

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 02-5E-L02 -X

| **SUBSYSTEM NAME:** PAYLOAD RETEN & DEPLOY - LATCHES

REVISION: 3

01/17/01

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: LIGHTWEIGHT LONGERON LATCH	V073-544100
LRU	: MIDDLEWEIGHT LONGERON LATCH	V073-544230
LRU	: SUPER MIDDLE WT LONGERON LATCH	V073-544530
SRU	: MOTOR/BRAKE ASSEMBLY SPERRY	MC287-0054-0001 2960614-021

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

| MOTOR/BRAKE ASSEMBLY

QUANTITY OF LIKE ITEMS:

40 MAX

| TWO MOTORS PER LATCH ASSEMBLY

FUNCTION:

LIGHTWEIGHT, MIDDLEWEIGHT OR SUPER MIDDLEWEIGHT LONGERON LATCH REACTS FLIGHT LOADS ON PAYLOAD HORIZONTAL TRUNNION HELD BETWEEN TWO SPHERICAL HALF BEARINGS. REDUNDANT MOTORS ACT THROUGH A DIFFERENTIAL AND GEARBOX TO DRIVE THE LINKAGES AND HOOK. THE MOTORS INCORPORATE INTEGRAL BRAKE MECHANISMS AND ARE CONTROLLED BY POSITION SWITCHES LOCATED WITHIN THE LATCH. TWO A/C PHASES ARE REQUIRED TO LIFT THE BRAKE AND POWER THE MOTOR. THERE ARE NO SINGLE FAILURE MODES WHICH WOULD ALLOW A FREE WHEELING MOTOR AFTER APPLICATION OF POWER.

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SUBSYSTEM NAME: PAYLOAD RETEN & DEPLOY - LATCHES

LRU: LIGHT, MIDDLE, SUPER MIDDLE WT LONGERON LATCH

ITEM NAME: MOTOR/BRAKE ASSEMBLY

CRITICALITY OF THIS FAILURE MODE: 1R3

FAILURE MODE:

BRAKE FAILS TO ENGAGE

MISSION PHASE:

OO ON-ORBIT
DO DE-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102 COLUMBIA
103 DISCOVERY
104 ATLANTIS
105 ENDEAVOUR

CAUSE:

ADVERSE TOLERANCES/WEAR, CONTAMINATION/FOREIGN OBJECT/DEBRIS, DEFECTIVE PART/MATERIAL OR MANUFACTURING DEFECT, FAILURE/DEFLECTION OF INTERNAL PART, ELECTRICAL FAILURE - OPEN, SHORT, ETC.

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN

- A) PASS
- B) FAIL
- C) PASS

PASS/FAIL RATIONALE:

A)

B)

FAILS REDUNDANCY SCREEN "B" SINCE THERE IS NO VISUAL OR INSTRUMENTED WAY OF DETECTING A FAILURE OF THE MOTOR/BRAKE ASSEMBLY IN FLIGHT.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

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FIRST FAILURE - NONE. SECOND FAILURE - FAILURE OF ASSOCIATED MOTOR WILL ALLOW THE OTHER REDUNDANT MOTOR TO BACKDRIVE THROUGH THE FAILED BRAKE AND LATCH POSITIONING CAPABILITY WOULD BE LOST.

(B) INTERFACING SUBSYSTEM(S):

FIRST FAILURE - NONE. SECOND FAILURE - FAILURE OF ASSOCIATED MOTOR WILL RESULT IN LOSS OF ABILITY TO DRIVE LATCH.

(C) MISSION:

FIRST FAILURE - NONE. SECOND FAILURE - FAILURE OF ASSOCIATED MOTOR WILL RESULT IN A POSSIBLE LOSS OF MISSION DUE TO INABILITY TO RELEASE OR RESTRAIN PAYLOADS.

