FAILURE MODES EFFECTS ANALYSIS (FMEA) — CRITICAL HARDWARE
NUMBER: M7-3-M1-X

SUBSYSTEM NAME: TUNNEL ADAPTER

REVISION : 1 05/17/91

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
■ LRU :	LATCH MECHANISM, HATCH "C"	M072-593302

PART DATA

■ EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
LATCH MECHANISM, HATCH "C"

■ QUANTITY OF LIKE ITEMS: 1
ONE

■ FUNCTION:
THIS MECHANISM IS MOUNTED ON OUTER (LOW PRESSURE) SIDE OF HATCH "C" (A MISSION MODIFIED HATCH "B") TO SECURE IT IN A CLOSED AND SEALED POSITION. THIS MECHANISM CONSISTS OF SIX (6) APOLLO CREW MODULE-TYPE LATCHES JOINED BY RODS AND LINKS THAT MOVE CIRCUMFERENTIALLY, DRIVEN BY A MANUALLY OPERATED REDUCTION GEARBOX (ACTUATOR). TWO "KICKER" LATCHES ON HATCH "C" INCORPORATE PROVISION FOR "BREAKING" THE HATCH SEALS AGAINST ANY SMALL RESIDUAL DELTA PRESSURE, WHEN OPENING THE HATCH.

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
NUMBER: M7-3-M1-01

REVISION# 1 05/17/91 R

SUBSYSTEM: TUNNEL ADAPTER
LRU :LATCH MECHANISM, HATCH "C"
ITEM NAME: LATCH MECHANISM, HATCH "C"

CRITICALITY OF THIS FAILURE MODE:1/1

■ FAILURE MODE:
FAILS TO DISENGAGE

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:
LATCHES THAT FAIL TO DISENGAGE WILL CAUSE THE LOSS OF THE ABILITY TO OPEN AND TRANSFER THROUGH HATCH "C" INTO THE PAYLOAD BAY FOR EMERGENCY EVA.

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■ (B) INTERFACING SUBSYSTEM(S):
LOSS OF ABILITY TO SUPPORT EMERGENCY EXTRAVEHICULAR ACTIVITY (EVA) IF HATCH "C" CANNOT BE UNLATCHED AND OPENED (PRE-EVA).

■ (C) MISSION:
SAME AS (B).

■ (D) CREW, VEHICLE, AND ELEMENT(S):
POSSIBLE LOSS OF CREW/VEHICLE ONLY IF EMERGENCY EVA PROCEDURES ARE REQUIRED AND HATCH "C" CANNOT BE UNLATCHED AND OPENED PRE-EVA.

■ (E) FUNCTIONAL CRITICALITY EFFECTS:

- DISPOSITION RATIONALE -

■ (A) DESIGN:
LATCH MECHANISM BASED ON PROVEN APOLLO DESIGN. LINKAGE ATTACHMENTS HAVE DUAL ROTATING SURFACES, MAXIMUM UNLATCHING FORCE IS 20 LB AT THE HANDLE, ACTUATOR AND LINKAGE DESIGNED FOR 150 LB LIMIT LOAD AT THE HANDLE, POSITIVE MARGINS ON ALL COMPONENTS, SEAL COMPRESSIVE FORCE ASSISTS UNLATCHING. LATCH AND LINKAGE MATERIALS (INCONEL, A286 CRES AND BERYLLIUM COPPER) CHOSEN FOR HIGH STRENGTH AND LOW WEAR. DRY FILM LUBE ON BEARING SURFACES. DESIGN STRESS ANALYSIS REPORT SD77-SH-0178, VOL. 6.

■ (B) TEST:
QUALIFICATION TESTS: LATCHES AND ACTUATOR SYSTEM QUALIFIED BY SIMILARITY (PER CR-28-593201-001C) TO THE MECHANISMS ON THE INGRESS/EGRESS HATCH. REFERENCE FMEA/CIL 02-4A-593201-01. ACTUATOR ALSO COMPONENT QUALIFIED BY SIMILARITY TO ACTUATOR ON INGRESS/EGRESS HATCH (PER CR-28-287-0036-0006C); REFERENCE FMEA/CIL 02-4A-593202-01. CERTIFICATION BY SIMILARITY/ANALYSIS (PER MF0004-014) INCLUDED: FUNGUS, SALT/FOG, OZONE, SAND/DUST, TEMPERATURE CYCLE, CRASH/SHOCK, ACCELERATION, CABIN ATMOSPHERE, LIFE CYCLE (2,000 CYCLES), VIBRATION AND STRUCTURAL LOAD REQUIREMENTS.

CERTIFICATION TESTS INCLUDED: ZERO-"G" AND ONE-"G" OPERATION (USING APPROPRIATE GSE EQUIPMENT) AND HATCH SEALING/LEAK TEST (WITH 15.0 PSID ACROSS HIGH-PRESSURE SIDE OF HATCH, WITH MAXIMUM ALLOWABLE LEAK RATE OF 1.03 SCIM), PROOF PRESSURE 17.7 PSID FOR 2.0 +/- 1.0 MINUTE (PER ML0206-0089). LATCH MECHANISM INSTALLED AND RIGGED PER TECH ORDER INSTALLATION M072-593301.

OMRSD: MECHANISM IS FUNCTIONALLY OPERATED FOR EVIDENCE OF BINDING, SURFACE CONTAMINATION AND POSSIBLE DAMAGE. VISUALLY INSPECT TUNNEL

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ADAPTER HATCH "C" MECHANISM LATCHES AND HINGES. FUNCTIONAL CHECK OF HATCH "C" IS PERFORMED BY OPENING AND CLOSING HATCH 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 V33AD0.0XX

■ (C) INSPECTION:
RECEIVING INSPECTION
MATERIAL AND PROCESS CERTIFICATIONS VERIFIED BY INSPECTION.

CONTAMINATION CONTROL
ASSEMBLY IS PERFORMED IN CLEAN ENVIRONMENT WHICH IS MONITORED BY INSPECTION.

ASSEMBLY/INSTALLATION
ASSEMBLY, ADJUSTMENT, TORQUING AND RIGGING ARE VERIFIED BY INSPECTION (M072-593301).

NONDESTRUCTIVE EVALUATION
PENETRANT INSPECTION OF DETAIL HARDWARE IS VERIFIED BY INSPECTION.

CRITICAL PROCESSES
DRY FILM LUBRICATION IS VERIFIED BY INSPECTION.

TESTING
FUNCTIONAL TESTING IS VERIFIED BY INSPECTION.

■ (D) FAILURE HISTORY:
CAR NO. 09FD05: AIRLOCK HATCH "A" (BETWEEN CREW MODULE AND AIRLOCK) DURING STS-9 MISSION WAS DIFFICULT TO OPEN; UPPER CENTER GUIDE SUPPORT BRACKET DEBONDED FROM HATCH AND HATCH MOVED UPWARD AFTER LATCHES WERE RELEASED ALLOWING AIRLOCK FLANGE TO BECOME TRAPPED BETWEEN UPPER CENTER LATCH "KICKER" ARM AND ROLLER; DEBONDED GUIDE SUPPORT WAS REBONDED.

■ (E) OPERATIONAL USE:
NO OPERATIONAL WORKAROUND IS FEASIBLE BECAUSE HATCH "C" LATCH MECHANISM IS ON THE OUTER SURFACE OF THE HATCH AND IS INACCESSIBLE TO CREW MEMBERS INSIDE THE TUNNEL ADAPTER. HATCH "C" IS LEFT OPEN DURING EVA OPERATIONS.

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- APPROVALS -

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