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.

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
NUMBER: M7-3-M3-03

REVISION# 1 05/17/91 R

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

CRITICALITY OF THIS FAILURE MODE:1/1

■ FAILURE MODE:
FAILS TO UNLOCK (LOCK MECHANISM)

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, PHYSICAL BINDING/JAMMING

■ 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 LATCH ACTUATOR FAILING TO UNLOCK WOULD PREVENT THE LATCHES FROM OPERATING AND WILL CAUSE THE LOSS OF THE ABILITY TO OPEN THE HATCH.

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
NUMBER: M7-3-M3-03

■ (B) INTERFACING SUBSYSTEM(S):
LOSS OF EMERGENCY EVA CAPABILITY IF THE HATCH LATCH LOCK MECHANISM FAILS TO UNLOCK THE HANDLE ON HATCH "C" PRE-EVA. LOSS OF SPACELAB MISSION OBJECTIVES IF THE HATCH LATCH LOCK MECHANISM FAILS TO UNLOCK THE HANDLE ON HATCH "D" PRIOR TO ENTERING THE SPACELAB.

■ (C) MISSION:
SAME AS (B).

■ (D) CREW, VEHICLE, AND ELEMENT(S):
POSSIBLE LOSS OF CREW/VEHICLE IF EMERGENCY EVA PROCEDURES ARE REQUIRED AND HATCH "C" CANNOT BE OPENED PRE-EVA. THIS FAILURE CANNOT HAPPEN ON HATCH "C" TO PREVENT THE EVA CREWMEMBERS SAFE RETURN INTO THE AIRLOCK/TUNNEL ADAPTER POST-EVA SINCE IT IS LEFT OPEN AND UNLATCHED DURING EVA.

■ (E) FUNCTIONAL CRITICALITY EFFECTS:

- DISPOSITION RATIONALE -

■ (A) DESIGN:
THE ACTUATOR HANDLE LOCK PROVIDES A POSITIVE MEANS TO LOCK OR UNLOCK THE LATCH ACTUATOR BY RESTRAINING OR UNRESTRAINING THE HANDLE WITH A SHEAR-PIN THAT IS ACTIVATED BY A FLIP-OVER LOCKING-LEVER (LOCATED ON EACH HANDLE). THE LOCKING-LEVER ALSO PROVIDES A VISUAL INDICATION OF THE LOCKED AND UNLOCKED CONDITION OF THE ACTUATOR AND REQUIRES 8-10 LB FORCE (TO OPPOSE A SPRING-LOADED DETENT) TO BE PLACED IN THE UNLOCKED POSITION. VIBRATION, BUMPING, KICKING OR OTHER UNINTENTIONAL MEANS SHALL NOT UNLOCK THE ACTUATOR.

■ (B) TEST:
QUALIFICATION TESTS: COMPONENT QUALIFIED BY SIMILARITY TO MC287-0036-0004 AND -0006 (PER CR-2B-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 +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), 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

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE NUMBER: M7-3-M3-03

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 HATCH "D" EVERY FLIGHT OF TUNNEL ADAPTER. HATCH "C" AND HATCH "D" FUNCTIONAL CHECKS ARE PERFORMED EACH FLIGHT OF TUNNEL ADAPTER. ALL ACTUATOR AND LATCH MECHANISM COMPONENTS ARE TESTED BY PERFORMING FUNCTIONAL CHECKS FROM EITHER SIDE OF HATCHES. TESTS ARE PERFORMED WHEN THE TUNNEL ADAPTER IS INSTALLED ON THE VEHICLE.

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

TESTINGS
GEAR HARDNESS TEST, ACROSS PIN MEASUREMENT (TO FIND MAXIMUM ACTUAL

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
NUMBER: M7-3-M3-03

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 WORKAROUND IS POSSIBLE IF TUNNEL ADAPTER HATCH "C" OR HATCH "D" ACTUATOR FAILS TO UNLOCK PRIOR TO EVA OR ENTRY TO SPACELAB. FAILURE MODE CANNOT OCCUR ON HATCH "C" AFTER OPENING BECAUSE HATCH REMAINS OPEN DURING EVA. HATCH "D" REMAINS OPEN DURING SPACELAB OPERATIONS.

- APPROVALS -

RELIABILITY ENGINEERING	D. M. MAYNE	D.M. Mayne 5/14/91
DESIGN ENGINEERING	R. A. SMITH	ACR for 5/14/91
QUALITY ENGINEERING	M. SAVALA	M Savala 6/18/91
NASA RELIABILITY		DMC for 7/24/91
NASA SUBSYSTEM MANAGER		7/30/91
NASA QUALITY ASSURANCE		7/26/91