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BRIEF ASSEMBLY ITEM 104 ---------- 0104-811071-04 (1)	1/1	External gas leakage beyond SOP makeup capability Separation of seam in bladder. Defective material: abrasion or puncture.	END ITEM: Suit gas leakage to ambient. GFE INTERFACE: Depletion of primary O2 supply and SOP. Rapid depressurizatio n of SSA beyond SOP makeup capability. MISSION: Loss of EVA. CREW/VEHICLE: Loss of crewman. TIME TO EFFECT /ACTIONS: Seconds. TIME AVAILABLE: N/A TIME REQUIRED: N/A REDUNDANCY SCREENS: A-N/A B-N/A C-N/A	A. Design - The bladder assembly is formed from a series of patterned pieces of urethane coated nylon oxford fabric, and seamed together by dielectric heat, to which flanges are also heat sealed. The bladder seams (and boot flange for Non-Enhanced) are reinforced by heat-sealed overtaping to enhance structural integrity. The waist bearing flange is overtaped using adhesive bonding for the Non-Enhanced Assembly. For the enhanced assembly, the waist bearing flange is heat-sealed to the bladder; the bladder seams and flanges are reinforced by heat sealed overtaping to enhance structural integrity. The solution coated bladder is protected internally in known areas of high wear, by an additional heat sealed abrasion layer. Externally, the bladder is protected by the restraint fabric and TMG layers. As a component of the lower torso (non-enhanced), or brief (enhanced), the bladder is entirely supported by the restraint assembly. The bladder is thereby not subjected to any of the loads (man or pressure induced) experienced by the lower torso restraint. Seam design creates a structure at least as strong as the base bladder. Thus, seam separation is precluded. There are two types of bladder fabric. One is constructed of a base nylon fabric with a solution coated urethane. The other is constructed of the same base nylon with a urethane laminate coating. The following paragraph applies to the solution coated nylon. Testing has shown that the bladder fabric minimum tensile strength is 105 lbs/inch (fill) and 140 lbs/inch (warp). The tearing strength is 3.5 lbs/inch in fill and 6.0 lbs/inch in warp. Nominally, hoop load is absorbed by the bias direction of the bladder fabric. However, the safety factors are based on the fabric yarns (fill yarns) which have the least strength. Based on a predicted hoop load of 35.2 lbs/inch at 4.4 psid (normal operating pressure), the minimum safety factor for hoop stress is 3.0. At 5.5 psid (max failure pressure) and at 8.8 psid (max BTA operating pressure) the safety factors are 2.4 and 1.5 respectively. The S/AD minimum safety factor for softgoods at 4.4 psid is 2.0. At both 5.5 and 8.8 psid, the S/AD minimum safety factor is 1.5. Testing has demonstrated that the breaking strength of the bladder seams meets or exceeds that of the bladder fabric. The following paragraph applies to the laminate coated nylon. Testing has shown that the bladder fabric minimum tensile strength is 180 lbs/inch in the fill direction and 170 lbs/inch in the fill direction. The tearing strength is 3.5 lbs/inch minimum in both directions. Based on a predicted hoop load of 35.2 lbs/inch, the minimum safety factor for hoop stress is 4.8 against a S/AD design minimum ultimate safety factor of 2.0 at 4.4 psid (normal operating pressure). At 5.5 psid (max failure pressure) and at 8.8 psid (max BTA operating pressure) the safety factors are 3.8 and 2.4, respectively. The presence of abrasion layers, restraint and TMG, along with the physical properties of the bladder, make inadvertent puncture or abrasion unlikely. B. Test - Acceptance: As required by the Table of Operations (T/O) for the fabrication of the bladder assembly, heat seal samples and adhesive seam samples (flange overtape) are

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tensile tested and peel tested, respectively, to verify seam acceptability. Heat seal samples for test are taken at the start of each work shift and immediately after each machine change, tool change, machine setting change and/or each material lay-up or material lot change.
Heat seam samples are made using production tooling and from the same portion of the roll as the material being heat sealed in production. Peel test samples are produced and tested for each bladder assembly production lot.

Following fabrication, each bladder assembly is assembled into a test restraint and subjected to a leakage test at

4.3 psig to verify leakage less than 10.0 scc/min for non-enhanced and less than 8.0 scc/min for enhanced.

PDA:
The following tests are conducted at the LTA level in accordance with ILC Document 0111-710112:
1. Initial leak test at 4.3 +/- 0.1 psig to verify leakage less than 46.5 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 46.5 scc/min.
4. Final leak test at 4.3 +/- 0.1 psig to verify leakage less than 46.5 scc/min.

When delivered as a separable component of the LTA, the following tests are conducted at the Assembly level in accordance with ILC Document 0111-710112:
1. Initial leakage at 4.3 +/- 0.1 psig to verify leakage less than 8.0 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 8.0 scc/min.
4. Final leakage at 4.3 +/- 0.1 psig to verify leakage less than 8.0 scc/min.

