

FAILURE MODES EFFECTS ANALYSIS (FMEA) - NON-CIL FAILURE MODE

NUMBER: M8-1MR-M003-01

REVISION# 3 9/15/95

SUBSYSTEM NAME: MECHANICAL - EXTERNAL AIRLOCK

LRU: ACTUATOR, HATCH LATCH

CRITICALITY OF THIS

ITEM NAME: ACTUATOR, HATCH LATCH

FAILURE MODE: 1R3

FAILURE MODE:

PHYSICAL BINDING/JAMMING (GEARBOX)

MISSION PHASE:

OO ON-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY: 104 ATLANTIS

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

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

CRITICALITY 1R2 DURING INTACT ABORT ONLY (AVIONICS ONLY)? N/A

REDUNDANCY SCREEN

A) PASS

B) N/A

C) PASS

PASS/FAIL RATIONALE:

A)

B)

N/A - AT LEAST TWO REMAINING PATHS ARE DETECTABLE IN FLIGHT.

C)

METHOD OF FAULT DETECTION:LATCH ACTUATOR BINDING OR JAMMING CAN VISUALLY/PHYSICALLY BE DETECTED BY
THE FLIGHT CREW.**CORRECTING ACTION:** EVA CREWMEMBER CAN REMOVE HATCH AND HOLD HATCH IN
CLOSED POSITION DURING REPRESSURIZATION OF EXTERNAL AIRLOCK, TO ALLOW RE-
ENTRY INTO CREW MODULE THROUGH FIFTH HATCH AND 'A' HATCH.**REMARKS/RECOMMENDATIONS:**EVA CAN BE PERFORMED OUT EXTERNAL AIRLOCK UPPER HATCH WHEN ORBITER AND
MIR ARE NOT DOCKED. EFFECTS ON EVA RECOVERY ARE MINIMIZED SINCE TUNNEL
ADAPTER 'C' HATCH IS THE PRIMARY HATCH FOR PERFORMING AN EVA AND AN ADDED
FIFTH HATCH WILL ISOLATE TUNNEL ADAPTER AND EXTERNAL AIRLOCK VOLUMES.

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- FAILURE EFFECTS -

(A) SUBSYSTEM:

A JAMMED ACTUATOR WOULD PREVENT THE LATCHES FROM OPERATING. INABILITY TO LATCH EXTERNAL AIRLOCK UPPER HATCH CLOSED FOR SEPARATION AND FOR PERFORMING AN EVA OUT EXTERNAL AIRLOCK.

(B) INTERFACING SUBSYSTEM(S):

INABILITY TO LATCH EXTERNAL AIRLOCK UPPER HATCH CLOSED WOULD EXPOSE INTERFACING SUBSYSTEMS TO VACUUM DURING SEPARATION AND PREVENT THE CAPABILITY TO RECOVER FROM AN EVA OUT EXTERNAL AIRLOCK.

(C) MISSION:

INABILITY TO PERFORM A PLANNED EVA OUT EXTERNAL AIRLOCK, IF JAMMED ACTUATOR PREVENTS EXTERNAL AIRLOCK UPPER HATCH FROM CLOSING WHEN ORBITER AND MIR ARE NOT DOCKED.

(D) CREW, VEHICLE, AND ELEMENT(S):

POSSIBLE LOSS OF EVA CREWMEMBERS IF UPPER HATCH CANNOT BE CLOSED AND SEALED FOLLOWING AN EVA OUT EXTERNAL AIRLOCK WHEN ORBITER AND MIR ARE NOT DOCKED.

IF EXTERNAL AIRLOCK UPPER HATCH IS REMOVED AND HELD INTO PLACE WHILE RE-PRESSURIZING EXTERNAL AIRLOCK VOLUME, THE POTENTIAL EXISTS FOR DAMAGE TO THE EXTERNAL AIRLOCK DURING DESCENT. ONCE PRESSURE ACROSS THIS HATCH HAS EQUALIZED THE UNATTACHED HATCH IS ALLOWED TO MOVE FREELY.

(E) FUNCTIONAL CRITICALITY EFFECTS:

A JAMMED ACTUATOR WOULD PREVENT EXTERNAL AIRLOCK UPPER HATCH FROM CLOSING. INABILITY TO CLOSE EXTERNAL AIRLOCK UPPER HATCH, AFTER PERFORMING A PLANNED EVA OUT EXTERNAL AIRLOCK WHEN ORBITER AND MIR ARE NOT DOCKED, WOULD PREVENT THE ABILITY TO REPRESSURIZE EXTERNAL AIRLOCK VOLUME. POSSIBLE LOSS OF EVA CREW MEMBERS IF EVA IS PERFORMED OUT EXTERNAL AIRLOCK UPPER HATCH AND HATCH CANNOT BE CLOSED & SEALED DURING REPRESSURIZATION FOR CREW RETURN TO CABIN (EVA CREW MEMBERS MUST REMAIN IN AIRLOCK UNTIL LANDING). THIS WOULD FIRST REQUIRE A FAILURE TO OPEN TUNNEL ADAPTER "C" HATCH SINCE IT IS PRIMARY FOR PERFORMING AN EVA.

DESIGN CRITICALITY (PRIOR TO DOWNGRADE, DESCRIBED IN (F)): 1/1

(F) RATIONALE FOR CRITICALITY DOWNGRADE:

THIRD FAILURE (INABILITY TO DISCONNECT HINGE OR HOLD HATCH IN CLOSED POSITION) - INABILITY TO CLOSE AND SEAL EXTERNAL AIRLOCK UPPER HATCH. EXTERNAL AIRLOCK VOLUME CANNOT BE REPRESSURIZED FOLLOWING A PLANNED EVA OUT THE UPPER HATCH WHEN ORBITER AND MIR ARE NOT DOCKED. POSSIBLE LOSS OF EVA CREW MEMBERS IF HABITABLE VOLUMES CANNOT BE REPRESSURIZED FOR CREW RETURN TO CABIN (EVA CREW MEMBERS MUST REMAIN IN AIRLOCK UNTIL LANDING).

