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PRINT DATE: 09/18/95

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL HARDWARE

NUMBER: M8-1MR-M004-X

SUBSYSTEM NAME: MECHANICAL - EXTERNAL AIRLOCK

REVISION: 3 9/15/95

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: ACTUATOR, HATCH LATCH	MC287-0036-0008

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
EXTERNAL AIRLOCK AFT HATCH LATCH ACTUATOR

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 1
ONE

FUNCTION:

MANUALLY DRIVEN REDUCTION GEARBOX - PROVIDES A CONTROLLED OUTPUT FOR DRIVING THE LATCH MECHANISM ON EXTERNAL AIRLOCK AFT HATCH OPEN OR CLOSED. PROVIDES THE FORCE FOR HATCH SEAL COMPRESSION AS IT PULLS THE SEALING SURFACES TOGETHER. TWO HANDLES FOR OPERATION ARE PROVIDED FOR THE HATCH; ONE IS ON EACH SIDE OF THE HATCH. A MECHANICAL LOCK AND A "NO-BACK" ARE PROVIDED FOR RESTRAINT BETWEEN USES. THE KNOB ON THE HANDLE ON THE SPACELAB SIDE (MIR 1) OR PAYLOAD BAY SIDE (MULTI-MIR) OF THE HATCH IS REMOVABLE. THE DESIGN UTILIZES DUAL O-RING SEALS TO PREVENT LEAKAGE OF ODS PRESSURE THROUGH OR PAST THE ACTUATORS.

REFERENCE DOCUMENTS: M072-593628

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FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL FAILURE MODE
NUMBER: M8-1MR-M004-02

REVISION# 3 9/15/95
SUBSYSTEM NAME: MECHANICAL - EXTERNAL AIRLOCK
LRU: ACTUATOR, HATCH LATCH
ITEM NAME: O-RING SEALS **CRITICALITY OF THIS FAILURE MODE: 2R3**

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

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

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

PASS/FAIL RATIONALE:

A)
FAILS REDUNDANCY SCREEN "A" BECAUSE SEALS CANNOT BE VERIFIED INDIVIDUALLY DURING GROUND CHECKOUT.

B)
N/A - AT LEAST ONE REMAINING PATH IS 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 PRESSURE (CONSUMABLES) IN ODS DURING IVA (MULTI-MIR).

- FAILURE EFFECTS -

(A) SUBSYSTEM:

NO EFFECT IF ONLY A SINGLE SEAL FAILS. FAILURE OF BOTH SEALS WOULD RESULT IN LOSS OF ISOLATION BETWEEN EXTERNAL AIRLOCK AND SPACELAB FOR MIR 1 OR LOSS OF ISOLATION BETWEEN EXTERNAL AIRLOCK AND PAYLOAD BAY FOR 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

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SPACELAB CONSUMABLES IF EVA "C" HATCH AND FIFTH HATCH ARE OPENED AND LEFT OPEN DURING DURATION OF EVA. REPRESSURIZATION OF ODS FOLLOWING EVA COULD RESULT IN SLOW LOSS OF CONSUMABLES INTO SPACELAB VACUUM. NO EFFECT DURING IVA SINCE EXTERNAL AIRLOCK AFT HATCH REMAINS OPEN.
 MULTI-MIR - LOSS OF ISOLATION WOULD RESULT IN A PRESSURE LEAK TO OUTSIDE ENVIRONMENT RESULTING IN AN INCREASED USE OF CONSUMABLES.

(C) MISSION:

MIR 1 - NO EFFECT DURING IVA SINCE EXTERNAL AIRLOCK AFT HATCH REMAINS OPEN.
 SECOND O-RING SEAL FAILURE: LOSS OF CAPABILITY TO PERFORM A PLANNED EVA IF SECOND FAILURE OCCURS PRIOR TO AN EVA; AND LOSS OF SPACELAB OPERATIONS FOLLOWING EVA.

MULTI-MIR - NO EFFECT FIRST O-RING FAILURE. WORST CASE, CREW DECISION TO ABORT MISSION DUE TO LOSS OF CONSUMABLES FOLLOWING SIMILAR FAILURE OF REDUNDANT O-RING.

