

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: M8-1SS-M020A-X *Qymb*

SUBSYSTEM NAME: MECHANICAL - CREW EQUIPMENT

REVISION: 1

10/23/98

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRJ	:LIGHT WT TOOL STOWAGE ASSY (PORT)	V849-660300-001
LRU	:LIGHT WT TOOL STOWAGE ASSY (STBD)	V849-660300-002
SRU	:DOOR LATCH ASSEMBLY	V849-000400-003

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
 LIGHT WEIGHT TOOL STOWAGE ASSEMBLY (LWTSAs) DOOR LATCH

QUANTITY OF LIKE ITEMS: 8
 EIGHT

FUNCTION:
 THERE ARE TWO LWTSAs, PORT & STARBOARD. EACH LWTSa CONTAINS ONLY ONE DOOR. THIS DOOR CONTAINS FOUR LATCHES THAT KEEP IT IN A CLOSED AND LOCKED POSITION. THESE LATCHES, WHICH CAN BE MANUALLY RELEASED ON ORBIT, ARE SINGLE FAULT TOLERANT. THAT IS, ONLY THREE OF THE FOUR LATCHES ARE REQUIRED TO KEEP THE CLOSED DOOR SECURED.

REFERENCE DOCUMENTS: V849-660300
 V849-660195
 V849-660200
 V849-000400

FAILURE MODES EFFECTS ANALYSIS FMEA - CIL FAILURE MODE

NUMBER: M8-1SS-M020-01 ^A *Drmb*

REVISION#: 3 12/22/98

SUBSYSTEM NAME: MECHANICAL - CREW EQUIPMENT

LRU: LIGHT WEIGHT TOOL STOWAGE ASSEMBLY

ITEM NAME: DOOR LATCH ASSEMBLY

CRITICALITY OF THIS
FAILURE MODE: 1R2

FAILURE MODE:

BREAKS UNDER FLIGHT LOAD (PREMATURE RELEASE)

MISSION PHASE:

LO LIFT-OFF
DO DE-ORBIT
LS LANDING/SAFING

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

CAUSE:

VIBRATION, MECHANICAL SHOCK, MATERIAL DEFECT

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN A) PASS
B) FAIL
C) FAIL

PASS/FAIL RATIONALE:

A)

B)

FAILS SCREEN "B" SINCE A LATCH BREAKING UNDER FLIGHT LOAD CANNOT BE DETECTED AT TIME OF FAILURE.

C)

FAILS SCREEN "C" SINCE EXCESSIVE LOADS COULD BREAK MORE THAN ONE LATCH, AS WELL AS DISLODGE TOOLS FROM THE LWTSAs COMPARTMENT RESTRAINING HARDWARE.

METHOD OF FAULT DETECTION:

NONE DURING LIFT OFF. A SINGLE LATCH BREAKING UNDER FLIGHT LOAD CANNOT BE DETECTED AT TIME OF FAILURE. VISUAL OBSERVATION OF THE LWTSAs DURING ON-ORBIT EVA OPERATIONS, MAY DETECT A BROKEN LATCH.

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL FAILURE MODE

NUMBER: M8-1SS-M020-01

A
A

DymB

REMARKS/RECOMMENDATIONS:

THE LWTS A DOOR CONTAINS FOUR LATCHES, ANY THREE OF WHICH WILL KEEP IT CLOSED UNDER NOMINAL FLIGHT LOAD CONDITIONS. IN ADDITION, TOOLS ARE RESTRAINED WITHIN THE COMPARTMENT AND TRAYS USING FOAM CUSHIONS. HOWEVER, RESTRAINING HARDWARE IS NOT DESIGNED TO CARRY LAUNCH/LANDING LOADS. AS SUCH, IF THE DOOR WERE TO OPEN DURING LAUNCH OR LANDING, IT IS ASSUMED THAT THE TOOLS WILL COME LOOSE.

- FAILURE EFFECTS -

(A) SUBSYSTEM:

INABILITY TO LATCH THE DOOR TO THE LWTS A AT ONE OF FOUR PLACES. NO EFFECT SINCE THE REMAINING THREE LATCHES WILL KEEP THE DOOR IN PLACE.

