NAME P/N QTY	CRIT	FAILURE MODE & CAUSES	FAILURE EFFECT	RATIONALE FOR ACCEPTANCE
		106FM04		
RESTRAINT, 4000, ITEM 106 (1) LEFT (1) RIGHT --- 0106-88936-11/12 (2) RESTRAINT, PHASE VI, ITEM 106 (1) LEFT (1) RIGHT --- 0106-812146-01/02 (2) --- 0106-812146-03/04 (2)	1/1	Loss of gimbal ring/wrist convolute rings/upper primary sheath. 4000/Phase VI: Defective material, impact. Phase VI: Defective fabric or broken stitching or cord.	END ITEM: Loss of primary/secondary axial restraining capability. GFE INTERFACE: Suit gas leakage to ambient. Depletion of primary O2 supply and SOP. Rapid depressurization of SSA beyond SOP makeup capability. MISSION: Abort 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 - 4000: The gimbal ring is fabricated from 17-4 PH stainless steel heat treated to H1050. Tensile testing of the gimbal ring demonstrated a minimum yield strength of 650 lbs and an ultimate strength of 1750 lbs. This provides a yield factor of safety of 2.81 and an ultimate factor of safety of 7.58 against the total glove assembly wrist limit load of 162 lbs. Structurally, gimbal ring factors of safety against yield and ultimate exceed S/AD requirements of 1.5 and 2.0 by factors of 1.87 and 3.79, respectively. The glove is covered by the TMG which protects the gimbal ring from impact. Phase VI: The gimbal rings are fabricated from 17-4 PH stainless steel heat treated to a 1050. Tensile testing of the gimbal rings demonstrated a minimum yield strength of 860 lbs and minimum ultimate strength of 1345 lbs. This provides a minimum yield factor of safety of 2.0 and an ultimate factor of safety of 3.1 against the total glove assembly wrist limit loads of 429 lbs (214.5 per side). The glove is covered by the TMG which protects the gimbal ring from impact. The upper primary attaches the upper gimbal ring to the restraint. The upper primary restraint system consists of a 6.0 oz polyester fabric reinforcement (.5" X 4") basted to a 6.0 oz polyester fabric sheath. The sheath includes a polyester cord captured in the seam allowance along the full length of each long side. There are two sheath assemblies, one for the front of the glove and one for the back. The assemblies are stitched to the restraint using four rows of 200 denier Kevlar thread. The Kevlar stitching stops .375" short of the ends of the sheath on either side. There are four polyester "E" bartacks, one each, at the ends of the Kevlar stitching that connects the end points. The upper primary is attached to the gimbal rings by wrapping the sheathes around the ring and lacing through the sheath with a lightweight Spectra cord. The upper primary has a tensile strength of 672.5 lbs demonstrating a minimum safety factor of 3.1 against a limit load of 214.5 lbs. B. Test - Acceptance: 4000/Phase VI: Component - See Inspection. PDA: 4000/Phase VI: The following test is conducted at the Glove Assembly level in accordance with ILC Document 0111-70028 (4000 glove) or 0111-710112 (Phase VI glove): Proof pressure test at 8.0 (+ 0.2 - 0.0) psig for a minimum of 5 minutes conducted with the TMG removed. Certification: 4000: The glove assembly was successfully tested (manned) during SSA certification to duplicate operational life. The following usage, reflecting requirements of significance for the 4000 series

NAME P/N QTY	CRIT	FAILURE MODE & CAUSES	FAILURE EFFECT	RATIONALE FOR ACCEPTANCE
		106FM04		

glove, was documented during certification (Ref. ILC Document 0111-77511):

Requirements	S/AD	Actual
Glove Joint Cycles		
Flex/Ext (Fingers)	42,412	56,726
Wrist Joint Cycles		
Add/Abd	21,206	29,484
Flex/Ext	21,206	29,484
Rotations	21,206	29,484
Pressurized Hours	461	615
Pressurized Cycles	432	576
Don/Doff	144	192

Per EM # 93-1131:
Secondary Axial Restraint Requirements:

Requirement	S/AD	Actual
Flex/Ext(Fingers)	8372	56420
Flex/Ext(Wrist)	4186	16120
Add/Abd(Wrist)	4186	21700
Rotation(Wrist)	4186	25420
Pressure Cycles	32	196

The glove assembly was successfully subjected to an ultimate pressure of 13.2 psig during SSA certification testing. This is 1.5 times the BTA maximum operating pressure of 8.8 psig. Recertification to 5.5 was by test and analysis (Ref. ILC EM 84-1108).

