FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL HARDWARE
NUMBER:M8-1SS-M015A -X

SUBSYSTEM NAME: MECHANICAL - SEALS
REVISION: 0 04/08/97

PART DATA

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	:PLUG, LEAK TEST PORT	ME276-0040-0001

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
EXTERNAL AIRLOCK UPPER CYLINDER/UPPER BULKHEAD ASSEMBLY LEAK TEST PORT PLUG

QUANTITY OF LIKE ITEMS: 1
ONE

FUNCTION:
THIS PLUG PROVIDES A TEST PORT FOR THE DUAL (REDUNDANT) STRUCTURAL SEALS LOCATED AT THE EXTERNAL AIRLOCK UPPER CYLINDER/UPPER BULKHEAD ASSEMBLY INTERFACE. THIS PORT IS USED WITH A PNEUMATIC PORTABLE TEST KIT (C70-0749) TO VERIFY STRUCTURAL SEAL INTEGRITY PRIOR TO LAUNCH.

REFERENCE DOCUMENTS: V828-341003
V828-341010

FAILURE MODES EFFECTS ANALYSIS FMEA – CIL FAILURE MODE
NUMBER: M8-1SS-M015A-01

REVISION#: 0 04/08/97

SUBSYSTEM NAME: MECHANICAL - SEALS
LRU: PLUG, LEAK TEST PORT
ITEM NAME: O-RING SEAL

CRITICALITY OF THIS FAILURE MODE: 1R3

FAILURE MODE:
EXTERNAL LEAKAGE

MISSION PHASE: OO ON-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY:
103 DISCOVERY
104 ATLANTIS
105 ENDEAVOUR

CAUSE:
AGING/OXIDATION/SUBLIMATION, CONTAMINATION/FOREIGN OBJECT/DEBRIS, DEFECTIVE PART MATERIAL OR MANUFACTURING DEFECT, INADEQUATE/EXCESSIVE/UNEVEN SEAL COMPRESSION LOADS, MISHANDLING, THERMAL DISTORTION

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN
A) FAIL
B) N/A
C) PASS

PASS/FAIL RATIONALE:
A)
FAILS SCREEN "A" BECAUSE INDIVIDUAL TEST PORT PLUG SEAL NOT VERIFIABLE ON VEHICLE DURING GROUND CHECKOUT.

B)
N/A - AT LEAST TWO REMAINING PATHS ARE DETECTABLE IN FLIGHT.

C)

METHOD OF FAULT DETECTION:
NONE FOR FAILURE OF BOTH LEAK TEST PORT PLUG SEALS. ADDITIONAL FAILURE OF OUTER STRUCTURAL O-RING SEAL ON EXTERNAL AIRLOCK UPPER BULKHEAD ASSEMBLY CAN BE DETECTED THROUGH INSTRUMENTATION/PHYSICAL OBSERVATION - LOSS OF OR REDUCED PRESSURE IN HABITABLE VOLUMES.

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REMARKS/RECOMMENDATIONS:
THREE SEAL FAILURES ARE REQUIRED BEFORE THERE CAN BE A LEAK PATH TO THE OUTSIDE.

- FAILURE EFFECTS -

(A) SUBSYSTEM:
NO EFFECT FIRST AND SECOND FAILURE. TWO SUCCESSIVE PLUG O-RING FAILURES WILL CAUSE ONLY THE LOSS OF OUTER STRUCTURAL SEAL INTEGRITY AT THE EXTERNAL AIRLOCK UPPER BULKHEAD INTERFACE. THE INNER STRUCTURAL O-RING SEAL MUST ALSO FAIL TO CAUSE A LOSS OF ISOLATION BETWEEN ODS AND OUTSIDE ATMOSPHERE.

(B) INTERFACING SUBSYSTEM(S):
NO EFFECT UNTIL LOSS OF BOTH PLUG O-RING SEALS AND LOSS OF INNER STRUCTURAL SEAL AT THE EXTERNAL AIRLOCK UPPER BULKHEAD INTERFACE. THEN EXCESSIVE LOSS OF ODS PRESSURE TO THE OUTSIDE WILL RESULT IN AN INCREASED USE OF OXYGEN/NITROGEN SUPPLY.

(C) MISSION:
NO EFFECT FIRST FAILURE. FAILURE OF REDUNDANT TEST PORT PLUG SEAL AND OUTER STRUCTURAL SEAL ON EXTERNAL AIRLOCK UPPER BULKHEAD INTERFACE WOULD RESULT IN POSSIBLE MISSION TERMINATION DEPENDING ON MAGNITUDE OF LEAK. EXCESSIVE USE OF CONSUMABLES MAY LIMIT MISSION DURATION.

