

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM : CREW MODULE SEALS FMEA NO 01-4 -CS25 -1 REV: 03/29/88

ASSEMBLY : AIRLOCK HATCH 'A', 'B', INGRESS/EGRESS HATCH CRIT. FUNC: 1R
 P/N RI : V070-332504-003, -004, -005, -006 CRIT. HDW: 3
 P/N VENDOR: VEHICLE 102 103 104
 QUANTITY : 6 EFFECTIVITY: X X X
 : ONE EACH -003, -004 ON PHASE(S): PL LO OO X DO LS
 : I/E HATCH
 : ONE EACH -005, -006 PER A/L HATCH

REDUNDANCY SCREEN: A-PASS B-FAIL C-PASS
 PREPARED BY: APPROVED BY: APPROVED BY (NASA):
 DES W. HENRY DES *W.P. Henry 7/28/88* SSM *DE [Signature]*
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ITEM:
 SEALS, AIRLOCK AND INGRESS/EGRESS HATCHES

FUNCTION:
 THESE SEALS PREVENT LEAKAGE OF CREW MODULE ATMOSPHERE.

FAILURE MODE:
 LEAKAGE

CAUSE(S):
 CRACKS, LOW TEMPERATURE, MATERIAL DEGRADATION

EFFECT(S) ON:
 (A) SUBSYSTEM (B) INTERFACES (C) MISSION (D) CREW/VEHICLE

- (A) FAILURE OF SINGLE SEAL HAS NO EFFECT. LOSS OF REDUNDANT SEAL WOULD RESULT IN THE LOSS OF CREW MODULE CONSUMABLES.
- (B) FAILURE OF A SINGLE SEAL HAS NO EFFECT. LOSS OF REDUNDANT SEAL WOULD RESULT IN THE LOSS OF CREW MODULE CONSUMABLES.
- (C) FAILURE OF A SINGLE SEAL HAS NO EFFECT. LOSS OF THE REDUNDANT SEAL WOULD RESULT IN LOSS OF CREW MODULE CONSUMABLES, HOWEVER, THIS WOULD NOT EXCEED THE MAKEUP CAPABILITY OF THE ARPCS BUT WOULD POSSIBLY RESULT IN EARLY TERMINATION OF MISSION. LEAKAGE OF BOTH SEALS AT HATCH "A" COULD PREVENT OPENING OF HATCH "B", CAUSING LOSS OF EVA CAPABILITY AND LOSS OF MISSION.
- (D) FAILURE OF SINGLE SEAL HAS NO EFFECT. LOSS OF THE REDUNDANT SEAL AND AN ADDITIONAL SEAL FAILURE WITHIN THE CREW MODULE COULD RESULT IN A LEAK RATE EXCEEDING THE ARPCS MAKEUP CAPABILITY RESULTING IN LOSS OF CREW/VEHICLE.

REDUNDANCY SCREENS: SEAL FAILS SCREEN "B" BECAUSE LEAK TEST OF EACH SEAL INDIVIDUALLY IS NOT FEASIBLE IN FLIGHT.

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DISPOSITION & RATIONALE:

(A) DESIGN (B) TEST (C) INSPECTION (D) FAILURE HISTORY (E) OPERATIONAL USE

(A) DESIGN

WHEN THE AIRLOCK HATCHES ARE CLOSED, REDUNDANT CONCENTRIC O-RING FACE SEALS ARE COMPRESSED BY SIX LATCHES DRIVEN BY A MANUALLY OPERATED ACTUATOR. THE SEALS ARE BONDED INTO DOVETAIL GROOVES, ONE IN HATCH AND ONE IN AIRLOCK FLANGE. THE HATCH IS A RIGID STRUCTURE. THE SEAL MATERIAL IS SILICONE RUBBER. THE INGRESS/EGRESS HATCH CONTAINS CONCENTRIC O-RING FACE SEALS WHICH WHEN HATCH IS CLOSED, ARE COMPRESSED BY 18 LATCHES DRIVEN BY A MANUALLY OPERATED ACTUATOR. SEAL MATERIAL IS SILICONE RUBBER.

(B) TEST

ACCEPTANCE TESTS: STRUCTURAL LEAK TEST OF AIRLOCK TO 14.7 PSID, INTERNAL AND EXTERNAL ON THE HATCH PROOF PRESSURE TEST OF HATCH TO 17.7 + 0.1 -0 PSID FOR 2.0 +/- 1.0 MINUTES IS PERFORMED.

QUALIFICATION TESTS: QUALIFICATION TESTS OF HATCH STRUCTURE PER TR S104018 INCLUDED PROOF PRESSURE TEST TO 17.7 PSID. QUALIFICATION TESTS OF SIDE HATCH INCLUDED HATCH STRUCTURAL TEST PER TR S104018 AND 2,000 OPERATING CYCLES OPEN AND CLOSE.

OMRSD: EACH SEAL CAN BE VERIFIED BY PRESSURIZING TO 15 PSID BETWEEN SEA USING TEST PORT AND PORTABLE TEST KIT. INGRESS/EGRESS HATCH CLOSURE PRIOR TO LAUNCH IS VERIFIED BY CREW MODULE LEAK TEST TO 2 PSID, BUT TEST IS UNLIKELY TO DETECT DUAL SEAL LEAKAGE OF ANY CLOSED HATCH.