(B) INTERFACING SUBSYSTEM(S):

NO EFFECT FIRST FAILURE. HOWEVER, SIMILAR FAILURE OF A SECOND LATCH COULD RESULT IN LOOSE TOOLS WITHIN THE PAYLOAD BAY AREA. THESE LOOSE TOOLS COULD DAMAGE OTHER ORBITER HARDWARE LOCATED IN THE PAYLOAD BAY.

(C) MISSION:

NO EFFECT FIRST FAILURE. FAILURE TO PROPERLY RESTRAIN TOOLS WITHIN THE LWTS A FOLLOWING SECOND LATCH FAILURE COULD RESULT IN DAMAGE TO THE RADIATORS, ODS HARDWARE, PAYLOAD HARDWARE, AND/OR OTHER ORBITER SYSTEMS WITHIN THE PAYLOAD BAY THAT MAY PRECLUDE MISSION OBJECTIVES.

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

NO EFFECT FIRST FAILURE. POSSIBLE LOSS OF CREW AND VEHICLE FOLLOWING SECOND LATCH FAILURE IF UNSECURED TOOLS ARE FREE TO MOVE AROUND WITHIN PAYLOAD BAY.

(E) FUNCTIONAL CRITICALITY EFFECTS:

FIRST FAILURE (ONE LATCH BREAKS UNDER LOAD) - NO EFFECT, REMAINING LATCHES WILL KEEP DOOR CLOSED.

SECOND FAILURE (SECOND LATCH BREAKS UNDER LOAD) - POTENTIAL FOR LWTS A DOOR OPENING RESULTING IN LOOSE TOOLS. UNRESTRAINED TOOLS CAN MOVE FREELY WITHIN PAYLOAD BAY. WORST CASE, POSSIBLE LOSS OF CREW AND VEHICLE IF DAMAGE TO ORBITER SUBSYSTEMS, WITHIN PAYLOAD BAY, CAUSED BY THE LOOSE TOOLS BECAME CATASTROPHIC.

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

NUMBER: M8-1SS-M020-01

A
A*Dmb*

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

(F) RATIONALE FOR CRITICALITY DOWNGRADE:

THERE IS NO WORKAROUND TO CIRCUMVENT LOOSE TOOLS IN THE PAYLOAD BAY DURING LIFTOFF, DE-ORBIT, OR LANDING FOLLOWING SECOND LATCH FAILURE. CRITICALITY REMAINS AT 1R2.

- TIME FRAME -

TIME FROM FAILURE TO CRITICAL EFFECT: MINUTES

TIME FROM FAILURE OCCURRENCE TO DETECTION: MINUTES

TIME FROM DETECTION TO COMPLETED CORRECTING ACTION: N/A

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

RATIONALE FOR TIME TO CORRECTING ACTION VS TIME TO EFFECT:

THERE IS NO CORRECTIVE ACTION IF THE TOOLS BECOME DISLODGED AND ARE ALLOWED TO MOVE FREELY WITHIN THE PAYLOAD BAY DURING LIFT-OFF, DE-ORBIT, OR LANDING.

HAZARD REPORT NUMBER(S): AOHA14 (ISS HAZARD ANALYSIS #)

HAZARD(S) DESCRIPTION:

DAMAGE TO ORBITER SYSTEMS DUE TO LOOSE EQUIPMENT/DEBRIS IN PAYLOAD BAY.

-DISPOSITION RATIONALE-

(A) DESIGN:

THE LWTSAs CONTAINS FOUR LATCHES, ONLY THREE OF WHICH ARE REQUIRED TO KEEP THE DOOR CLOSED UNDER NOMINAL LOAD CONDITIONS. EACH LATCH CONTAINS A HANDLE THAT WHEN STOWED (POSITIONED DOWN) KEEPS THE LATCH IN A LOCKED POSITION. (A SPRING IS USED TO KEEP THE HANDLE IN THE DOWN POSITION.) WHEN THE HANDLE IS POSITIONED UP, THE LATCH IS FREE TO ROTATE (1/4 TURN) TO THE OPEN POSITION. THE LATCH HARDWARE, INCLUDING THE HANDLE AND RECEIVER, IS FABRICATED FROM A-286 STAINLESS STEEL. A WAVE SPRING WASHER HAS BEEN ADDED BETWEEN THE LATCH PAWL NUT AND THE DOOR SURFACE TO PROVIDE THE FRICTIONAL FORCE NECESSARY TO KEEP THE LATCH FROM ROTATING WHEN THE LATCH HANDLE IS IN THE "UP" POSITION.