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- TIME FRAME -

TIME FROM FAILURE TO CRITICAL EFFECT: HOURS TO DAYS

TIME FROM FAILURE OCCURRENCE TO DETECTION: SECONDS

TIME FROM DETECTION TO COMPLETED CORRECTIVE ACTION: MINUTES TO HOURS

IS TIME REQUIRED TO IMPLEMENT CORRECTIVE ACTION LESS THAN TIME TO EFFECT?
YES

RATIONALE FOR TIME TO CORRECTING ACTION VS TIME TO EFFECT:
CREW WOULD HAVE AMPLE TIME TO REMOVE HATCH AND HOLD HATCH IN CLOSED
POSITION TO ALLOW REPRESSURIZATION OF EXTERNAL AIRLOCK TO HOLD HATCH IN
CLOSED POSITION BEFORE FAILURE BECAME CATASTROPHIC.

HAZARDS REPORT NUMBER(S): DM10HA06(F)

HAZARD(S) DESCRIPTION:
EVA HAZARD.

- APPROVALS -

PRODUCT ASSURANCE ENGR. :	M. W. GUENTHER	: <u><i>M. W. Guenther</i></u>
DESIGN ENGINEER :	T. S. COOK	: <u><i>T. S. Cook</i></u>

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**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL FAILURE MODE
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(C) MISSION:
LOSS OF PRIMARY MISSION OBJECTIVES (ACCESS TO MIR) IF THE HATCH LATCH LOCK MECHANISM FAILS TO UNLOCK THE HANDLE ON EXTERNAL AIRLOCK UPPER HATCH AND HATCH CANNOT BE OPENED FOR ENTRY INTO VESTIBULE TUNNEL.

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT ON CREW OR VEHICLE.

(E) FUNCTIONAL CRITICALITY EFFECTS:
N/A

DESIGN CRITICALITY (PRIOR TO DOWNGRADE, DESCRIBED IN (F)): 2/2

(F) RATIONALE FOR CRITICALITY DOWNGRADE:
N/A (THERE ARE NO WORKAROUNDS TO CIRCUMVENT THIS FAILURE).

- TIME FRAME -

TIME FROM FAILURE TO CRITICAL EFFECT: MINUTES

TIME FROM FAILURE OCCURRENCE TO DETECTION: SECONDS

TIME FROM DETECTION TO COMPLETED CORRECTIVE ACTION: N/A

IS TIME REQUIRED TO IMPLEMENT CORRECTIVE ACTION LESS THAN TIME TO EFFECT?
NO

RATIONALE FOR TIME TO CORRECTING ACTION VS TIME TO EFFECT:
THERE IS NO CORRECTIVE ACTION TO UNLOCK A LOCKED UPPER HATCH LATCH ACTUATOR.

HAZARDS REPORT NUMBER(S): NONE

HAZARD(S) DESCRIPTION:
N/A

-DISPOSITION RATIONALE-

(A) DESIGN:
THE ACTUATOR HANDLE LOCK PROVIDES A POSITIVE MEANS TO LOCK OR UNLOCK THE LATCH ACTUATOR BY RESTRAINING OR UNDERSTANDING THE HANDLE WITH A SHEAR-PIN THAT IS ACTIVATED PROVIDEDS 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 IN PLACE IN THE UNLOCKED POSITION. VIBRATION, BUMPING, KICKING OR OTHER UNINTENTIONAL MEANS SHALL NOT UNLOCK THE ACTUATOR.

(B) TEST:
QUALIFICATION TESTS: ACTUATOR COMPONENT QUALIFIED BY SIMILARITY TO MC257-0035-0004 AND -0006 (PER CR-257-0035-0006C). QUALIFICATION TESTS INCLUDE: VIBRATION FOR 48 MINUTES IN EACH OF 3 ORTHOGONAL AXES, CABIN ATMOSPHERE

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(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), 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 TEST INCLUDES MECHANICAL LOCK TEST (NO ROTATION WITH 150 LB LIMIT LOAD AT HANDLE), NORMAL LOAD TESTS (10 CYCLES, WITH 30 LB HANDLE AND 775-988 LB AT 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 - TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:**RECEIVING INSPECTION**

RAW MATERIAL VERIFIED VISUAL INSPECTION/IDENTIFICATION PERFORMED, PARTS PROTECTION VERIFIED.

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 (MIP'S), 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.

NONDESTRUCTIVE EVALUATION

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.

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(D) FAILURE HISTORY:

CURRENT DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN PRACA DATA BASE.

(E) OPERATIONAL USE:

NO OPERATIONAL WORKAROUND IS POSSIBLE IF THE EXTERNAL AIRLOCK UPPER HATCH ACTUATOR FAILS TO UNLOCK.

- APPROVALS -

PRODUCT ASSURANCE ENGR	: M. W. GUENTHER
PAE MANAGER	: W. R. MARLOWE
DESIGN ENGINEER	: T. S. COOK
CHIEF ENGINEER	: B.J. BRANDT
NASA SSMA	:
NASA SUBSYSTEM MANAGER	:
JSC MOD	:

<i>M.G. Smith</i>
<i>W.R. Marlowe</i>
<i>T.S. Cook</i>
<i>B.J. Brandt</i>
<i>W.R. Marlowe</i>
<i>W.R. Marlowe</i>
<i>W.R. Marlowe</i>