FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE
NUMBER: M7-3-M3-X

SUBSYSTEM NAME: TUNNEL ADAPTER

REVISION : 1 05/17/91

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
■ LRU :	ACTUATOR, HATCH LATCH	MC287-0036-0008
■	ELLANEF	A1039A10-8
■ LRU :	ACTUATOR, HATCH LATCH	MC287-0036-0009
■	ELLANEF	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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NUMBER: M7-3-M3-01

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

CRITICALITY OF THIS FAILURE MODE:1/1

■ FAILURE MODE:
PHYSICAL BINDING/JAMMING (GEARBOX)

MISSION PHASE:
00 ON-ORBIT

■ VEHICLE/PAYLOAD/KIT EFFECTIVITY: 102 COLUMBIA
: 103 DISCOVERY
: 104 ATLANTIS
: 105 ENDEAVOUR

■ CAUSE:
ADVERSE TOLERANCES/WEAR, CONTAMINATION/FOREIGN OBJECT/DEBRIS, FAILURE/DEFLECTION OF INTERNAL PART

■ CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

■ REDUNDANCY SCREEN A) N/A
■ B) N/A
■ C) N/A

PASS/FAIL RATIONALE:
■ A)
N/A

■ B)
N/A

■ C)
N/A

- FAILURE EFFECTS -

■ (A) SUBSYSTEM:
A JAMMED ACTUATOR WOULD PREVENT THE LATCHES FROM OPERATING AND THUS MIGHT PREVENT THE OPENING OF HATCH "C" FOR AN EMERGENCY EVA OR THE LATCHING OF HATCH "C" POST-EVA. A JAMMED ACTUATOR WOULD ALSO PREVENT

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THE OPENING OF HATCH "D" FOR SPACELAB OPERATIONS OR THE LATCHING OF HATCH "D" POST-SPACELAB OPERATIONS.

■ (B) INTERFACING SUBSYSTEM(S):
POSSIBLE LOSS OF EMERGENCY EVA CAPABILITY IF THE HATCH "C" LATCH MECHANISM FAILS TO ROTATE OPEN. POSSIBLE LOSS OF MISSION OBJECTIVES IF THE HATCH "D" LATCH MECHANISM FAILS TO ROTATE OPEN (LOSS OF ACCESS TO THE SPACELAB). DEGRADED CAPABILITY TO DE-PRESSURIZE OR RE-PRESSURIZE THE AIRLOCK/TUNNEL ADAPTER (PRE-EVA OR POST-EVA) IF A FLIGHT CREWMEMBER HAS TO FIRST PUSH ON ONE OF THE HATCHES TO MAKE THE INITIAL SEAL DURING THE PRESSURE CHANGE.

■ (C) MISSION:
SAME AS (B).

■ (D) CREW, VEHICLE, AND ELEMENT(S):
POSSIBLE LOSS OF CREW/VEHICLE IF HATCH "C" CANNOT BE OPENED FOR EMERGENCY EVA. POSSIBLE INJURY TO OR LOSS OF THE EVA CREWMEMBERS IF EITHER HATCH "C" OR "D" CANNOT BE KEPT CLOSED AND SEALED TO ALLOW SAFE RETURN INTO THE CREW CABIN THROUGH HATCH "A" POST-EVA.

■ (E) FUNCTIONAL CRITICALITY EFFECTS:

- DISPOSITION RATIONALE -

■ (A) DESIGN:
THE LATCH DRIVE ACTUATOR HAS DUAL ROTATING SURFACES. THE ACTUATOR IS DESIGNED FOR A 150 LB FORCE LIMIT LOAD AT THE HANDLE (AND A 1.4 FACTOR OF SAFETY). THE MAXIMUM HANDLE LOAD FOR UNLATCHING IS 20 LB FORCE. THE MAXIMUM HANDLE LOAD FOR LATCHING IS 30 LB FORCE. THE ACTUATOR GEARBOX IS DUAL O-RING SEALED TO PREVENT INTERNAL CONTAMINATION. THE EFFECTS OF HARD VACUUM EXPOSURE (TO THE PLANETARY GEARS, BALL BEARINGS, SHAFTS AND THE "NO-BACK") OR LEAKAGE OF CABIN ATMOSPHERE THROUGH OR PAST THE ACTUATOR. DRY FILM LUBE ON BEARING SURFACES. POSITIVE MARGINS ON ALL COMPONENTS.

