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PRINT DATE: 10/23/95

FAILURE MODES EFFECTS ANALYSIS (FMEA) - NON-CIL HARDWARE  
NUMBER: M8-1MR-M012-X

SUBSYSTEM NAME: MECHANICAL - EXTERNAL AIRLOCK

REVISION: 3 9/15/95

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: SEAL, HATCH PRESSURE	V070-332504

**PART DATA**

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:  
EXTERNAL AIRLOCK AFT HATCH PRESSURE SEAL

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 2  
TWO

**FUNCTION:**

THE PERIMETER OF EXTERNAL AIRLOCK AFT HATCH IS SEALED WITH TWO (DUAL/REDUNDANT) CONCENTRIC ANNULAR O-RINGS SEALS IN DOVETAIL GROOVES. AN INNER SEAL IS ON THE HATCH AND AN OUTER SEAL IS MOUNTED ON THE EXTERNAL AIRLOCK AFT FLANGE. SEAL PREVENTS PRESSURE LEAKAGE BETWEEN EXTERNAL AIRLOCK AND SPACELAB FOR MIR 1 AND PREVENTS PRESSURE LEAKAGE TO OUTSIDE ENVIRONMENT FOR MULT-MIR.

REFERENCE DOCUMENTS: V070-332504  
M072-593825

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**FAILURE MODES EFFECTS ANALYSIS (FMEA) - NON-CIL FAILURE MODE**  
NUMBER: M8-1MR-M012-01

REVISION# 3 9/15/95

SUBSYSTEM NAME: MECHANICAL - EXTERNAL AIRLOCK

LRU: SEAL, HATCH PRESSURE

CRITICALITY OF THIS

ITEM NAME: SEAL, HATCH PRESSURE

FAILURE MODE: 1R3

**FAILURE MODE:**

LEAKAGE (O-RING SEALS)

**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) PASS  
B) N/A  
C) PASS

**PASS/FAIL RATIONALE:**

A)

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 FOR MIR 1 OR LOSS OF PRESSURE  
(CONSUMABLES) IN ODS DURING IVA FOR MULTI-MIR.

**CORRECTING ACTION:** 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 "A" HATCH OR FIFTH HATCH (MULTI-MIR).

**REMARKS/RECOMMENDATIONS:**

THIS FAILURE MODE APPLIES TO THE EXTERNAL AIRLOCK AFT HATCH WHILE IT IS  
CLOSED.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - NON-GL FAILURE MODE  
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**- FAILURE EFFECTS -**

**(A) SUBSYSTEM:**

NO EFFECT FIRST FAILURE. SECOND SEAL FAILURE WILL RESULT IN LOSS OF ISOLATION BETWEEN EXTERNAL AIRLOCK AND SPACELAB VOLUMES (MIR 1) OR LOSS OF EXTERNAL AIRLOCK PRESSURE TO OUTSIDE (MULTI-MIR).

**(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 - FAILURE OF REDUNDANT SEAL WILL RESULT IN AN INCREASED USE OF CONSUMABLES IN HABITABLE VOLUME WITH CREW CABIN "A" HATCH, FIFTH HATCH, AND EXTERNAL AIRLOCK UPPER HATCH OPEN.

**(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 FAILURE. EXTERNAL LEAKAGE OF PRESSURE FOLLOWING FAILURE OF REDUNDANT SEAL COULD RESULT IN POSSIBLE EARLY MISSION TERMINATION IF SECOND FAILURE OCCURS PRIOR TO MATING WITH THE SPACE STATION OR PRIOR TO COMPLETION OF IVA. LOSS OF PLANNED EVA CAPABILITY OUT EXTERNAL AIRLOCK IF BOTH SEALS FAIL.

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

MIR 1 - 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 VACUUM IN SPACELAB DURING EVA MAY AFFECT EQUIPMENT WITHIN SPACELAB.

MULTI-MIR - NO EFFECT FIRST FAILURE UNTIL LOSS OF REDUNDANT SEAL AND AN ADDITIONAL SEAL FAILURE WITHIN HABITABLE VOLUME OCCURS. THEN LOSS OF PRESSURE/CONSUMABLES COULD JEOPARDIZE THE SAFETY OF CREW AND VEHICLE.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

FIRST O-RING SEAL FAILURE - NO EFFECT.

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

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

MIR 1 - POSSIBLE LOSS OF CAPABILITY TO REPRESSURIZE INTERNAL AIRLOCK, TUNNEL ADAPTER, EXTERNAL AIRLOCK, AND SPACELAB 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). THIS WOULD FIRST REQUIRE A

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FAILURE TO OPEN TUNNEL ADAPTER "C" HATCH SINCE IT IS PRIMARY FOR PERFORMING AN EVA.

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). THIS WOULD FIRST REQUIRE A FAILURE TO OPEN TUNNEL ADAPTER "C" HATCH SINCE IT IS PRIMARY FOR PERFORMING AN EVA.

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).

DESIGN CRITICALITY (PRIOR TO DOWNGRADE, DESCRIBED IN (F)): N/A

(F) RATIONALE FOR CRITICALITY DOWNGRADE:  
NONE. UTILIZING WORKAROUND TO CLOSE HATCHES TO ISOLATE LEAKAGE HAS NO EFFECT ON THE CRITICALITY OF THIS FAILURE MODE. CRITICALITY REMAINS A 1R3 FOR MULTI-MIR.

**- TIME FRAME -**

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): ORBI 511

HAZARD(S) DESCRIPTION:  
LOSS OF HABITABLE PRESSURE.

**- APPROVALS -**

PRODUCT ASSURANCE ENGR. : M. W. GUENTHER  
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