NAME P/N QTY	CRIT	FAILURE MODE & CAUSES	FAILURE EFFECT	RATIONALE FOR ACCEPTANCE
		104FM28W		
LEG RESTRAINT AND BLADDER ASSEMBLY ITEM 104 (1) LEFT (1) RIGHT ---------- 0104-810467-02 (2)	1/1	External gas leakage beyond SOP make-up capability. Separation of seam or puncture in bladder. Defective material abrasion.	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 leg bladder assembly is formed from a series of patterned pieces of urethane coated nylon oxford fabric, seamed together by dielectric heat, to which flanges are also heat sealed. The bladder seams 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. The bladder is entirely supported by the leg 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 17.2 lbs/inch at 4.4 psid (normal operating pressure), the minimum safety factor for hoop stress is 6.2. At 5.5 psid (max failure pressure) and at 8.8 psid (max BTA operating pressure) the safety factors are 4.9 and 3.0, 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 warp 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 17.2 lbs/inch, the minimum safety factor for hoop stress is 9.8 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 7.9 and 4.8, 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 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 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

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		104FM28W		

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 6.0 scc/min.

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 were conducted at the Leg Assembly level in accordance with ILC Document 0111-710112:
1. Initial leakage at 4.3 +/- 0.1 psig to verify leakage less than 6.0 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 6.0 scc/min.
4. Final leakage at 4.3 +/- 0.1 psig to verify leakage less than 6.0 scc/min.

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

Requirement	S/AD	Actual
Knee Cycles	9078	20000
Don/Doff	98	400
Pressure Hours	458	916
Walking Steps	4320	77760

The leg restraint and bladder assembly was successfully subjected to an ultimate pressure of 13.2 psid during SSA certification testing (Ref. ILC Document 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 Report 712436). The following usage, reflecting requirements of significance to the bladder assembly, was documented during certification:

Requirement	S/AD	Actual

NAME P/N QTY	CRIT	FAILURE MODE & CAUSES	FAILURE EFFECT	RATIONALE FOR ACCEPTANCE
		104FM28W		

Knee Cycles	9078	18,400
Don/Doff	98	205
Pressure Hours	458	983
Walking Steps	4320	8,640

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 traceabiltiy information.

Where applicable, the following MIPs 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 leg 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 -
None.

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 chronological time or 229 hours manned pressurized time, the leg restraint and bladder assembly is removed from the LTA and subjected to complete visual inspection for material degradation or damage.

F. Operational Use -
Crew Response -
EVA: When CWS data confirms SOP activation, abort EVA.

Special Training -

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		104FM28W		Standard training covers this failure mode. 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: _____
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Approved by: _____ 21 MAY 02
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