

| NAME P/N QTY | CRIT | FAILURE MODE & CAUSES | FAILURE EFFECT | RATIONALE FOR ACCEPTANCE |
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| HARD TORSO SHELL, ITEM 102 ----- SV772375-24 PIVOTED HTS (1) | 2/1R | External leakage, integral water line. | END ITEM: Water leakage to HUT cavity and vent loop. | A. Design - Water tubes within the HTS are manufactured from fiberglass sleeving and an epoxy resin system which is designed to withstand an ultimate water pressure of 56.2 psid. Maximum operating pressure is 28.1 psid. HUT has a design leakage limit of less than 2 cc/hr @ 23.5 +/- 1 psig which is normal operating pressure. |
| OR ----- SV810003 PLANAR HTS (1) | | Defective Material: Integral passageway; o- seals, impact from HUT stowed items. | GFE INTERFACE: Loss of cooling capability. Loss of water from water reservoir. Possible fogging of helmet. MISSION: Terminate EVA. Loss of use of one EMU. CREW/VEHICLE: None for single failure. Loss of crewman if SOP fails. | B. Test - Acceptance: Pivoted and Planar: The HTS waterlines are leaked tested to 28.35 +/- .25 psig and proof tested to 42.45 +/- .25 psig at HSD prior to delivery to ILC. PDA: The following test is conducted at the HUT Assembly level in accordance with ILC Document 0111-70028J (Pivoted HUT) or 0111-710112 (Planar HUT). The Pivoted HUT pump outlet, sublimator inlet and sublimator outlet waterlines are leak tested to 23.5 psig and proof pressure tested to 42.2 psig for five minutes. All other Pivoted HUT waterlines are leak tested to 23.5 psi and proof pressure tested to 37.5 psig for five minutes. All Planar HUT waterlines are leak tested to 23.5 psig and proof pressure tested to 37.5 psig for five minutes. Certification: Pivoted HUT: Waterlines have been tested to S/AD requirements, 461 hours pressurized time, 432 pressure cycles at 17.7 psig during "delta-cert" testing. Ref. Cert Test Report for the SSA, ILC Document 0111-70027. The cert HUT has been subjected to 557 hours of pressurized time and 436 pressure cycles at 17.7 psig. |
| | | | TIME TO EFFECT /ACTIONS: Minutes. Activate the Purge Valve. Return to airlock. | The HUT waterlines are certified for the 42.2 psid proof pressure because the calculated safety factor for ultimate is 57 at the maximum operating pressure of 28.1 psid. Pressure cycle certification is by similarity to the Planar HUT/PLSS Connector Plate & Pin which has identical o-rings to the Bypass Plate. The Planar HUT has undergone certification testing to consist of 360 water loop pressure cycles against a requirement of 196 cycles. |
| | | | TIME AVAILABLE: Minutes | Planar HUT: Waterlines were tested for 458 hours at a line pressure of 16.7 psid. Initial inspection proof pressure test at 50 psid for water tubing. Maintenance inspection (at 458 hours) tested fill and drain line leakage at 17 psid and cooling line leakage at 17.7 psid. Final inspection (at 916 hours) ultimate pressure test on water lines at 50 psid. Leakage was within specified limits during all inspections. Post test inspection revealed no damage to the water lines. Ref. Cert Test report for the Planar HUT, ILC document 0102-711982. |
| | | | TIME REQUIRED: Seconds. | |
| | | REDUNDANCY SCREENS: A-PASS B-PASS C-PASS | | C. Inspection - Prior to HTS assembly, all materials are vendor certified. Batch lot acceptance tests are run to verify integrity of materials prior to use in manufacture of the HTS. During fabrication, fiberglass test specimens are made and tensile tested to verify integrity of the material. The following MIP's are performed during manufacture of the Hard Torso Shell to assure that the failure causes are precluded from the fabricated item: |