THE METHOD USED TO HOLD THE TOOLS WITHIN EACH TRAY IS CUT CUSHIONS WHICH ARE BONDED TOGETHER TO FORM A POCKET FOR EACH TOOL AND COVERED WITH BETA CLOTH. HOWEVER, RESTRAINING HARDWARE IS NOT DESIGNED TO CARRY LAUNCH/LANDING LOADS.

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL FAILURE MODE
 NUMBER: M8-1SS-M020-01

A
 A *Dmb*

STRUCTURAL LOAD ANALYSIS, PERFORMED ON THE LW TSA, HAS SHOWN THAT ALL COMPONENTS HAVE OF FACTOR OF SAFETY OF 1.4, MINIMUM. THERMAL ANALYSIS OF THE LW TSA SHOWS THAT THE MINIMUM AND MAXIMUM TEMPERATURE EXPOSURES OF THE LW TSA ARE -89°F AND 191°F, RESPECTIVELY. THIS IS WELL WITHIN THE STRUCTURAL/OPERATIONAL RANGE OF THE LW TSA AND ITS COMPONENTS. THE GROUND, FERRY FLIGHT, AND ON-ORBIT PRESSURE DIFFERENTIAL PERFORMANCE REQUIREMENTS FOR THE LW TSA ARE CERTIFIED THROUGH ANALYSIS. THE LW TSA FUNGUS, HUMIDITY, LIGHTNING, OZONE, SALT SPRAY, SAND AND DUST, SOLAR RADIATION (THERMAL), SHOCK, ACCELERATION, AND AEROACOUSTIC NOISE PERFORMANCE REQUIREMENTS ARE ALL VERIFIED BY ANALYSIS AND/OR ASSESSMENT. THE LW TSA SOLAR RADATION (NUCLEAR) AND METEOROID PERFORMANCE REQUIREMENTS ARE VERIFIED THROUGH SIMILARITY TO THE TSA.

(B) TEST:

LATCH CERTIFICATION - CERTIFICATION OF THE LATCH ASSEMBLY IS PERFORMED BY TEST, ANALYSIS, AND SIMILARITY. ANALYSIS AND SIMILARITY DATA IS PREVIOUSLY ADDRESSED IN THE "DESIGN" SECTION AND BOTH QUALIFICATION AND ACCEPTANCE TEST DATA IS SHOWN BELOW.

A. QUALIFICATION TESTING (LW TSA).

1. DYNAMIC TESTING - A RANDOM VIBRATION TEST IS PERFORMED ON THE LW TSA TEST ARTICLE. THE TEST ARTICLE IS MOUNTED ON A VIBRATION FIXTURE IN THE INVERTED POSITION (DOOR FACING DOWNWARD IN - Z AXIS) FOR VIBRATION IN THE X, Y, AND Z AXES. THE VIBRATION FIXTURE IS CONNECTED TO AN ELECTROMECHANICAL SHAKER BY MEANS OF A HEAD EXPANDER FOR Z AXIS VIBRATION. THE VIBRATION FIXTURE IS CONNECTED TO AN ELECTROMECHANICAL SHAKER BY MEANS OF A SLIP PLATE FOR THE X AND Y AXES VIBRATION. THE LW TSA TEST ARTICLE IS FILLED WITH LIMIT DESIGN WEIGHT IN THE COMPARTMENT AND VIBRATED ON ALL THREE AXES AT THE FOLLOWING FLIGHT LEVELS.

20 TO 50 HZ:	INCREASING AT 5 DB/OCTAVE
50 TO 400 HZ:	CONSTANT AT 0.01 G ² /HZ
400 TO 2000 HZ:	DECREASING AT 4 DB/OCTAVE
GRMS:	3.0
DURATION:	16.7 MINUTES PER AXIS
TEST TOLERANCES:	GRMS = +15%, - 5%
	G ² /HZ = + 4 DB, - 2 DB

B. ACCEPTANCE TESTING (LW TSA) - FOLLOWING COMPLETION OF THE QUALIFICATION VIBRATION TEST, THE LW TSA TEST ARTICLE IS SUBJECTED TO THE FOLLOWING ACCEPTANCE TESTS: VISUAL EXAMINATION AND LATCH FUNCTIONAL TEST. BOTH OF THESE ACCEPTANCE TESTS/INSPECTIONS ARE PERFORMED ON EACH FLIGHT UNIT. EACH IS FURTHER DESCRIBED BELOW.