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

FIRST FAILURE - NONE. SECOND FAILURE - POSSIBLE LOSS OF CREW/VEHICLE DUE TO UNRESTRAINED PAYLOAD DURING ENTRY.

(E) FUNCTIONAL CRITICALITY EFFECTS:

LOSS OF LATCH OPERATION IN MID-TRAVEL POSITION WOULD RESULT IN UNRESTRAINED PAYLOAD DURING ENTRY/LANDING, AND COULD RESULT IN LOSS OF VEHICLE AND/OR CREW.

DESIGN CRITICALITY (PRIOR TO DOWNGRADE, DESCRIBED IN (F)): 1R2

(F) RATIONALE FOR CRITICALITY DOWNGRADE:

CRITICALITY IS DOWNGRADED FROM THE DESIGN CRITICALITY, 1R/2, TO 1R/3 DUE TO CONSIDERATION OF THE EVA OPERATIONAL WORKAROUND CAPABILITY. WITH EVA CAPABILITY BUILT IN, THE CREW CAN OPEN OR CLOSE LATCHES MANUALLY.

-DISPOSITION RATIONALE-

(A) DESIGN:

THE MOTOR HAS THE DESIGN REQUIREMENTS OF THREE PHASE, 400 HZ, AC INDUCTION MOTOR AND INTEGRAL BRAKE THAT WILL BE USED IN A SPACE ENVIRONMENT. THE MOTOR IS ENCLOSED WITH COVER TO EXCLUDE CONTAMINATION. IT HAS FACTOR OF SAFETY OF 1.4 OVER LIMIT LOAD. MATERIALS AND PROCESSES FOR THE MOTOR ARE IN ACCORDANCE WITH MC999-0096. THIS MOTOR IS SAME AS USED ON ALL PAYLOAD RETENTION LATCHES.

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NUMBER: 02-5E-L02- 02

(B) TEST:

ACCEPTANCE TESTS: THE FOLLOWING TESTS ARE PERFORMED FOR ALL FLIGHT ARTICLES AND WERE PERFORMED FOR EACH QUALIFICATION TEST ARTICLE: VIBRATION - RANGE 20 TO 2,000 HZ MAXIMUM LEVEL OF 0.04 G2/HZ FROM 80 TO 350 HZ, ALL AXES. THERMAL - STABILIZED RANGE FROM -180 DEG F TO +255 DEG F. FUNCTIONAL TESTS CONDUCTED AT - 80 DEG F, +70 DEG F, AND +255 DEG F. LOADS/ALIGNMENT - VERIFY RETENTION OF LATCHED POSITION AT 80% LIMIT LOAD, AS WELL AS SPHERICAL BEARING TORQUE RESISTANCE AND TRAVEL LIMITS. ONE UNIT TESTED TO 110% LIMIT LOAD. ELECTRICAL - VERIFY (WITHIN DESIGN LIMITS) CONTINUITY, DIELECTRIC STRENGTH, INSULATION RESISTANCE, AND SWITCH OPERATION.

QUALIFICATION TESTS: THE FOLLOWING IS A SUMMARY OF TESTS CONDUCTED PER CR 44-544230-001 TO INCLUDE BOTH NATURAL AND INDUCED ENVIRONMENTAL EFFECTS TO THE LATCH ASSEMBLY AND THE LATCH-TO-BRIDGE/TRUNNION FRICTION/ LOAD INTERFACE. FUNCTIONAL TESTS WERE CONDUCTED DURING AND FOLLOWING EACH PHASE OF TESTING TO DETERMINE EFFECTS. ENVIRONMENTS AND REQUIREMENTS ACCEPTED BY ANALYSIS INCLUDE FUNGUS, OZONE, SALT SPRAY, ACCELERATION, SOLAR RADIATION (THERMAL AND NUCLEAR), METEORIODS, SAND AND DUST, STORAGE, FACTOR OF SAFETY, RELIABILITY, MAINTAINABILITY, MATERIALS AND PROCESSES, ELECTRICAL DESIGN AND SAFETY. CERTIFICATION BY SIMILARITY INCLUDED VACUUM, RANDOM VIBRATION, HANDLING SHOCK, THERMAL CYCLING, FULL OPERATING LIFE, QUALIFICATION ACCEPTANCE VIBRATION TEST (QAVT), QUALIFICATION ACCEPTANCE THERMAL TEST (QATT), TRUNNION/BRIDGE FRICTION, MECHANICAL STOPS, AND EXPLOSIVE ATMOSPHERE.

