PRINT DATE: 10/08/90

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE
NUMBER: 02-4A-593202-X

SUBSYSTEM NAME: ACTUATION MECHANISM - HATCHES

REVISION : 2 10/08/90

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU :	ACTUATOR, LATCH DR, I/E HATCH ELLANEF	MC287-0036-0007 A1039A10-7

PART DATA

- EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
  ACTUATOR, LATCH DRIVE, INGRESS/EGRESS HATCH

- QUANTITY OF LIKE ITEMS: 1
  ONE

- FUNCTION:
  THIS COMPONENT IS A SEALED AND MANUALLY OPERATED REDUCTION GEARBOX THAT PROVIDES A MEANS FOR DRIVING THE HATCH LATCHES TO EITHER THE OPEN OR THE CLOSED POSITION. THE ACTUATOR CAN BE OPERATED FROM EITHER SIDE OF THE HATCH BY THE FLIGHT CREW OR GROUND PERSONNEL. A MECHANICAL LOCK AND A "NO-BACK" IS PROVIDED FOR RESTRAINT BETWEEN USES. THE DESIGN UTILIZES DUAL (REDUNDANT) O-RING SEALS TO PREVENT LEAKAGE OF CABIN ATMOSPHERE THROUGH OR PAST THE ACTUATOR.

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
NUMBER: 02-4A-593202-01

REVISION# 2 10/08/90 R

SUBSYSTEM: ACTUATION MECHANISM - HATCHES
LRU :ACTUATOR, LATCH DR, I/E HATCH
ITEM NAME: ACTUATOR, LATCH DR, I/E HATCH

CRITICALITY OF THIS FAILURE MODE:1/1

■ FAILURE MODE:
PHYSICAL BINDING/JAMMING (GEARBOX)

MISSION PHASE:
PL PRELAUNCH

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

■ CAUSE:
ADVERSE TOLERANCE/WEAR, CONTAMINATION/FOREIGN OBJECT/DEBRIS, FAILURE/DEFLECTION OF INTERNAL PART, INABILITY TO UNLOCK ACTUATOR.

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, PREVENT THE INGRESS OR EGRESS FROM THE ORBITER THROUGH THE SIDE HATCH AND/OR PREVENT THE CLOSE OUT OF THE CREW MODULE FOR FLIGHT.

■ (B) INTERFACING SUBSYSTEM(S):
NO EFFECT. FAILURE TO OPEN SIDE HATCH DOES NOT AFFECT INTERFACING SYSTEMS.

(C) MISSION:
POSSIBLE LOSS OF MISSION OBJECTIVES AND CREW IF FAILURE OCCURS WHEN EMERGENCY EGRESS ON THE PAD IS REQUIRED (OVERHEAD EMERGENCY EGRESS WINDOW IS NOT USABLE ON THE PAD; ONLY AFTER A LANDING). NO EFFECT IN FLIGHT. TOOLS ARE AVAILABLE TO DISCONNECT AND TO DRIVE LATCHES OPEN FOR A NON-EMERGENCY EGRESS IF TIME IS AVAILABLE. IF FAILURE OCCURS DURING A POST-LANDING EMERGENCY, THE OVERHEAD EMERGENCY EGRESS WINDOW OR PYROTECHNIC SIDE HATCH CREW ESCAPE SYSTEM CAN BE UTILIZED.

■ (D) CREW, VEHICLE, AND ELEMENT(S):
SAME AS (C).

(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 30 LB FORCE. THE MAXIMUM HANDLE LOAD FOR LATCHING IS 50 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: 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-8018, 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), PROOF PRESSURE/LEAK AT 16/16.5 PSID (WITH MAXIMUM OF 0.00001 STD CC/SEC/INCH OF SEAL LEAKAGE), CRASH/SHOCK AT +/- 20 G'S (FOR 11 MILLISECONDS, 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 TESTS: 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: 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 OPENING THE CABIN HATCH FROM OUTSIDE-HORIZONTAL, OPENING FROM INSIDE-HORIZONTAL, CLOSING FROM OUTSIDE-VERTICAL AND OPENING FROM INSIDE-VERTICAL. PROPER FUNCTION IS VERIFIED AT EACH GROUND TURNAROUND.

■ (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 LEVEL 300 PRIOR TO ASSEMBLY AND VERIFIED BY INSPECTION.

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

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

TESTING
GEAR HARDNESS TEST, ACROSS PIN MEASUREMENT AND REDLINE TESTS FOR

COMPOSITE ERROR ARE VERIFIED BY INSPECTION.

HANDLING/PACKAGING
HANDLING AND STORAGE REQUIREMENTS ARE VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:
CAR NO. A2826 : LOCKPIN LINKAGE OF LATCH ACTUATOR DID NOT TRAVEL FULLY DURING UNLOCKING AND FRICTION FORCES EXISTED BETWEEN LOCKPIN AND HOUSING; BUSHING HIGH DURING UNLOCKING, LOCKPIN DID NOT LINE UP WITH BUSHING; ADDITIONAL CAM PIECE WAS MOUNTED ON LOCK LEVER FOR POSITIVE PHYSICAL CONTACT IN TWO LOCATIONS WITH MODIFIED LOCK MECHANISM BELLCRANK AND BUSHING INSIDE DIAMETER INCREASED FOR POSITIVE PICKUP OF HOLE BY LOCKPIN WITHOUT UNACCEPTABLE FREEPLAY.

CAR NO. A9087 : INABILITY TO UNLOCK HATCH FROM INSIDE/OUTSIDE WHEN LATCH LOCK MECHANISM WAS ENGAGED INADVERTENTLY DURING GROUND CHECKOUT; INADVERTENT LOCKPIN ENGAGEMENT WAS INHERENT IN THE DESIGN; MCR 4945 AUTHORIZED REDESIGN OF LOCKPIN AND LOCK LEVER BY ACTUATOR SUPPLIER (ELLANEF) TO PRECLUDE INADVERTENT LOCKPIN ENGAGEMENT.

CAR NO. AC9754 : DETENT CAM AND RETAINER SLIPPED DOWN HANDLE OF LATCH ACTUATOR, INTERFERING WITH HATCH OPENING; DETENT BRACKET VIBRATED LOOSE AND CLAMP FRICTION WAS INADEQUATE; NO PREVIOUS PROBLEM HISTORY; DETENT CAM BRACKET REINSTALLED AND VERIFIED.

(E) OPERATIONAL USE:
CREW CAN MANUALLY DISCONNECT AND THEN DRIVE THE LATCHES (WITH AVAILABLE TOOLS) TO EXIT THE CABIN ON THE PAD OR AFTER A NON-EMERGENCY LANDING. THE OVERHEAD EMERGENCY EGRESS WINDOW MAY BE USED BY CREWMEMBERS OR GROUND PERSONNEL ONLY AFTER AN EMERGENCY LANDING. THE (PYROTECHNIC) SIDE HATCH CREW ESCAPE SYSTEM HAS NOW BEEN INSTALLED AND CAN BE USED FOR EMERGENCY EXIT.

- APPROVALS -

RELIABILITY ENGINEERING	D. M. MAYNE	:
DESIGN ENGINEERING	: G. ARMENDARIZ	:
QUALITY ENGINEERING	: M. SAVALA	:
NASA RELIABILITY	:	:
NASA SUBSYSTEM MANAGER	:	:
NASA QUALITY ASSURANCE	:	: