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PRINT DATE: 09/18/95

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL HARDWARE

NUMBER: M8-1MR-M019-X

SUBSYSTEM NAME: MECHANICAL - EXTERNAL AIRLOCK

REVISION: 1 9/15/95

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: SEAL, LATCH ACTUATOR TO HATCH	M83248/1-245

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**PART DATA**

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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**  
EXTERNAL AIRLOCK AFT HATCH LATCH ACTUATOR TO HATCH STRUCTURE SEAL

**REFERENCE DESIGNATORS:****QUANTITY OF LIKE ITEMS: 2**  
TWO

**FUNCTION:**  
SEALS THE LATCH ACTUATOR TO THE EXTERNAL AIRLOCK AFT HATCH STRUCTURE  
TO PREVENT LEAKAGE BETWEEN EXTERNAL AIRLOCK AND SPACELAB FOR MIR 1 AND  
BETWEEN EXTERNAL AIRLOCK AND OUTSIDE ENVIRONMENT FOR MULTI-MIR.

**REFERENCE DOCUMENTS: M072-593828**

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## FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL FAILURE MODE

NUMBER: M8-1MR-M019-01

REVISION# 1 9/15/95

SUBSYSTEM NAME: MECHANICAL - EXTERNAL AIRLOCK

LRU: SEAL, LATCH ACTUATOR TO HATCH STRUCTURE

CRITICALITY OF THIS

ITEM NAME: O-RING SEALS

FAILURE MODE: 1R3

FAILURE MODE:

LEAKAGE

MISSION PHASE:

OO ON-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY: 104 ATLANTIS

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

CRITICALITY 1R2 DURING INTACT ABORT ONLY (AVIONICS ONLY)? N/A

REDUNDANCY SCREEN

A) FAIL  
B) N/A  
C) PASS

PASS/FAIL RATIONALE:

A)  
FAILS SCREEN "A" BECAUSE A LEAK TEST OF EACH (INDIVIDUAL) SEAL IS NOT POSSIBLE  
DURING GROUND CHECKOUT.B)  
N/A - AT LEAST TWO REMAINING PATHS ARE DETECTABLE IN FLIGHT.

C)

METHOD OF FAULT DETECTION:

NONE FOR A SINGLE O-RING SEAL FAILURE. FAILURE OF REDUNDANT O-RING SEAL  
CAN BE DETECTED THROUGH INSTRUMENTATION - LOSS OF PRESSURE  
(CONSUMABLES) IN SPACELAB DURING EVA (MIR 1) OR LOSS OF ODS PRESSURE  
DURING IVA (MULTI-MIR).

- FAILURE EFFECTS -

(A) SUBSYSTEM:

NO EFFECT FIRST FAILURE. SECOND SEAL FAILURE WILL RESULT IN LOSS OF  
ISOLATION BETWEEN EXTERNAL AIRLOCK AND SPACELAB VOLUMES FOR MIR 1 OR  
CAUSE EXTERNAL LEAKAGE OF ODS HABITABLE PRESSURE FOR MULTI-MIR.

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## FAILURE MODES EFFECTS ANALYSIS (FMEA) - OIL FAILURE MODE

NUMBER: M8-1MR-M019-01

## (B) INTERFACING SUBSYSTEM(S):

NO EFFECT FIRST FAILURE.

MIR 1 - FAILURE OF REDUNDANT SEAL WILL RESULT IN LOSS OF ISOLATION BETWEEN EXTERNAL AIRLOCK AND SPACELAB. LOSS OF ISOLATION COULD RESULT IN LOSS OF SPACELAB CONSUMABLES IF EVA 'C' HATCH IS OPENED AND LEFT OPEN DURING DURATION OF EVA. REPRESSURIZATION OF ODS FOLLOWING EVA WILL RESULT IN EXCESSIVE LEAKAGE OF CONSUMABLES INTO SPACELAB VACUUM. NO EFFECT DURING IVA SINCE EXTERNAL AIRLOCK AFT HATCH REMAINS OPEN.

MULTI-MIR - NO EFFECT FIRST FAILURE. LOSS OF PRESSURE TO OUTSIDE ATMOSPHERE AND INCREASED USE OF O2/N2 CONSUMABLES GIVEN A SIMILAR FAILURE OF SECOND O-RING.

