NAME P/N QTY	CRIT	FAILURE MODE & CAUSES	FAILURE EFFECT	RATIONALE FOR ACCEPTANCE
		104FM01		
BODY SEAL CLOSURE, ITEM 104 --- A/L 9787-07 (1)	1/1	External gas leakage beyond SOP makeup capability. Contamination, wear, or deterioration of lip seal or O-ring, defective helicoils.	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: Abort EVA. CREW/VEHICLE: Loss of crewman. TIME TO EFFECT /ACTIONS: Seconds. None. TIME AVAILABLE: N/A TIME REQUIRED: N/A REDUNDANCY SCREENS: A-N/A B-N/A C-N/A	A. Design - The Body Seal Closure (BSC) housing is designed with a groove in the inner diameter to allow for the fit of a lip seal which acts as the pressure seal between the LTA and HUT side BSC. The lip seal is made of polyurethane and is lubricated lightly with Krytox grease to preclude wear. The leading edge of the mating half to this disconnect is ramped to prevent damage to the lip seal during mating. Once mated, the seal becomes static and is not subject to wear from relative motion. A Fluorosilicone "O" ring is mounted on the housing of the BSC to preclude leakage between the BSC and waist flange. The "O" ring is in a static condition and is unlikely to be damaged or degraded during usage. Proper lead-in, chamfers and radii on mating hardware components preclude damage to "O"-ring during installation. The body seal closure housing is made from 7075-T73 aluminum with latches of 17-4 stainless steel heat treated to the 1050 condition. Loading from plug pressure and man loads are reacted at the two latches per side which are in line with the waist restraint. Under normal conditions the minimum factor of safety is 2.61 vs. yield and occurs at the area in the housing above the latch. For a single latch failure the load will increase on the remaining latch resulting in a factor of safety of 1.56 vs. yield against the SAD requirement of 929 lb per axial restraint. Loss of clamping ring screws is precluded in design by adherence to standard engineering torque (20-24in.-lb) requirements for screw installation. Testing, during the screw thread engagement study showed that the lowest ultimate thread shear out safety factor for the BSC axial restraint ring screw is 4.1. Design requirements for proper installation of helicoils are specified in the assembly procedures when the helicoils are installed in the BSC. B. Test - Component Acceptance Test - The body seal closure is subjected to testing per ATP 9787 at airlock with ILC source verification. The assembly is pressurized in the test fixture to 8.0 (+2.0-0.0) psig for a 5 minute duration, and leakage tested to 4.3 +/- 0.1 psig. The assembly is engaged/disengaged five times. The engagement force is verified to be a maximum of 36.0 lbs. PDA Test - 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 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. Test - PDA Five BSC disconnect engagement cycles, actuations and disengagements are performed prior to the pressure tests to insure that the lip seal is installed correctly and normal disconnect mating does not damage the lip seal.

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Certification:
The body seal closure was successfully tested (manned) during SSA certification to duplicate operational life. Ref. Cert. Test Report for the SSA, ILC Document 0111-70027 and ILC Engineering Memorandum Document EM 83-1083.

The following usage, reflecting requirements of significance to the waist assembly, was documented during certification.

Requirement	S/AD	Actual
Pressure Hours	458	1646
Pressure Cycles	300	2045
BSC Actuation Cycles	300	1080
Don/Doff Cycles	98	445

The LTA was successfully subjected to an ultimate pressure of 13.2 psig during SSA Certification testing. Ref. ILC Document 0111-70027. This is 1.5 times BTA maximum operating pressure of 8.8 psi.
Recertification to 5.5 psi was by test and analysis (ref. ILC Document 84-1108).

The BSC disconnect successfully passed the shock, vibration and acceleration tests without loss of screw torque. Ref. ILC EM 84-1097.

Tests run on the BSC during the ZPS program (zero pre breath) loaded a single latch to 1494 lb without any visual indication of permanent deformation. This shows a factor of safety against yield of 1.9 with a single pin failure condition.

During shock, vibration and acceleration test, the SSA, was struck by a 2 inch diameter spherical ball moving at a rate of 2 ft./sec. No visible or performance degradation was observed. During bench shock testing, the LTA was dropped from a height of 4' on to a wooden surface without visible degradation.

Loss of clamping ring screws is precluded in design by adherence to standard engineering torque (20-24in.-lb) requirements for screw installation.

Testing, during the screw thread engagement study showed that the lowest ultimate thread shear out safety factor for the BSC axial restraint ring screw is 4.1.

Design requiremtnts for proper installation of helicoils are specified in the assembly procedures when the helicoils are installed in the BSC.

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.

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The following MIP's are performed during the body seal closure assembly manufacturing process to assure the failure causes is precluded from the fabricated item.
1. Visually inspect the lip seal for gouges, nicks, tears and degradation.
2. Visually inspect the "O" ring for gouges, nicks, tears and degradation.
3. Verification of the presence of screws during the torquing operation.
4. Helicoil installation is verified during source inspection at the supplier.
5. Inspection for cleanliness to VC level.
6. Inspection after proof and leakage testing for deformation, defects or damage.

During PDA, the following inspection points are performed at the LTA assembly level in accordance with ILC Document 0111-710112:
1. Inspection for cleanliness to VC level.
2. Verification of body seal closure engagement force not to exceed 36.0 lbs.
3. Inspection for structural damage after proof pressure test.

D. Failure History -
B-EMU-104-A052 (01/06/98) - The Lower Torso Assembly failed leakage testing due to leakage at the Body Seal Closure (BSC) static seal. Those seals exhibited a rough surface finish that precludes adequate sealing. All new build BSC seals will be inspected to a revised visual inspection procedure that includes surface finish criteria.

B-EMU-104-A063 (7/1/99) - Most probable cause of failure is a combination of several factors: off-nominal LTA sizing, off-nominal WLVTA length, no weight relief, and waist cycle testing. No C/A. Damage is a result of conditions that do not occur with flight hardware.

B-EMU-104-A070 (5/17/01) - Following post flight manned evaluation, bladder on right leg found to be cut. Root cause was off-nominal procedure of donning LTA without boots connected. Procedure to be discontinued.

E. Ground Turnaround -
Tested for non-EET processing per FEMU-R-001, Pre-Flight LTA Leakage. None for EET processing. Additionally, every four years or 229 hours of manned pressurized time the BSC is disassembled, inspected, cleaned, lubricated, reassembled and functionally tested.

F. Operational Use -
Crew Response -
Pre/post - Eva: 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.

Special Training - Standard training covers this failure mode.
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.

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

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

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NASA – EMU SSM

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NASA – S&MA

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NASA – MOD

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NASA – CTOW

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NASA – Program Manager