps. The stop straps also preclude applying any loading to the bonded interfaces; the adhesives serve as sealants only and experience no loading due to the gimbal action.
			MISSION: Abort EVA.	The bellows is designed to withstand a minimum ultimate pressure of 11.0 psig. This provides a minimum ultimate factor of safety of 2.0 over the maximum normal operating pressure of 5.5 psig.
			CREW/VEHICLE: Loss of crewman.	Inadequate and defective bonds are precluded by proper surface preparation and cleaning, surface finish, selection of appropriate adhesives/materials for the application, and maximum bonding surface area.
			TIME TO EFFECT /ACTIONS: Seconds. TIME AVAILABLE: N/A TIME REQUIRED: N/A REDUNDANCY SCREENS: A-N/A B-N/A C-N/A	B. Test - Acceptance: Peel test samples are produced and tested for each bellows that is fabricated. The following minimum values are verified for each bellows: Bellows Construction layer 13 lbs/in. Seam Construction 7 lbs/in. PDA: The following tests are conducted at the HUT Assembly level in accordance with ILC Document 0111-70028J. 1. Initial leak test at 4.3 +/- 0.1 psig to verify leakage less than 21.0 scc/min. 2. Proof pressure test at 8.0 + 0.2 - 0.0 psig to verify no structural damage. 3. Post-proof pressure leak test at 4.3 +/- 0.1 psig to verify leakage less than 21.0 scc/min. 4. Final leak test at 4.3 +/- 0.1 psig to verify leakage less than 21.0 scc/min. Certification: The bellows were successfully tested (manned) during SSA certification to duplicate operational life. (Ref. EM 83-1083, ILC Report 0111-70027 and EM 98-0008). The following usage reflecting requirements of significance to the bellows was documented during certification: Requirement S/AD Actual ---------- ---- ------ Shoulder Abd/Add 10142 15260

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Shoulder Lat/Med	10142	15260
Shoulder Flex/Ext	10142	15260
Don/Doff Cycles	144	364
Pressure Hours	461	612
Pressure Cycles	432	436

The bellows were successfully subjected to an ultimate pressure of 13.2 psid during SSA certification testing (Ref. ILC Report 0111-79405). This is 1.5 times the maximum BTA operating pressure based on 8.8 psid.

C. Inspection -
Components and material manufactured to ILC requirements at an approved supplier are documented from procurement through shipping by the supplier. ILC incoming receiving inspection verifies that the materials received are as identified in the procurement documents, that no damage has occurred during shipment and that supplier certifications have been received which provides traceability information.

Inspection to Table of Operation (T/O) requirements conducted during fabrication of the bellows includes verification of materials control, pattern piece parts, critical characteristics (seams, beads, lack of wrinkles, etc.), and cleanliness.

Inspection to Table of Operation (T/O) requirements during HUT assembly, of specific significance to the bellows installation, includes verification of materials control, surface preparation, bellows/gimbal installation and alignment, potting and cure, bellows/HUT installation and cure, and bellows retaining ring installation RTV cure and retaining ring clamp screw torque.

D. Failure History -
No history of failure mode to date. However, the following failures have occurred that were within SOP makeup capability:

1. ILC-EMU-102-010 (04/05/79) Leakage from bellows fabric. Puncture from screwdriver during assembly. ECO 0793-0790 revised assembly procedure.
2. ILC-EMU-102-016 (09/29/79) Leakage between bellows and gimbal. Thin spots in neoprene coating of fabric. ECO 792-1607 modified tooling used for manufacture.
3. ILC-EMU-102-019 (10/09/79). See 2 above.
4. I-EMU-102--002 - Worn spot on bellows. Cause unknown, inspection added to field procedure in order to visually detect subject anomaly.
5. B-EMU-102-A008 (04/5/89). Leakage due to cut/abrasion in left arm bellows caused by foreign object/tool damage which propagated through the material during cyclic operation. No corrective action taken.
6. B-EMU-102-A019 (10/12/90). A WETF HUT/scye gimbal bellows exhibited material degradation/leakage in a three corner fold or kink occurring in the bellows circular fold around the gimbal perimeter. When the gimbal pivots, these three corner folds move axially along the bellows causing high stress/wear spots. No corrective action because failure occurred in a WETF HUT bellows with high time usage and a water environment which accelerated material degradation. This condition would probably not occur within the Class I flight units 461 hour life time.
7. B-EMU-102-A021 (10/12/92) - Leakage in right arm of class III WETF bellows due to cut in dacron fabric from unidentified foreign sharp object. Class I sharp object requirements added to WETF FEMU-R-001 procedures. Gear processing

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personnel given sharp object awareness training.
8. B-EMU-102-A026 (03/15/94) - The left and right HUT bellows were installed in the opposite Scye bearing openings during routine processing at BAO. ECO 942-0136 verifies bellows orientation during new HUT builds and bellows replacements.
9. B-EMU-102-A027 (10/14/94) - During break-in cycling, the right arm bellows of the HUT exhibited two small delaminations on the inside (crewmember) side seam where the bellows meets the gimbal ring. Subsequent cyclic testing (182 hours) revealed that the delaminations did not propagate or leak. No corrective action taken.

E. Ground Turnaround -
Tested per FEMU-R-001, Pre-Flight Final SEMU Gas Structural and Leakage.

F. Operational Use -
1. Crew Response -

Pre/PostEVA: If during airlock operations, repress airlock, otherwise consider third EMU if available. EMU no go for EVA.
EVA: When CWS data confirms SOP activation, abort EVA.

2. Training - Standard training covers this failure mode.

3. Operational Considerations -

EVA checklist procedures verify hardware integrity and systems operational status prior to EVA. Flight rules define go/no-go criteria related to EMU pressure integrity. Real Time Data System allows ground monitoring of EMU systems.

EXTRAVEHICULAR MOBILITY UNIT

SYSTEMS SAFETY REVIEW PANEL REVIEW

FOR THE

I-102 HARD UPPER TORSO (HUT)

CRITICAL ITEM LIST (CIL)

EMU CONTRACT NO. NAS 9-97150

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