■ (B) TEST:
QUALIFICATION TESTS: ACTUATOR COMPONENT QUALIFIED BY SIMILARITY TO MC287-0036-0004 AND -0006 (PER CR-287-0036-0006C). QUALIFICATION TESTS INCLUDE: VIBRATION FOR 48 MINUTES IN EACH OF 3 ORTHOGONAL AXES, CABIN ATMOSPHERE (PER MIL-STD-810B, INCLUDES: 1 HOUR SALT/FOG, THERMAL/HUMIDITY AT +60 DEG F TO +120 DEG F AT 80% RELATIVE HUMIDITY FOR 120 HOURS), LIMIT LOAD (150 LB AT HANDLE 3,750-4,941 LB AT OUTPUT ARM, 10 CYCLES), THERMAL CYCLE TESTS (INCLUDES: THERMAL-VACUUM AT -65 DEG F AND +275 DEG F FOR 5 OPERATIONAL CYCLES, AT EACH TEMPERATURE),

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PROOF PRESSURE/LEAK AT 16/16.5 PSI, CRASH/SHOCK AT +/- 20 G'S (FOR 11 MILLI-SECONDS, PER MIL-STD-810B), ACCELERATION (5 G'S IN EACH OF 3 ORTHOGONAL AXES, 5 MINUTES EACH), BACKLASH TESTS (MAXIMUM +/- 1 DEGREE WITH +/- 10 LB ON OUTPUT ARM, AND OPERATING LIFE (2,000 CYCLES) WITH 775 LB AT OUTPUT ARM. "NO-BACK" TEST (4,941 LB AND NO GREATER THAN 2 DEGREES DEFLECTION AT OUTPUT ARM), MECHANICAL STOP TEST (ROTATE HANDLE TO EACH STOP AND APPLY 150 LB, 50 CYCLES WITH NO JAMMING), LOCK CONTROL AND INDICATOR TEST (APPLY 150 LB TO LOCKED HANDLE, 10 TIMES, WITH LOCK OPERABLE FROM BOTH HANDLES; APPLY 8-10 LB TO LOCKING-LEVER TO UNLOCK 25 TIMES), MECHANICAL LOCK TEST (APPLY 223 LB TO INPUT LOAD CABLE, WITH NON-REMOVABLE HANDLE FULL CLOCKWISE AND LOCKED).

ACCEPTANCE TEST: ACTUATOR ACCEPTANCE TESTS INCLUDE MECHANICAL LOCK TEST (NO ROTATION WITH 150 LB LIMIT LOAD AT HANDLE), NORMAL LOAD TESTS (10 CYCLES, WITH 30 LB AT HANDLE AND 775-988 LB AT OUTPUT ARM), X-RAY (2 VIEWS, PER MIL-STD-453, FOR FOREIGN OBJECTS/MATERIALS, AND LEAKAGE TEST (MAXIMUM 0.00001 STD CC/SEC/INCH OF SEAL WITH 16 PSID LIMIT).

OMRSD: HATCH LATCH ACTUATOR IS FUNCTIONALLY OPERATED FOR EVIDENCE OF BINDING, SURFACE CONTAMINATION AND POSSIBLE DAMAGE. VISUALLY INSPECT TUNNEL ADAPTER HATCH "C" AND "D" MECHANISM LATCHES AND HINGES. FUNCTIONAL CHECK OF HATCH "C" AND "D" ARE PERFORMED BY OPENING AND CLOSING HATCHES FROM INSIDE TUNNEL ADAPTER AND REPEATING FROM OUTSIDE ADAPTER. ACTUATOR HANDLE AND LOCK LEVER FORCES ARE CHECKED. TESTS ARE PERFORMED WHEN THE TUNNEL ADAPTER IS INSTALLED ON THE VEHICLE.

REFERENCE OMRSD V33A00.0XX AND V33AE0.0XX

(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
MANUFACTURING, INSTALLATION AND ASSEMBLY OPERATIONS VERIFIED BY SHOP TRAVELERS. MANDATORY INSPECTION POINTS (MIPS), LATCH AND HANDLE FORCES, GEARBOX ASSEMBLY, AND BEARING INSTALLATION ARE VERIFIED BY INSPECTION. ALL PURCHASED PART DATA PACKS AND SPRING DIAMETERS AND FORCES ARE VERIFIED BY INSPECTION. O-RINGS ARE MAGNIFICATION INSPECTED PRIOR TO INSTALLATION.

NONDESTRUCTIVE EVALUATION

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

TESTING
GEAR HARDNESS TEST, ACROSS PIN MEASUREMENT (TO FIND MAXIMUM ACTUAL SPACE WIDTH AND MINIMUM ACTUAL TOOTH THICKNESS OF SPLINES), AND REDLINE TEST FOR COMPOSITE ERROR 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:
NO OPERATIONAL WORKAROUND IS POSSIBLE FOR FAILURE TO OPEN HATCH "C" (RESULTING IN LOSS OF EVA CAPABILITY) OR FAILURE TO OPEN HATCH "D" (RESULTING IN INABILITY TO ENTER SPACELAB). WORKAROUND FOR FAILURE TO CLOSE HATCH "C" OR "D" IS FOR EVA CREWMEMBER TO HOLD HATCH IN CLOSED POSITION DURING REPRESSURIZATION OF TUNNEL ADAPTER AND AIRLOCK, TO ALLOW RE-ENTRY INTO CREW MODULE THROUGH AIRLOCK HATCH "A".

- APPROVALS -

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