Certification -
The brief bladder assembly was successfully tested (manned) to duplicate 458 operational life (Ref. ILC Report 0111-711330). The following usage, reflecting requirements of significance to the brief bladder assembly, was documented during certification:

Requirement	S/AD	Actual
Hip Abd/Add	458	1200
Hip Flex/Ext	1524	3200
Waist Flex/Ext	1234	2800
Waist Rotation	2466	6000
Don/Doff	98	400
Pressure Hours	458	916

The brief bladder assembly was successfully subjected to an ultimate pressure of 13.2 psid during SSA certification testing (Ref. ILC Report 0111-711330). This is 1.5 times maximum BTA operating pressure based on 8.8 psid.

The bladder assembly (laminate coated urethane) was successfully tested (manned) during SSA certification to duplicate 458 hours of operational life (Ref. ILC

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Report 0111-712436). The following usage, reflecting requirements of significance to the bladder assembly, was documented during certification:

Requirement	S/AD	Actual
Hip Add/Abd	458	1200
Hip Flex/Ext	1524	3200
Waist Flex/Ext	1234	2800
Waist Rotation	2466	5200
Don/Doff	98	205
Pressure Hours	458	983

The bladder assembly was successfully subjected to an ultimate pressure of 13.2 psid during SSA certification testing (Ref. ILC Report 0111-712436). 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 provide traceability information.

Where applicable, the following MIP's are performed during the LTA manufacturing process to assure that the failure causes are precluded from the fabricated item:
1. Visual inspection of abrasion layer heat seal for delamination.
2. Visual inspection of bladder, before overtaping and flange installation, to classification of defects criteria.
3. Visual inspection of heat seal width.
4. Visual inspection of reinforcement tapes and flanges for positioning and bond acceptability.
5. Verification of seam acceptability test results.

During PDA, the following inspection points are performed at the lower torso assembly level in accordance with ILC Document 0111-710112:
1. Visual inspection for material degradation.
2. Visual inspection for structural damage following proof pressure test.

When delivered as a separable component of the LTA, the following inspection points are conducted at the Trouser Assembly level in accordance with ILC Document 0111-710112:
1. Visual inspection for material degradation.
2. Visual inspection for structural damage following proof pressure test.

D. Failure History -
B-EMU-104-A061 (3/22/99) -
Visual defect in coating of bladder in the brief flange area. Defect is a surface condition that does not extend through to the base fabric. Root cause not identified, but class II ECO 992-0309 generated to add specific text to the current visual inspection to assist in identifying these type of conditions. Pre-flight visual inspections and leakage tests per FEMU-R-001 exist to identify such anomalies.

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B-EMU-104-T008 (3/22/99)
Abraded hole in restraint material (NBL unit) on the outboard side of the crewmember's left leg caused by contact against the top of the bracket on the thigh side of the brief. This condition has only occurred in NBL gear. Studies have determined that restraint fabric wears significantly faster when subjected to abrasion in water and this failure condition should not occur in class I or Class II briefs within their certified life. Pre-flight visual inspections and leakage tests per FEMU-R-001 exist to identify such anomalies.

B-EMU-104-T009 (4/2/99)-
"T" pin found sticking out of the rear left upper leg area of the brief between the Mylar and Ortho layer of the (class III) TMG. Following manufacture and repair/rework involving exposed TMG layers, TMG's are X-rayed at ILC for foreign objects. Per CCBD H6972, class I/II and class IIIW sections of FEMU-R-001 have been revised to specify post-repair screening for foreign metallic objects. Additionally, pre-flight inspections per FEMU-R-001 exist to identify such anomalies.

E. Ground Turnaround -
Tested for non-EET processing per FEMU-R-001, Pre-Flight LTA Leakage Test. None for EET processing.

Additionally, every 4 years or 229 hours of manned pressurized time the lower torso restraint and bladder assembly is removed from the LTA and subjected to complete visual inspection for material degradation or damage.

F. Operational Use -
1. Crew Response -
EVA : When CWS data confirms SOP activation, abort EVA.
2. Special Training -
Standard training covers this failure mode.
3. Operational Consideration -
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.

EXTRAVEHICULAR MOBILITY UNIT

SYSTEMS SAFETY REVIEW PANEL REVIEW

FOR THE

I-104 LOWER TORSO ASSEMBLY (LTA)

CRITICAL ITEM LIST (CIL)

EMU CONTRACT NO. NAS 9-97150

Prepared by: _____
HS - Project Engineering

_____
HS - Reliability

_____ 4/24/02
HS - Engineering Manager

Approved by: _____ 21 MAY 02
NASA – SSA/SSM

_____ 5/24/02
NASA – EMU SSM

_____ 5.29.02
NASA – S&MA

_____ 5-30-02
NASA – MOD

_____ 6/04/02
NASA – CTOW

_____ 6/3/02
NASA – Program Manager