OMRSD: GROUND TURNAROUND INCLUDES RELEASE OPERATION (SYSTEM 1), LATCHING OPERATION (SYSTEM 1), RELEASE OPERATION (SYSTEM 2), AND LATCHING OPERATION (SYSTEM 2). ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:**RECEIVING INSPECTION**

MATERIAL AND PROCESS CERTIFICATIONS VERIFIED BY INSPECTION. INSPECTION VERIFIES THAT A SAMPLE FROM EACH LOT OF MATERIAL IS SPECTROSCOPICALLY ANALYZED TO VERIFY MATERIAL CHEMISTRY.

CONTAMINATION CONTROL

ALL PARTS ARE CLEANED BEFORE ENTERING STOCK ROOM AND RECLEANED BEFORE ENTERING CLEAN ROOM, VERIFIED BY INSPECTION. INSPECTION VERIFIES THAT PARTS ARE CLEANED TO LEVEL "VISIBLY CLEAN" OF MA0110-301 PRIOR TO ASSEMBLY. MOTOR/BRAKE ASSEMBLY IS ASSEMBLED IN A CLASS 10,000 CLEAN ROOM, VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

ALL PARTS ARE DIMENSIONALLY INSPECTED, VERIFIED BY INSPECTION. ASSEMBLY OPERATIONS ARE VERIFIED BY INSPECTION. RTV APPLICATION TO KEEP MOISTURE OUT OF THE MOTOR IS VERIFIED BY INSPECTION.

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CRITICAL PROCESSES

HEAT TREATING AND SOLDERING ARE VERIFIED BY INSPECTION. PASSIVATION OF STAINLESS STEEL PARTS IS VERIFIED BY INSPECTION. EXAMINATION OF SOLDER JOINTS BEFORE THEY ARE CLOSED UP AND SEALED IN WINDINGS IS A MANDATORY INSPECTION POINT. HEAT TREATING OF SHAFTS IS VERIFIED BY HARDNESS TEST.

TESTING

ATP (INCLUDING TESTING AT EXTREME TEMPERATURES, AT VARIOUS LOADS AND AT VARIOUS POSITIONS) IS VERIFIED PER PROCEDURE. WINDING RESISTANCE TEST IS VERIFIED BY INSPECTION. HIGH POTENTIAL TEST IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

HANDLING AND PACKAGING REQUIREMENTS ARE VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

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

(E) OPERATIONAL USE:

SECOND FAILURE WILL REQUIRE CREW TO PERFORM EXTRAVEHICULAR (EVA) PROCEDURES FOR MANUAL LATCH OPEN/CLOSE.

- APPROVALS -

S&R ENGINEER	: T. T. AI	: <i>[Signature]</i> 2/26/01
S&R ENGINEERING ITM	: P. A. STENGER-NGUYEN	: <i>[Signature]</i> 3/8/01
DESIGN ENGINEER	: D. E. HAEHLKE	: <i>[Signature]</i> 2/26/01
SUBSYSTEM MANAGER	: P. REESE	: <i>[Signature]</i> 2/27/01
MOD	: D. B. LYLE	: <i>[Signature]</i> 3/8/01
USA SAM	: B. BOURGEOIS	: <i>[Signature]</i> 3/8/01
USA ORBITER ELEMENT	: S. LITTLE	: <i>[Signature]</i> 3/8/01