## (C) MISSION:

MIR 1 - NO EFFECT DURING IVA SINCE EXTERNAL AIRLOCK AFT HATCH REMAINS OPEN. LOSS OF SPACELAB OPERATIONS IF BOTH O-RING SEALS FAIL DURING EVA. LOSS OF CAPABILITY TO PERFORM A PLANNED EVA IF FAILURE OF REDUNDANT SEALS OCCUR PRIOR TO EVA.

MULTI-MIR - NO EFFECT FIRST O-RING FAILURE. WORST CASE IF SECOND O-RING FAILURE OCCURS PRIOR TO DOCKING - CREW DECISION TO ABORT MISSION DUE TO LOSS OF CONSUMABLES. INABILITY TO PERFORM PLANNED EVA FOLLOWING SECOND O-RING FAILURE.

## (D) CREW, VEHICLE, AND ELEMENT(S):

NO EFFECT UNTIL EVA IS PERFORMED. IF BOTH SEALS FAIL AND AN ADDITIONAL SEAL FAILS WITHIN ODS, LEAK RATE MAY EXCEED MAKEUP CAPABILITY OF ATMOSPHERIC REVITALIZATION PRESSURE CONTROL SYSTEM (ARPCS).

POSSIBLE LOSS OF EVA CREW MEMBERS FOLLOWING THIRD SEAL FAILURE DUE TO INABILITY TO RECOVER FROM AN EVA (MIR 1 & MULTI-MIR). VACUUM IN SPACELAB DURING EVA MAY AFFECT EQUIPMENT WITHIN SPACELAB (MIR 1 ONLY). LOSS OF ODS PRESSURE DURING IVA FOLLOWING THIRD SEAL FAILURE COULD JEOPARDIZE SAFETY OF CREW AND VEHICLE (MULTI-MIR ONLY).

## (E) FUNCTIONAL CRITICALITY EFFECTS:

FIRST O-RING SEAL FAILURE - NO EFFECT.

SECOND O-RING SEAL FAILURE - LOSS OF SPACELAB CONSUMABLES DURING EVA. POSSIBLE EARLY MISSION TERMINATION (MIR 1) OR POSSIBLE EARLY MISSION TERMINATION DUE TO LEAKAGE TO OUTSIDE ATMOSPHERE RESULTING IN AN INCREASED USE OF CONSUMABLES (MULTI-MIR). - CRITICALITY 2R3 CONDITION.

THIRD FAILURE (ADDITIONAL SINGLE SEAL FAILURE WITHIN HABITABLE VOLUME):

MIR 1 - POSSIBLE LOSS OF CAPABILITY TO REPRESSURIZE ODS VOLUMES DUE TO LACK OF AVAILABLE O2/N2. LOSS OF EVA CREW MEMBERS IF EVA IS PERFORMED AND HABITABLE VOLUMES CANNOT BE REPRESSURIZED FOR CREW RETURN TO CABIN (EVA CREW MEMBERS MUST REMAIN IN AIRLOCK UNTIL LANDING). - CRITICALITY 1R3 CONDITION.

MULTI-MIR - (1) IF THIRD FAILURE OCCURS DURING IVA EXCESSIVE LOSS OF CONSUMABLES CAN JEOPARDIZE CREW SAFETY; (2) IF THIRD FAILURE OCCURS DURING EVA OUT EXTERNAL AIRLOCK, POSSIBLE LOSS OF EVA CREWMEMBERS IF EXTERNAL AIRLOCK VOLUME CANNOT BE REPRESSURIZED FOR RETURN TO CREW CABIN. (EVA CREWMEMBERS MUST REMAIN IN AIRLOCK UNTIL LANDING).

IF SECOND FAILURE OCCURS WHEN ORBITER/MIR ARE DOCKED, POSSIBLE LOSS OF PRESSURE IN MIR WHEN EXTERNAL AIRLOCK UPPER HATCH IS OPEN (MULTI-MIR ONLY).

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FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL FAILURE MODE  
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DESIGN CRITICALITY (PRIOR TO DOWNGRADE, DESCRIBED IN (F)): 1R3

(F) RATIONALE FOR CRITICALITY DOWNGRADE:  
FOURTH & FIFTH FAILURE (INABILITY TO CLOSE APPROPRIATE HATCH(S)) - FAILURE TO ISOLATE LEAKAGE FROM CREW CABIN RESULTING IN POTENTIAL LOSS OF CREW AND VEHICLE.