(C) INSPECTION

RECEIVING INSPECTION

RECEIVING INSPECTORS INSPECT FOR DAMAGE AND WORKMANSHIP AND VERIFY THAT IT IS OF SINGLE PIECE MOLDED CONSTRUCTION. RECEIVING INSPECTORS CHECK IDENTIFICATION AND WALL CROSS-SECTIONAL DIAMETER ON A S-3 SAMPLING BASIS. IT IS ALSO VERIFIED THAT THE SUPPLIER SUBMITTED THE REQUIRED REPORTS.

CONTAMINATION CONTROL

RECEIVING INSPECTORS VISUALLY INSPECT SEAL FOR CLEANLINESS. INSPECTORS VERIFY, BEFORE INSTALLATION, THAT THE SEAL AND SEALING SURFACE AND VITON SEAL ARE CLEAN, PER MA0106-328.

ASSEMBLY/INSTALLATION

THE SEALS ARE INSTALLED PER MA0106-328. PRIOR TO INSTALLATION AN INSPECTION IS PERFORMED TO VERIFY THAT THE SEALING SURFACE IS NOT DAMAGED.

CRITICAL PROCESSES

BONDING OF SEALS PER MA0106-328 IS VERIFIED BY INSPECTION.

TESTING

THE CREW MODULE HIGH PRESSURE TEST TO 14.7 PSID, AND LOW PRESSURE TESTS TO 3.2 PSID ARE VERIFIED BY INSPECTION.

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HANDLING/PACKAGING

THE RECEIVING INSPECTORS VERIFY THAT THE SEAL IS INDIVIDUALLY PACKAGED WITH PART NUMBER, MANUFACTURER NAME, COMPOUND NUMBER AND CURE DATE. RECEIVING INSPECTORS ALSO VERIFY THAT THE SEAL IS PACKAGED IN A WAY THAT WILL PROTECT IT DURING STORAGE.

(D) FAILURE HISTORY

CAR NO. AC7947: DURING INGRESS/EGRESS HATCH SEAL CHECK, PRESSURE COULD NOT BE MAINTAINED WITHIN TOLERANCE (LOST 1.5 LB IN ONE MINUTE, SHOULD HAVE MAINTAINED WITHIN 1 LB IN ONE MINUTE); FAILURE ANALYSIS OF THE ORIGINAL SEALS INDICATED A CONFUSION AS TO PART NUMBER SINCE PART NUMBER WAS NOT IDENTIFIED TO THE PART BY DASH NUMBER WHICH COULD CAUSE LARGER OR SMALLER SEALS TO BE INSTALLED; ENGINEERING ACTIONS (E.O. A-09, V070-332504) APPROVED TO MARK SEALS AND PROMOTE CLOSER ATTENTION TO SEAL HANDLING.

CAR NO. 06F015: DURING OV-099 ON ORBIT OPERATION OF AIRLOCK HATCH "A" IN STS-6 MISSION, THE SEAL IN AIRLOCK FLANGE (OUTER SEAL) PARTIALLY CAME OUT OF ITS RETAINING GROOVE; FAILURE CAUSED BY A COMBINATION OF AN UNDERSIZE SEAL, AN OVERSIZE GROOVE, AND SEAL STICKING TO THE MATING SURFACE; ALUMINUM TAPE WAS ADDED TO THE SIDE WALLS OF THE SEAL GROOVE IN THE AIRLOCK FLANGE OF HATCH "A" WHERE OVERSIZE, AND BOTH SEALS (IN HATCH AND AIRLOCK FLANGE) WERE REPLACED TO RESTORE RETAINING GROOVE AND SEAL DIMENSIONS.

CAR NO. AB6601: OV-102 AIRLOCK HATCH "B" SEALS HAD A LEAK RATE OF 2.9 PSI IN ONE MINUTE (SHOULD BE 1.0 PSI MAXIMUM IN ONE MINUTE); AIRLOCK HATCH SEAL LEAKAGE WAS CAUSED BY INSUFFICIENT COMPRESSION OF SEALS DUE TO ADVERSE TOLERANCE BUILDUP BETWEEN SEALS AND GROOVES OR PERMANENT SET OF SEALS; INNER AND OUTER SEALS WERE REMOVED AND REPLACED WITH NO CORRECTIVE ACTION REQUIRED AS TOLERANCES ON SEAL DIAMETER, GROOVE DIMENSIONS AND LATCH ROLLERS WERE SATISFACTORY WITH SEAL LEAKAGE REQUIREMENTS.

CAR NO. AC7792: DURING OV-099 AIRLOCK HATCH "B" OPERATIONS, THE SEAL BONDED IN AIRLOCK FLANGE CAME OUT OF GROOVE WHEN HATCH WAS OPENED; FAILURE CAUSED BY BOND FAILURE AND SEAL STICKING TO THE MATING SURFACE AS A RESULT OF AN IMPROPERLY POST CURED SEAL; SEALS RE-BONDED (FUTURE OCCURRENCES IN FLIGHT WOULD REQUIRE A SUITED CREWMEMBER TO REPLACE THE SEAL OR IF SEAL DAMAGE OCCURS DURING HATCH CLOSING, THE REDUNDANT SEAL WOULD BE CAPABLE OF MEETING MAXIMUM ALLOWABLE LEAKAGE REQUIREMENTS).

(E) OPERATIONAL USE

IF BOTH SEALS FAIL ON EITHER AIRLOCK HATCH, THE OTHER AIRLOCK HATCH CAN BE CLOSED. IF BOTH SEALS FAIL ON INGRESS/EGRESS HATCH OR EITHER AIRLOCK HATCH, INCREASED USE OF CREW MODULE CONSUMABLES CAN BE MONITORED AND ASSESSED FOR FEASIBILITY OF CONTINUING THE MISSION PER CABIN LEAK PROCEDURES AND FLIGHT RULES.