1. VISUAL EXAMINATION - THE LW TSA IS VISUALLY EXAMINED AND DETERMINED TO CONFORM TO THE FOLLOWING: (A) WORKMANSHIP - COMPOSITE SURFACES, LATCHES, HINGE, DOOR HOLD-OPEN MECHANISM, EVA HANDHOLDS, CORNER FITTINGS, AND DRY FILM LUBRICATED BALL SCREWS SHALL BE INSPECTED FOR DAMAGE; (B) CLEANLINESS - VISUALLY CLEAN; (C) IDENTIFICATION - ACCURACY OF INFORMATION AS COMPARED TO THE ASSEMBLY DRAWING; AND (D) TRACEABILITY -

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

NUMBER: M8-1SS-M020-01

A
A

JMB

THE LW TSA TRACEABILITY LEVEL IS OCN. ACCORDINGLY, THE PART NUMBER AND OCN SHALL BE RECORDED ON THE ACCEPTANCE DATA SHEET(S) PRIOR TO THE START OF ACCEPTANCE TESTING.

2. LATCH FUNCTIONAL TEST - THE LATCHES MAY BE TESTED IN ANY SEQUENCE IN ACCORDANCE WITH THE FOLLOWING. THE DOOR MAY BE PUSHED DOWN OR PULLED UP TO ENSURE ALIGNMENT OF THE LATCH AND RECEIVER: (A) IT IS VERIFIED THAT ALL 4 OF THE LATCHES ARE IN THE LATCHED POSITION, FULLY ENGAGED IN THE RECEIVER; (B) IT IS VERIFIED THAT WHEN THE LATCH PAWL IS ROTATED, THERE IS NO INTERFERENCE BETWEEN THE LATCH AND THE LATCH HOUSING OR THE LATCH RECEIVER, AND THAT THE HANDLE TURNS SMOOTHLY; (C) IT IS VERIFIED THAT WHEN THE LATCH HANDLE IS IN THE LOCKED POSITION AGAINST THE HOUSING, IT IS UNABLE TO MOVE, AND IS HELD FIRMLY IN PLACE BY THE SPRING; (D) THE FORCE REQUIRED TO FULL UP THE LATCH HANDLE TO THE VERTICAL POSITION, TAKEN FROM THE CENTER OF GRAVITY OF THE HANDLE IS MEASURED IS IN THE RANGE OF 5 TO 10 LBS; (E) THE TORQUE REQUIRED TO ROTATE THE LATCH HANDLE TO THE UNLOCKED POSITION IS MEASURED TO BE LESS THAN 30 INCH-LBS; (F) THE TORQUE REQUIRED TO ROTATE THE LATCH HANDLE TO THE VERTICAL LOCKED POSITION IS MEASURED TO BE LESS THAN 30 INCH-LBS; AND (G) THE FORCE REQUIRED TO PUSH THE LATCH HANDLE IN THE LOCKED POSITION, TAKEN FROM THE CENTER OF GRAVITY OF THE HANDLE IS MEASURED TO BE IN THE RANGE OF 5 TO 10 LBS.

LIFE CYCLE TESTING (TSA ONLY) - LW TSA LATCHES ARE IDENTICAL TO THE EXISTING TSA LATCHES WITH THE EXCEPTION OF A WAVE WASHER. AS SUCH, LIFE CYCLE TESTING OF THE EXISTING DOOR/DRAWER LATCHES WOULD APPLY TO THE LW TSA DOOR LATCHES. LIFE CYCLE TESTING OF THE EXISTING TSA DOOR/DRAWER LATCHES IS DESCRIBED AS FOLLOWS:

PRIOR TO PERFORMING THE LIFE CYCLE TEST OF THE LATCHES AND DRAWERS, A FUNCTIONAL TEST IS PERFORMED ON A SINGLE LATCH AND THE FOLLOWING IS VERIFIED: (A) THE FORCE REQUIRED TO PULL UP THE LATCH HANDLE TO THE VERTICAL POSITION FROM THE HANDLE CENTER OF GRAVITY IS IN THE 5 TO 10 LB RANGE; (B) THE FORCE REQUIRED TO PUSH THE LATCH HANDLE INTO THE LOCKED POSITION IS IN THE 5 TO 10 LB RANGE; AND (C) THE TORQUE REQUIRED TO TURN THE LATCH TO THE UNLOCKED POSITION (ONCE THE LATCH IS LIFTED AND THE HANDLE IS VERTICAL), AND THEN BACK TO THE LOCKED POSITION IS IN THE 2 TO 30IN-LB RANGE. WITH THE LATCH IN THE LATCHED POSITION (FULLY ENGAGED IN THE RECEIVER), THE LATCH IS TURNED FROM THE LOCKED POSITION TO THE UNLOCKED POSITION AND THEN BACK TO THE LOCKED POSITION. DURING THIS CYCLE, THE SMALL PRELOAD ON THE LATCH PAWL TO PRECLUDE VIBRATION OF THE PAWL AGAINST THE RECEIVER IS VERIFIED WHEN THE LATCH PAWL IS ROTATED INTO THE RECEIVER. THIS CYCLE IS REPEATED A TOTAL OF 400 TIMES. FOLLOWING THIS LIFE CYCLE TEST THE FUNCTIONAL TEST, AS PREVIOUSLY DESCRIBED IN STEPS A, B, AND C ABOVE, IS REPEATED.

MISSION MANIFEST VERIFICATION - PRIOR TO EACH FLIGHT, THE ORBITER IS CONFIGURED TO SUPPORT A MISSION AS DEFINED IN THE MISSION MANIFEST. AT THIS TIME, IF THE MISSION IS TO SUPPORT ISS, THE LW TSA WILL BE INSTALLED ON THE EXTERNAL AIRLOCK TRUSS ASSEMBLY AND THE FOLLOWING WILL BE VERIFIED: THE LW TSA CONTAINS THE CORRECT TOOLS FOR THAT MISSION; THE TOOLS ARE INSTALLED PROPERLY; AND ALL DOOR LATCHES ARE IN THEIR CLOSED AND LOCKED POSITION.

FAILURE MODES EFFECTS ANALYSIS (FMEA) → CIL FAILURE MODE
 NUMBER: M8-1SS-M020-01

A
 A

Dmb

(C) INSPECTION:

RECEIVING INSPECTION
 RAW MATERIAL VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

CORROSION PROTECTION PROVISIONS ARE VERIFIED BY INSPECTION. CLEANLINESS
 LEVEL GC PER MA0110-301.

ASSEMBLY/INSTALLATION

ALL PARTS FABRICATED AND INSPECTED AT THE DETAIL LEVEL AND AT THE ASSEMBLY
 LEVEL. BONDED ASSEMBLY OF THE BOX, I.E. WITHOUT PARTITIONS, CLOSE-OUTS, AND
 COVERS, INSPECTED AT MANDATORY INSPECTION POINTS. INSTALLATION OF LATCHES
 PER TSA ASSEMBLY TOP LEVEL DRAWING V849-660300.

NONDESTRUCTIVE EVALUATION

PRIOR TO PAINTING, LATCHES INSPECTED AT DETAIL LEVEL USING DYE PENETRANT
 PER MTO501-508.

TESTING

CERTIFICATION TEST/PULL TEST/MISSION MANIFEST CHECKLIST VERIFIED BY
 INSPECTION.

HANDLING/PACKAGING

HANDLING, PACKAGING, STORAGE, AND SHIPPING PROCEDURES 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:

THERE IS NO CORRECTIVE ACTION IF ONE OR MORE LATCHES BREAK UNDER LOAD
 DURING LIFTOFF/DE-ORBIT/LANDING PHASE. TOOL RESTRAINING SYSTEM IS ADEQUATE
 TO KEEP THE TOOLS WITHIN THE LW TSA DURING ON-ORBIT OPERATIONS ONLY.

- APPROVALS -

SS & PAE ENGINEER	:	M. W. GUENTHER	:	<i>M. W. Guenther</i>
SS & PAE MANAGER	:	C. A. ALLISON	:	<i>C. A. Allison</i>
DESIGN ENGINEER	:	S. L. SHARP	:	<i>S. L. Sharp</i>
NASA SS/MA	:		:	<i>V. Miller</i>
BNA SUBSYSTEM MANAGER	:		:	<i>S. L. Sharp</i>
JSC MOD	:		:	<i>S. L. Sharp</i>
USA Orbiter, SRQA	:		:	<i>Suzanne P. P. P.</i>
USA SAM	:		:	<i>W. A. Woodworth</i>