NAME P/N QTY	CRIT	FAILURE MODE & CAUSES	FAILURE EFFECT	RATIONALE FOR ACCEPTANCE
		103FM07		
UPPER ARM RESTRAINT AND BLADDER ASSEMBLY, ITEM 103 (1) LEFT (1) RIGHT ---------- 0103-89953-04 (2)	2/1RB	Loss of fabric restraint. Separation of seam or hole in fabric. Defective thread, restraint material.	END ITEM: Opening in fabric restraint exposing bladder. Loss of restraint circumferential load carrying capability. GFE INTERFACE: Loading and abrading of bladder. MISSION: None. CREW/VEHICLE: None with single failure. Loss of crewman with loss of bladder. TIME TO EFFECT /ACTIONS: Seconds. TIME AVAILABLE: Minutes. TIME REQUIRED: Immediate. REDUNDANCY SCREENS: A-PASS B-FAIL C-PASS	A. Design - The upper arm assembly fabric restraint is fabricated from 6.4 ounce dacron fabric which exhibits a minimum tensile strength of 300 lb/in (warp) and 250 lb/in (fill). At 4.4 psid (normal operating pressure) the hoop load is 18.7 lb/in giving the restraint fabric an ultimate safety factor of 16.0 for warp and 13.4 for fill. At 5.5 psid (max failure pressure) the restraint fabric provides ultimate safety factors of 12.8 for warp and 10.7 for fill. At 8.8 psid (max BTA operating pressure), the restraint fabric provides ultimate safety factors of 8.0 for warp and 6.7 for fill. S/AD minimum safety factors for softgoods at 4.4 psid is 2.0 for ultimate. At both 5.5 psid and 8.8 psid, the S/AD minimum safety factor for softgoods is 1.5 for ultimate. The basic seam employed in the construction of the arm restraints is a double row of top stitching over a single row of joint stitching. Structural testing has determined that seam strength is equal to or better than the strength of the restraint material. The upper arm bladder assemblies are 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 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 abrasion layer. There are two types of bladder fabric. One is contracted of a base nylon fabric with a solution coated urethane. The other is contracted 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, the bladder is unloaded with the restraint taking the load. If the bladder were to be loaded, the hoop load would be 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 18.7 lbs/inch, the minimum safety factor for hoop stress is 5.6 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 fabric ultimate safety factors are 4.5 and 2.8 against hoop loads of 23.4 and 37.4 lbs, respectively. The S/AD required minimum ultimate safety factor at 5.5 and 8.8 psid 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. Nominally, the bladder is unloaded with the restraint taking the load. If the bladder were to be loaded, the hoop load would be absorbed by the bias direction of the bladder fabric. The minimum strength value, 170 lbs/inch is therefore used for determining safety factors. Based on a predicted hoop load of 18.7 lbs/inch, the minimum safety factor for hoop stress is 9.1 against a S/AD design minimum ultimate safety factor of 2.0

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at 4.4 psid (normal operating pressure). At 5.5 psid (max failure pressure) and at 8.8 psid (max BTA operating pressure), the fabric ultimate safety factors are 7.2 and 4.5 against hoop loads of 23.4 and 37.4 lbs, respectively. The S/AD required minimum ultimate safety factor at 5.5 and 8.8 psid is 1.5. Testing has demonstrated that the breaking strength of the bladder seams meets or exceeds that of the bladder fabric.

B. Test -
Acceptance:
Component, see inspection for acceptance.

PDA:
The following test is conducted at the arm assembly level in accordance with ILC Document 0111-710112:

Visual examination for structural damage following a Proof pressure test at 8.0 + 0.2 - 0.0 psig for a minimum of 5 minutes conducted with the TMG removed.

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

Requirement	S/AD	Actual
Add/Abd	8484	18000
Lateral/Medial	4092	10000
Flex/Extension	7430	16000
Don/Doff Cycles	98	400
Pressure Hours	458	916

The upper arm restraint 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.

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 the supplier certifications have been received which provide tractability information.

MIP's are performed for inspection of sewn seams during the arm restraint manufacturing process to assure that this particular failure cause is precluded from the fabricated item.

During PDA, the following inspection points are performed at the Arm assembly level in accordance with ILC Document 0111-710112:

Visual inspection for damage, wear or material degradation. Inspection of

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EXTRAVEHICULAR MOBILITY UNIT

SYSTEMS SAFETY REVIEW PANEL REVIEW

FOR THE

I-103 ARM ASSEMBLY

CRITICAL ITEM LIST (CIL)

EMU CONTRACT NO. NAS 9-97150

Prepared by: _____
HS - Project Engineering

Approved by: _____
NASA - SSA/SSM

_____
HS - Reliability

_____
NASA - EMU/SSM

_____ 4/24/02
HS - Engineering Manager

_____ 6/26/02
NASA - S&MA

_____ 6/27/02
NASA - MOD

_____ 7/1/02
NASA - Crew

_____ 7-1-02
NASA - Program Manager