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- TIME FRAME -

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TIME FROM FAILURE TO CRITICAL EFFECT: HOURS TO DAYS

TIME FROM FAILURE OCCURRENCE TO DETECTION: MINUTES

TIME FROM DETECTION TO COMPLETED CORRECTIVE ACTION: SECONDS TO MINUTES

IS TIME REQUIRED TO IMPLEMENT CORRECTIVE ACTION LESS THAN TIME TO EFFECT?  
YES

RATIONALE FOR TIME TO CORRECTING ACTION VS TIME TO EFFECT:  
CREW WOULD HAVE SUFFICIENT TIME TO CLOSE APPROPRIATE HATCH(S) TO ISOLATE LEAKAGE FROM THE CREW CABIN VOLUME BEFORE EXCESSIVE LEAKAGE BECAME CATASTROPHIC.

HAZARDS REPORT NUMBER(S): OPBI 511

HAZARD(S) DESCRIPTION:  
LOSS OF HABITABLE PRESSURE.

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-DISPOSITION RATIONALE-

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(A) DESIGN:  
ACTUATOR MOUNTING FLANGE IS INSTALLED ON HATCH BASE STRUCTURE WITH 12 ATTACH BOLTS. DUAL CONCENTRIC O-RING FACE SEALS IN ACTUATOR FLANGE GROOVES ARE ADJACENT TO ATTACH BOLTS. O-RINGS ARE LUBRICATED WITH MB0140-010 TYPE II GREASE PER MAQ112-303. EITHER O-RING CAN PREVENT LEAKAGE THROUGH HATCH. FLANGE TO HATCH INTERFACE IS METAL TO METAL CONTACT. SEAL MATERIAL IS FLUOROCARBON ELASTOMER (VITON).

(B) TEST:  
ACCEPTANCE TESTS: STRUCTURAL LEAK TEST TO 14.7 PSID IS PERFORMED.

QUALIFICATION TESTS: NO QUALIFICATION TESTS WERE PERFORMED ON THE INDIVIDUAL SEAL. CERTIFICATION IS BASED ON ACCEPTANCE TESTS AND SEAL MATERIALS DATA. QUALIFICATION TESTS OF ACTUATOR INCLUDED LIMIT LOAD TEST (10 CYCLES), 2000 OPERATING CYCLES AT 30 INCH-LB INPUT TORQUE, THERMAL CYCLING BETWEEN -66 DEG F AND +250 DEG F.

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

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**(C) INSPECTION:**

RECEIVING INSPECTION  
RECEIVING INSPECTORS INSPECT FOR DAMAGE AND WORKMANSHIP AND VERIFY THAT SEAL IS OF SINGLE PIECE MOLDED CONSTRUCTION. RECEIVING INSPECTORS ALSO CHECK IDENTIFICATION AND WALL CROSS-SECTIONAL DIAMETER ON A 5-3 SAMPLING BASIS AND THAT SUPPLIER SUBMITTED REQUIRED REPORTS.

**CONTAMINATION CONTROL**

RECEIVING INSPECTORS VISUALLY INSPECT SEAL FOR CLEANLINESS. INSPECTORS VERIFY CLEANLINESS OF SEALING SURFACE & VITON SEAL PRIOR TO INSTALLATION.

**ASSEMBLY/INSTALLATION**

THE SEALS ARE INSTALLED PER MAO106-328. PRIOR TO INSTALLATION AN INSPECTION IS PERFORMED TO VERIFY THAT THE SEALING SURFACE IS NOT DAMAGED. INSPECTION VERIFIES MB0140-010 TYPE II GREASE WAS APPLIED TO O-RINGS AND O-RING GROOVES PRIOR TO ASSEMBLY PER MAO112-303. INSPECTION VERIFIES DIMENSIONS OF DETAIL PARTS.

**TESTING**

EXTERNAL AIRLOCK PRESSURE TESTS VERIFIED BY INSPECTION.

**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:**

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 SINGLE O-RING FAILURE. FAILURE OF REDUNDANT O-RING SEAL - RATE OF LEAKAGE AND THE FEASIBILITY OF COMPLETING THE MISSION OR EVA CAN BE DETERMINED (MIR 1). CREW COULD ISOLATE LEAKAGE FROM CREW COMPARTMENT, BY CLOSING APPROPRIATE HATCH(S) IN THE EVENT BOTH SEALS FAIL ON EXTERNAL AIRLOCK AFT HATCH (MULTI-MIR).

**- APPROVALS -**

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