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

NO EFFECT ON CREW AND VEHICLE SINCE CREW HAS SUFFICIENT TIME TO RECOVER FROM THE LEAK.

(E) FUNCTIONAL CRITICALITY EFFECTS:

FIRST O-RING SEAL FAILURE - NO EFFECT.

SECOND O-RING SEAL FAILURE:

MIR 1 - LOSS OF SPACELAB CONSUMABLES DURING EVA COULD IMPACT SPACELAB EQUIPMENT. INCREASED USE OF CONSUMABLES DURING REPRESSURIZATION, FOLLOWING EVA, WOULD PRECLUDE SUBSEQUENT MISSION ACTIVITIES. (WITH VACUUM CREATED IN SPACELAB DURING EVA, REPRESSURIZATION OF ODS WILL RESULT IN LEAKAGE OF ODS PRESSURE INTO SPACELAB.)

MULTI-MIR - (1) IF SECOND FAILURE OCCURS DURING IVA (CAMERA PREPARATION FOR DOCKING) LOSS OF CONSUMABLES WOULD RESULT IN EARLY TERMINATION OF MISSION; OR (2) IF SECOND FAILURE OCCURS DURING EVA INCREASED USE OF CONSUMABLES DURING REPRESSURIZATION WOULD PRECLUDE SUBSEQUENT MISSION ACTIVITIES.

DESIGN CRITICALITY (PRIOR TO DOWNGRADE, DESCRIBED IN (F)): 2R3

(F) RATIONALE FOR CRITICALITY DOWNGRADE:

THIRD FAILURE (INABILITY TO CLOSE APPROPRIATE HATCH(S)) - FAILURE TO ISOLATE LEAKAGE FROM CREW CABIN. NO EFFECT SINCE ORBITER ARPCS SYSTEM WILL PROVIDE AIR MAKE-UP CAPABILITIES AND MISSION AT THIS POINT HAS ALREADY BEEN ABORTED.

- TIME FRAME -

TIME FROM FAILURE TO CRITICAL EFFECT: MINUTES

TIME FROM FAILURE OCCURRENCE TO DETECTION: SECONDS

TIME FROM DETECTION TO COMPLETED CORRECTIVE ACTION: N/A

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

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RATIONALE FOR TIME TO CORRECTING ACTION VS TIME TO EFFECT:
THERE IS NO CORRECTIVE ACTION TO SEAL THE LEAKAGE. CORRECTIVE ACTION
ADDRESSED WILL ONLY ISOLATE THE LEAKAGE FROM THE CREW CABIN.

HAZARDS REPORT NUMBER(S): NONE

HAZARD(S) DESCRIPTION:
N/A

-DISPOSITION RATIONALE-

(A) DESIGN:

SEALS ARE STANDARD TYPE DUAL O-RING SEALS HELD IN SEPARATE GROOVES AGAINST A ROTATING INPUT SHAFT (LIMITED TO +450 DEG) OR AGAINST A SLIDING LOCKING STEM (LIMITED TO LESS THAN 3/8 INCH STROKE). DESIGNED FOR REPEATED USE - 2,000 CYCLES; EACH ROTATIONAL CYCLE OF THE INPUT SHAFT INCLUDES ONE FULL CLOCKWISE AND ONE FULL COUNTERCLOCKWISE ROTATION WITH A NORMAL 30 LB LOAD AT THE HANDLE (EQUIVALENT TO 10 YEAR, 100 MISSION LIFE) - WITHOUT SCHEDULED SERVICING OR MAINTENANCE. EACH SLIDING CYCLE OF THE LOCKING STEM INCLUDES ONE FULL UNLOCKING AND ONE FULL LOCKING ACTION OF THE FLIP-OVER LOCKING LEVER.

(B) TEST:

QUALIFICATION TESTS: SEALS QUALIFIED AS PART OF COMPONENT QUALIFICATION TESTING OF MC287-0036-0004 AND -0006 LATCH ACTUATOR PER CR-28-287-0036-0006C. QUALIFICATION TESTS INCLUDE: LIMIT LOAD TEST (10 CYCLES, WITH 3,750-4,941 LB AT OUTPUT ARM AND 150 LB AT HANDLE), CABIN ATMOSPHERE TEST (INCLUDES SALT FOG FOR 1 HOUR, +60 DEGREES F AND +120 DEGREES F AT 80% RELATIVE HUMIDITY FOR 120 HOURS), RANDOM VIBRATION TESTING FOR 48 MINUTES IN EACH OF THREE ORTHOGONAL AXES, SHOCK TEST (+/- 20 G'S, 11 MILLISECONDS EACH SHOCK, 110 TOTAL; PER MIL-STD-810), NORMAL OUTPUT TEST (2,000 CYCLES WITH 30 LB LOAD AT THE HANDLE; NOMINAL 8 CYCLES PER MISSION AND GROUND TURNAROUND; 600 CYCLES PER 100-MISSION LIFE), THERMAL CYCLE TEST BETWEEN -65 DEG F AND +275 DEG F (5 COMPLETE CYCLES AT EACH EXTREME TEMPERATURE - WITH A MINIMUM TEMPERATURE SOAK OF 60 MINUTES) AND ACCELERATION TEST (+/- 5 G'S IN EACH OF THREE ORTHOGONAL AXES, 5 MINUTES IN EACH AXIS).

ACCEPTANCE TESTS: ACCEPTANCE TESTING INCLUDES 100% EXAMINATION, 100% X-RAY, 100% LEAKAGE TESTING (NOT TO EXCEED 0.00001 STD CC/SEC/INCH OF SEAL AT 18 PSI LIMIT DELTA P) AND 100% NORMAL LOAD TEST (10 CYCLES, WITH 30 LB AT HANDLE AND 775-965 LB ON OUTPUT ARM).

OPERATIONS. TESTS ARE PERFORMED WHEN THE EXTERNAL AIRLOCK IS INSTALLED ON THE VEHICLE. NO OMRSD TEST CAPABLE OF DETECTING FIRST FAILURE OF SEAL. MAINTENANCE SAMPLING ON ACTUATOR AND SEALS AFTER FIRST 35 FLIGHTS/8 YEARS AND THEN AFTER NEXT 12 FLIGHTS/2 YEARS.

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

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(C) INSPECTION:

RECEIVING INSPECTION

RAW MATERIAL VERIFIED VISUAL INSPECTION/IDENTIFICATION PERFORMED, PARTS PROTECTION VERIFIED. O-RINGS ARE MAGNIFICATION INSPECTED FOR DAMAGE.

CONTAMINATION CONTROL

CONTAMINATION CONTROL PROCESSES AND CORROSION PROTECTION PROVISIONS VERIFIED. ALL PARTS ARE CLEANED TO 300 LEVEL PRIOR TO ASSEMBLY AND VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

RAW MATERIAL VERIFIED, VISUAL INSPECTION/IDENTIFICATION PERFORMED, PARTS PROTECTION VERIFIED, MANUFACTURING, INSTALLATION AND ASSEMBLY OPERATIONS VERIFIED BY SHOP TRAVELER MANDATORY INSPECTION POINTS (MIPS). O-RINGS ARE MAGNIFICATION INSPECTED AT RECEIVING AND INSTALLATION.

NONDESTRUCTIVE EVALUATION

STRUCTURAL INTEGRITY VERIFIED BY NONDESTRUCTIVE EVALUATION (NDE) (X-RAY) AND TECHNICIANS CERTIFICATIONS ARE VERIFIED BY INSPECTION.

TESTING

TESTING VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PROPERLY MONITORED HANDLING AND STORAGE ENVIRONMENT VERIFIED.

(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. MIR 1 - FAILURE OF REDUNDANT O-RING SEAL - RATE OF LEAKAGE AND THE FEASIBILITY OF COMPLETING THE MISSION OR EVA CAN BE DETERMINED. MULTI-MIR - AMOUNT OF LEAKAGE, GIVEN A FAILURE OF BOTH SEALS, IS LOW ENOUGH TO ALLOW THE CREW TO CLOSE APPROPRIATE HATCH(S) TO ISOLATE LEAKAGE FROM CREW CABIN.

- APPROVALS -

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