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT FIRST FAILURE. FAILURE OF REDUNDANT TEST PORT PLUG SEAL AND OUTER STRUCTURAL SEAL ON EXTERNAL AIRLOCK UPPER BULKHEAD INTERFACE COULD CAUSE LOSS OF CREW AND VEHICLE.

(E) FUNCTIONAL CRITICALITY EFFECTS:
FIRST LEAK TEST PORT PLUG O-RING SEAL FAILURE - NO EFFECT, LOSS OF REDUNDANCY ONLY.

SECOND LEAK TEST PORT PLUG O-RING SEAL FAILURE - LOSS OF OUTER STRUCTURAL SEAL INTEGRITY ON EXTERNAL AIRLOCK UPPER BULKHEAD INTERFACE.

THIRD FAILURE (INNER STRUCTURAL O-RING SEAL ON EXTERNAL AIRLOCK UPPER BULKHEAD INTERFACE: IF FAILURE OCCURS:
(3A) DURING DOCKED IVA ACTIVITIES EXCESSIVE LOSS OF CONSUMABLES CAN JEOPARDIZE CREW SAFETY.
(3B) DURING EVA, POSSIBLE LOSS OF EVA CREWMEMBERS IF ODS VOLUMES CANNOT BE REPRESSURIZED FOR RETURN TO CREW CABIN. (EVA CREWMEMBERS MUST REMAIN IN AIRLOCK UNTIL LANDING). - CRITICALITY 1R3 CONDITION.
(3C) DURING NON-DOCKED OPERATIONS, LOSS OF PRESSURE WITHIN ODS. LOSS OF SUBSEQUENT EVA CAPABILITIES IF ODS CANNOT BE REPRESSURIZED RESULTING IN

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LOSS OF MISSION OBJECTIVES ASSOCIATED WITH PLANNED EVA'S. - CRITICALITY 2R3 CONDITION.
IF THIRD FAILURE OCCURS WHEN ORBITER/SPACE STATION ARE DOCKED, POSSIBLE LOSS OF PRESSURE IN SPACE STATION WHEN EXTERNAL AIRLOCK UPPER HATCH IS OPEN.

DESIGN CRITICALITY (PRIOR TO DOWNGRADE, DESCRIBED IN (F)): 1R3

(F) RATIONALE FOR CRITICALITY DOWNGRADE:
(4A) - FOURTH FAILURE (INABILITY TO CLOSE 576 BULKHEAD HATCH) - FAILURE TO ISOLATE LEAKAGE FROM CREW CABIN RESULTING IN POTENTIAL LOSS OF CREW AND VEHICLE.
(4C) - FOURTH FAILURE (FAILURE NECESSITATING AN EVA TO PREVENT A POTENTIAL CATASTROPHIC SITUATION) - INABILITY TO PERFORM A CONTINGENCY EVA TO CORRECT A CRIT 1 CONDITION COULD RESULT IN LOSS OF CREW AND VEHICLE.

- TIME FRAME -

TIME FROM FAILURE TO CRITICAL EFFECT: DAYS

TIME FROM FAILURE OCCURRENCE TO DETECTION: MINUTES

TIME FROM DETECTION TO COMPLETED CORRECTING ACTION: N/A

IS TIME REQUIRED TO IMPLEMENT CORRECTING ACTION LESS THAN TIME TO EFFECT?
NO

RATIONALE FOR TIME TO CORRECTING ACTION VS TIME TO EFFECT:
THERE IS NO CORRECTIVE ACTION IF THIRD FAILURE OCCURS DURING AN EVA AND EXTERNAL AIRLOCK CANNOT BE REPRESSURIZED FOR EVA CREW'S RETURN TO CREW CABIN.

HAZARD REPORT NUMBER(S): ORBI 511, ORBI 405, FF-09

HAZARD(S) DESCRIPTION:
LOSS OF HABITABLE PRESSURE (ORBI 511). EVA CREW HAZARDS DUE TO ISS ODS (ORBI 405). INABILITY TO SAFELY PERFORM EVA (FF-09).

-DISPOSITION RATIONALE-

(A) DESIGN:
O-RING SEALS IN LEAK TEST PORT COUPLING ARE ETHYLENE PROPYLENE. O-RING SEAL AT COUPLING INTERFACE FLANGE IS BUTYL RUBBER. PROTECTIVE PRESSURE CAP SEAL IS REDUNDANT TO POPPET VALVE SEAL WHEN TEST PORT COUPLING IS NOT IN USE. TEST PORT COUPLING SEAL LEAKAGE WILL NOT RESULT IN LEAKAGE OF HABITABLE ATMOSPHERE OVERBOARD UNLESS EXTERNAL AIRLOCK UPPER BULKHEAD INTERFACE INNER PERIPHERAL O-RING STRUCTURAL SEAL ALSO FAILS.