Phase VI:
The glove restraint assembly was successfully tested (manned) during certification testing to duplicate operational usage (Ref. Certification Test Report for the Phase VI Glove, ILC Doc. 0111-712701). The following usage, reflecting requirements of significance to the glove restraint assembly, was documented during certification testing. The S/AD applies 229 hours in certification while the actual indicates 198 hours toward the Phase VI glove restraint in the Hamilton Sundstrand Limited Life Items list (EMU1-19-001).

Requirements	S/AD	Actual
Glove Joint Cycles		
Flex/Ext (fingers)	45142	39169
Wrist Joint Cycles		
Add/Abd	17104	14830
Flex/Ext	12646	10830
Rotations	20112	17393
Pressurized Hours	229	198
Pressurized Cycle @ 4.3 psig	97	99
5.3 psig	37	63
6.6 psig	16	18
Don/Doff Cycles	49	49

NAME P/N QTY	CRIT	FAILURE MODE & CAUSES	FAILURE EFFECT	RATIONALE FOR ACCEPTANCE
		106FM04		

The glove assembly was successfully subjected to an ultimate pressure of 13.2 psig during Certification Testing (Ref. ILC doc 0111-712701). This is 1.5 times the maximum BTA operating pressure based on 8.8 psig.

C. Inspection -
4000/Phase VI:
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.

4000:
Gimbal rings are subjected to NDT radiographic (casting) and magnetic particle (machined) inspection.

During PDA, the following inspection points are performed at the glove assembly level in accordance with ILC Document 0111-70028J:
1. Visual inspection for fabric or material degradation.
2. Visual inspection for structural damage following proof pressure test.

Phase VI:
The following MIP's are performed for visual inspection during the glove manufacturing process to assure that this particular failure cause is precluded from the fabricated item:
1. Perform visual inspection of wrist assembly.

During PDA, the following inspection points are performed at the glove assembly level in accordance with ILC Document 0111-70028 (4000 glove) or 0111-710112 (Phase VI glove):
1. Visual inspection for fabric or material degradation.
2. Visual inspection for damage following proof pressure test and restraint loading.

D. Failure History -
4000/Phase VI:
None.

E. Ground Turnaround -
4000/Phase VI:
During ground turnaround, in accordance with FEMU-R-001, the glove (with TMG removed) including gimbal ring is visually inspected for structural integrity, material degradation or damage, and proper operation of gimbal ring swivels. Every 56 hours of manned pressurized time on the 4000 the gimbal ring is demated from the glove swivels and completely inspected for structural integrity, material damage or degradation.

F. Operational Use -
4000/Phase VI:
Crew Response -
Pre/Post EVA: If during airlock operations, repress airlock. Consider use of backup gloves.

NAME P/N QTY	CRIT	FAILURE MODE & CAUSES	FAILURE EFFECT	RATIONALE FOR ACCEPTANCE
		106FM04		EVA: When CWS data confirms SOP activation, abort EVA. Special Training - Standard training covers this failure mode. Operational Considerations - Flight rule A15.1.2-2 of "Space Shuttle Operational Flight Rules", NSTS-12820 defines go/no go criteria related to EMU pressure integrity. Generic EVA Checklist, JSC-48023, procedures Section 3 (EMU Checkout) and 4 (EVA prep) verify hardware integrity and systems operational status prior to EVA. Real Time Data System allows ground monitoring of EMU systems.

EXTRAVEHICULAR MOBILITY UNIT

SYSTEMS SAFETY REVIEW PANEL REVIEW

FOR THE

I-106 GLOVE ASSEMBLY

CRITICAL ITEM LIST (CIL)

EMU CONTRACT NO. NAS 9-97150

Prepared by: _____
HS - Project Engineering

_____
HS - Reliability

_____
HS - Engineering Manager

Approved by: _____
NASA – SSA/SSM

_____
NASA – EMU/SSM

_____
NASA – S&MA

_____
NASA – MOD

_____
NASA – Crew

_____
NASA – Program Manager