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| | | 102FM08 | | <p>1. The issuance of all adhesives, resins, curing agents and fiberglass are controlled by inspection.</p> <p>2. Verification that the correct materials as specified by the operation sheets are used and that shelf life is within specification.</p> <p>3. Recording of lot numbers.</p> <p>Assembly of the HTS into the Hard Torso Shell (HUT) is monitored by inspection to Table of Operations (T.O.) requirements. This includes verification of material and cleanliness requirement.</p> <p>During PDA per ILC Document 0111-70028J (Pivoted HUT) or 0111-710112 (Planar HUT), successful completion of leakage and proof pressure testing is verified.</p> <p>D. Failure History - Pivoted HUT: 1. J-EMU-602--001 (10/08/80). Obsolete configuration.</p> <p>2. B-EMU-102-A013 (07/13/89). Water leakage into the HUT interior from the DCM pad pump outlet tube. Leakage caused by pushing the adjacent alignment pin bushing into the HUT interior which opened a leak path from the adjacent pump outlet tube. The pin and bushing were pushed in by pin impact (without DCM or protective cover attached) or improper installation of the DCM mockup or test fixture. A caution note was added to FEMU-R-001 to require installation of PLSS and DCM pad protective covers when hardware is demated and to require caution when mating any hardware to the HUT PLSS or DCM pads.</p> <p>3. B-EMU-102-A016 (11/8/89). Internal HUT water leakage from a HUT fill/drain line occurred due to a water line thin wall caused by a drawing error which located an adjacent PLSS/HUT mounting hole too close to the fiberglass water line. EC 163402-464 places a fiberglass patch in the counterbore tangent to the fill and drain line to all medium HUTS in the field to preclude any potential for a thin wall condition. EC 163402-464 also changes medium size HUT drawing SV772345 to require a 0.010 inch minimum clearance requirement between the fill and drain line and the PLSS/HUT mounting holes.</p> <p>Planar HUT: 1. I-EMU-102-A006 (02/18/97). Planar HUT S/N PH008 failed water line leakage test. Found water line damaged. Most probable cause was contact by ball nose wrench while torquing adjacent DCM/HUT attachment screws. Procedures changed to preclude use of ball nose drivers. Also, EC 182135-116 generated to incorporate a water line guard at this location.</p> <p>2. I-EMU-102-A007 (12/08/97). During proof pressure test, a water drop formed at the interface of the water line and clamp. Leakage cause was a small void between the water tube and epoxy that was not filled during buildup of the epoxy fillet. Test procedure revised from .4 sccm air flow leakage test to a bubble leakage test (HUT is submerged in water, line is pressurized with air, no visible bubbles allowed).</p> <p>3. B-EMU-102-A033 (01/19/99). Voids detected in adhesive around water tube ports P5 and P6 on the DCM/HUT interface pad. Adhesive voids are acceptable provided they do not create a leak</p> |

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| | | 102FM08 | | <p>path. Design provides for adequate adhesive bond area to prevent axial leakage along the tube and has dimensional controls to assure the O-ring seals beyond the bond joint. Tube and duct adhesive joint voids are exempt from FEMU-R-001 PLSS and DCM pad 10X Inspection of Critical Interfaces per CCBD H6930. B-EMU-102-A033 (8/31/99) - Epoxy adhesive voids around DCM pad water tube ports P5 and P6. Neither void is large enough to provide a leak path. Design of joints provide adequate bond area. Per CCBD H6930, FEMU-R-001 para. 7.1.13.3D, 10X inspection of critical interfaces, will be changed to exempt tube and duct adhesive joint voids from PLSS and DCM pad inspection.</p> <p>E. Ground Turnaround - During ground turnaround for non-EET processing in accordance with the FEMU-R-001, the HUT at SEMU and EMU level is subjected to gas and water structural and leakage tests. None for EET processing.</p> <p>Every 56 hours of manned pressurized time the Pivoted HUT is removed from the DCM and PLSS and subjected to HUT level inspection and functional tests.</p> <p>Every 229 hours of manned pressurized time the Planar HUT is removed from the DCM and PLSS and subjected to HUT level inspection and functional tests.</p> <p>F. Operational Use - Crew Response - Pre/PostEVA: Trouble shoot problem, if no success, consider third EMU if available. EMU no go for EVA. EVA: If significant amount of localized water detected, turn fan off to protect against toxic water carryover into helmet. Open helmet purge valve for CO2 control and anti-fog as required. Terminate EVA. Training - No training specifically 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 ventilation flow pressure integrity. Real Time Data System allows ground monitoring of EMU systems.</p> |

EXTRAVEHICULAR MOBILITY UNIT
SYSTEMS SAFETY REVIEW PANEL REVIEW
FOR THE
I-102 HARD UPPER TORSO (HUT)
CRITICAL ITEM LIST (CIL)
EMU CONTRACT NO. NAS 9-97150

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