(B) TEST:
ACCEPTANCE TESTS OF LEAK TEST PORT COUPLING INCLUDE EXAMINATION OF PRODUCT, PROOF PRESSURE TEST AND OPERATIONAL TEST. PROOF PRESSURE TEST OF THE LEAK TEST PORT (MALE HALF COUPLING) WITH PRESSURE CAP INSTALLED IS 30 PSIG TWO TIMES FOR TWO MINUTES EACH. OPERATIONAL TEST OF THE LEAK TEST PORT WITH PRESSURE CAP INSTALLED AND POPPET HELD OPEN IS 15 PSIG GN2 WITH LEAKAGE NOT TO EXCEED ONE BUBBLE IN FIVE MINUTES. WITH PRESSURE CAP REMOVED AND 15 PSIG APPLIED, LEAKAGE IS NOT TO EXCEED ONE BUBBLE IN FIVE MINUTES.

QUALIFICATION TESTS: NO QUALIFICATION TESTS OF COUPLING WERE PERFORMED.

IN-PROCESS AND ACCEPTANCE TESTS OF EXTERNAL AIRLOCK INCLUDES THREE TESTS TO TEST THE INTEGRITY OF AIRLOCK STRUCTURE. THESE TESTS ARE ADDRESSED AS FOLLOWS: (1) STRUCTURAL PROOF PRESSURE TEST PERFORMED PER PARA 4.01.01.01/4.01.01.02 OF ML0101-0104-001- WITH UPPER BULKHEAD ASSEMBLY INSTALLED AIRLOCK IS PRESSURIZED TO 17.6 +0.1/-0 PSIG AND HELD FOR A MINIMUM OF 5 MINUTES; (2) HIGH PRESSURE LEAK TEST PERFORMED PER PARA 4.01.01.02.01.02 OF ML0101-0104-001 - WITH UPPER BULKHEAD ASSEMBLY INSTALLED AIRLOCK IS PRESSURIZED TO 14.9 +0/-0.2 PSIG AND HELD FOR A MINIMUM OF 4 HOURS. LEAK RATE IS VERIFIED NOT TO EXCEED 4.096 SCIM; (3) LOW PRESSURE LEAK TEST PERFORMED PER PARA 4.01.01.02.01.05 OF ML0101-0104-001 - WITH UPPER BULKHEAD ASSEMBLY INSTALLED AIRLOCK IS PRESSURIZED TO 3.2 +/- 0.1 PSIG AND HELD FOR A MINIMUM OF 5 MINUTES. LEAK RATE IS VERIFIED NOT TO EXCEED 2.8 SCIM.

OMRSD - TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:
RECEIVING INSPECTION
RAW MATERIAL IS VERIFIED BY INSPECTION TO ASSURE SPECIFIC SHUTTLE REQUIREMENTS ARE SATISFIED.

CONTAMINATION CONTROL
CLEANLINESS OF SIGNIFICANT INTERNAL AND EXTERNAL SURFACES TO LEVEL GC (GENERALLY CLEAN) OF MA0110-301 IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
OPERATIONS VERIFIED BY ASSEMBLY AND TEST OPERATIONS ON SHOP TRAVELER.

CRITICAL PROCESSES
CRITICAL PROCESSES SUCH AS WELDING, PLATING, HEAT TREATING, PASSIVATION AND ANODIZING ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
NO NONDESTRUCTIVE EVALUATION (NDE) IS DONE/PERFORMED.

TESTING
ATP/OMRSD VERIFIED BY INSPECTION.

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HANDLING/PACKAGING
HANDLING AND PACKAGING IS VERIFIED BY INSPECTION PER THE REQUIREMENTS OF SPECIFICATION MA0110-301.

(D) FAILURE HISTORY:
CURRENT DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN PRACA DATA BASE.

(E) OPERATIONAL USE:
NONE FOR FAILURE OF BOTH LEAK TEST PORT PLUG SEALS. ADDITIONAL FAILURE OF EXTERNAL AIRLOCK UPPER BULKHEAD ASSEMBLY INNER O-RING STRUCTURAL SEAL - GIVEN SUFFICIENT TIME CREW COULD CLOSE APPROPRIATE HATCH(S) TO ISOLATE LEAKAGE.

- APPROVALS -

SS & PAE	: M. W. GUENTHER	:
SS & PAE MANAGER	: C. A. ALLISON	:
DESIGN ENGINEER	: T. S. COOK	:
NASA SSMA	:	:
NASA SUBSYSTEM MANAGER	:	:
JSC MOD	:	: