

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE

NUMBER: M7-3-M3-X

S050270A

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SUBSYSTEM NAME: TUNNEL ADAPTER

REVISION : 1 05/17/91

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
■ LRU	ACTUATOR, HATCH LATCH ELLANEF	MC287-0036-0008 A1039A10-8
■ LRU	ACTUATOR, HATCH LATCH ELLANEF	MC287-0036-0009 A1039A10-9

PART DATA

■ EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
HATCH LATCH ACTUATOR, HATCH "C" AND "D"

■ QUANTITY OF LIKE ITEMS: 2
ONE PER HATCH "C" (MC287-0036-0009)
ONE PER HATCH "D" (MC287-0036-0008)

■ FUNCTION:
THIS DEVICE IS MOUNTED ON BOTH TUNNEL ADAPTER HATCHES "C" AND "D" AND IS A SEALED AND MANUALLY DRIVEN REDUCTION GEARBOX THAT PROVIDES A CONTROLLED OUTPUT FOR DRIVING THE LATCH MECHANISM OPEN OR CLOSED. IN SO DOING, IT PROVIDES THE FORCE FOR HATCH SEAL COMPRESSION AS IT PULLS THE SEALING SURFACES TOGETHER. TWO HANDLES FOR OPERATION ARE PROVIDED FOR EACH HATCH; ONE IS ON EACH SIDE OF EACH HATCH. A MECHANICAL LOCK AND A "NO-BACK" ARE PROVIDED FOR RESTRAINT BETWEEN USES. THE KNOB ON THE HANDLE ON THE PAYLOAD BAY SIDE OF HATCH "C" IS REMOVABLE. THE DESIGN UTILIZES DUAL O-RING SEALS TO PREVENT LEAKAGE OF CABIN/AIRLOCK ATMOSPHERE THROUGH OR PAST THE ACTUATORS.

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SUBSYSTEM: TUNNEL ADAPTER
LRU :ACTUATOR, HATCH LATCH
ITEM NAME: ACTUATOR, HATCH LATCH

CRITICALITY OF THIS
FAILURE MODE:2R3

- FAILURE MODE:
LEAKAGE (O-RING SEALS)

MISSION PHASE:

LO	LIFT-OFF
OO	ON-ORBIT
DO	DE-ORBIT

- VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102	COLUMBIA
: 103	DISCOVERY
: 104	ATLANTIS
: 105	ENDEAVOUR

- 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) FAIL
- C) PASS

PASS/FAIL RATIONALE:

- A)
FAILS REDUNDANCY SCREEN "A" BECAUSE THE SEALS CANNOT BE VERIFIED INDIVIDUALLY.
- B)
FAILS REDUNDANCY SCREEN "B" BECAUSE THE SEALS CANNOT BE VERIFIED INDIVIDUALLY.
- C)
PASSES REDUNDANCY SCREEN "C" SINCE THE FAILURE OF ANY ONE SEAL CANNOT CAUSE THE FAILURE OF THE OTHER REDUNDANT SEAL.

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 - FAILURE EFFECTS -

■ (A) SUBSYSTEM:

NO EFFECT IF A SINGLE O-RING SEAL FAILS. TWO SUCCESSIVE O-RING SEAL FAILURES ON BOTH HATCH "C" AND HATCH "D" (OR, A TOTAL OF FOUR O-RING SEAL FAILURES) ARE REQUIRED BEFORE THERE CAN BE A LOSS OF SPACELAB ATMOSPHERE THROUGH THE AIRLOCK/TUNNEL ADAPTER AND TO THE OUTSIDE. TWO SUCCESSIVE O-RING SEAL FAILURES ARE REQUIRED ON HATCH "C" BEFORE THERE CAN BE A LOSS OF SPACELAB ATMOSPHERE THROUGH THE AIRLOCK/TUNNEL ADAPTER DURING SPACELAB OPERATIONS (WITH HATCH "D" OPEN). TWO SUCCESSIVE O-RING SEAL FAILURES ARE REQUIRED ON HATCH "D" BEFORE THERE CAN BE A LOSS OF SPACELAB ATMOSPHERE TO THE OUTSIDE DURING EVA (WITH HATCH "D" CLOSED AND HATCH "C" OPEN). FOLLOWING A SECOND O-RING SEAL FAILURE, THE LEAKAGE WILL STILL BE LOW ENOUGH TO ALLOW A SAFE COMPLETION OF THE MISSION OR EVA. EARLY TERMINATION OF THE MISSION OR EVA WOULD RESULT ONLY IF THE LEAK RATE WAS EXCESSIVE, BUT THERE WOULD BE NO LOSS OF CREW OR VEHICLE.

■ (B) INTERFACING SUBSYSTEM(S):

SAME AS (A).

■ (C) MISSION:

SAME AS (A).

■ (D) CREW, VEHICLE, AND ELEMENT(S):

SAME AS (A).

■ (E) FUNCTIONAL CRITICALITY EFFECTS:

 - 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

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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 6 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 16 PSI LIMIT DELTA P) AND 100% NORMAL LOAD TEST (10 CYCLES, WITH 30 LB AT HANDLE AND 775-988 LB ON OUTPUT ARM).

OMRSD: GROUND TURNAROUND INCLUDES VISUAL INSPECTION OF HATCH LATCH ACTUATOR FOR EVIDENCE OF BINDING, SURFACE CONTAMINATION AND POSSIBLE DAMAGE. GROUND TURNAROUND ALSO INCLUDES VISUAL INSPECTION OF THE TUNNEL ADAPTER HATCH "C" OPERATIONS AND TUNNEL ADAPTER HATCH "D" OPERATIONS. TESTS ARE PERFORMED WHEN THE TUNNEL ADAPTER IS INSTALLED ON THE VEHICLE. NO OMRSD TEST CAPABLE OF DETECTING FIRST FAILURE OF SEAL. MAINTENANCE SAMPLING ON ACTUATOR AND SEALS AFTER FIRST 36 FLIGHTS/8 YEARS AND THEN AFTER NEXT 12 FLIGHTS/2 YEARS.

- (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

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

HANDLING/PACKAGING
PROPERLY MONITORED HANDLING AND STORAGE ENVIRONMENT VERIFIED.

- (D) FAILURE HISTORY:
THERE HAVE BEEN NO ACCEPTANCE TEST, QUALIFICATION TEST, FIELD OR FLIGHT FAILURES ASSOCIATED WITH THIS FAILURE MODE.
- (E) OPERATIONAL USE:
THE RATE OF LEAKAGE AND THE FEASIBILITY OF COMPLETING THE MISSION OR EVA CAN BE DETERMINED.

- APPROVALS -

RELIABILITY ENGINEERING: D. M. MAYNE
 DESIGN ENGINEERING : R. A. SMITH
 QUALITY ENGINEERING : M. SAVALA
 NASA RELIABILITY :
 NASA SUBSYSTEM MANAGER :
 NASA QUALITY ASSURANCE :

: *D.M. Mayne*
 : *RAE 9/24/91*
 : *MJ 8/9/91*
 : *DMC 7/24/91*
 : *Cancel Campbell 7/20/91*
 : *UNR 4/15/91*