

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- GIL HARDWARE

NUMBER: M8-1SS-M022A-X *Dmb*

SUBSYSTEM NAME: MECHANICAL - CREW EQUIPMENT

REVISION: 1

10/23/98

PART DATA

| | PART NAME VENDOR NAME | PART NUMBER VENDOR NUMBER |
|-----|------------------------------------|------------------------------|
| LRL | :LIGHT WT TOOL STOWAGE ASSY (PORT) | V849-660300-001 |
| LRL | :LIGHT WT TOOL STOWAGE ASSY (STBD) | V849-660300-002 |
| SRU | :HINGE ASSEMBLY | V849-660180-001 |

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

LIGHT WEIGHT TOOL STOWAGE ASSEMBLY (LWTSA) DOOR HINGE ASSEMBLY

QUANTITY OF LIKE ITEMS: 2
TWO

FUNCTION:

THERE ARE TWO LWTSAs, PORT & STARBOARD. EACH LWTSa CONTAINS A SINGLE DOOR. ATTACHED TO THIS DOOR IS A HINGE ASSEMBLY THAT ALLOWS EASY OPENING AND CLOSING OF THE DOOR.

REFERENCE DOCUMENTS:

V849-660180
V849-660195
V849-660200
V849-660300

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NUMBER: M8-1SS-M022-01

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REVISION#: 3

12/22/98

SUBSYSTEM NAME: MECHANICAL - CREW EQUIPMENT

LRU: LIGHT WEIGHT TOOL STOWAGE ASSEMBLY

ITEM NAME: DOOR HINGE ASSEMBLY

CRITICALITY OF THIS

FAILURE MODE: 1R2

FAILURE MODE:

JAMMED, INCREASED RESISTANCE

MISSION PHASE:

OO ON-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

| | |
|-----|-----------|
| 102 | COLUMBIA |
| 103 | DISCOVERY |
| 104 | ATLANTIS |
| 105 | ENDEAVOUR |

CAUSE:

CONTAMINATION, STRUCTURAL FAILURE DUE TO THERMAL OR MECHANICAL SHOCK,
MANUFACTURER/MATERIAL DEFECT, LACK OF LUBRICATION

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN

A) PASS
B) PASS
C) PASS

PASS/FAIL RATIONALE:

A)

B)

C)

METHOD OF FAULT DETECTION:

PHYSICAL OBSERVATION DURING DOOR OPENING/CLOSING.

REMARKS/RECOMMENDATIONS:

LWTSR DOOR CONTAINS A SINGLE HINGE ASSEMBLY REQUIRED FOR DOOR
OPENING/CLOSING. WITH DOOR FULLY OPEN, THE DOOR EXTENSION WILL NOT
INTERFERE WITH PROPER CLOSING OF THE PAYLOAD BAY DOORS.

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- FAILURE EFFECTS -

(A) SUBSYSTEM:

PREVENTS MOVEMENT OF THE DOOR IN EITHER THE OPENING OR CLOSING POSITION. AN INCREASE AMOUNT OF RESISTANCE COULD BE OVERCOME BY THE FORCE OF OPENING/CLOSING.

(B) INTERFACING SUBSYSTEM(S):

WORST CASE (DURING OPENING) - INABILITY TO OPEN A DOOR WOULD PREVENT USE OF THE TOOLS CONTAINED IN THE LW TSA.

(C) MISSION:

IF FAILURE OCCURS:

DURING DOOR OPENING - UNABLE TO OPEN DOOR TO ACCESS MISSION SPECIFIC TOOLS. INABILITY TO UTILIZE THESE TOOLS MAY AFFECT MISSION COMPLETION - CRITICALITY 2/2 CONDITION.

DURING DOOR CLOSING - INABILITY TO CLOSE DOOR HAS NO EFFECT ON MISSION SUCCESS SINCE MISSION OBJECTIVES ARE MET WITH LW TSA DOOR OPEN.

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

IF FAILURE OCCURS:

DURING DOOR OPENING - UNABLE TO OPEN DOOR TO ACCESS CONTINGENCY TOOLS. LOSS OF CAPABILITY TO UTILIZE THESE TOOLS COULD RESULT IN LOSS OF CREW AND VEHICLE IF CONTINGENCY EVA IS REQUIRED.

DURING DOOR CLOSING - LW TSA DOOR WOULD HAVE TO REMAIN OPEN DURING DE-ORBIT AND LANDING PHASES. NO EFFECT SINCE TOOLS WOULD BE REMOVED FROM THE LW TSA.

(E) FUNCTIONAL CRITICALITY EFFECTS:

FIRST FAILURE (DOOR HINGE ASSEMBLY JAMMED IN CLOSED POSITION) - LOSS OF CAPABILITY TO UTILIZE TOOLS CONTAINED WITHIN LW TSA. INABILITY TO COMPLETE MISSION OBJECTIVES ASSOCIATED WITH THESE ISS TOOLS. - CRITICALITY 2/2 CONDITION

SECOND FAILURE (FAILURE NECESSITATES AN EVA TO CORRECT A CRIT 1 CONDITION) - POSSIBLE LOSS OF CREW AND VEHICLE DUE TO THE INABILITY TO CONDUCT AN EMERGENCY EVA BECAUSE EVA TOOLS ARE NOT AVAILABLE FOR USE. - CRITICALITY 1R2 CONDITION

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

(F) RATIONALE FOR CRITICALITY DOWNGRADE:

THERE IS NO CORRECTIVE ACTION TO CIRCUMVENT A HINGE ASSY THAT JAMS DURING DOOR OPENING. CRITICALITY REMAINS AT 1R2.

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- TIME FRAME -

TIME FROM FAILURE TO CRITICAL EFFECT: DAYS

TIME FROM FAILURE OCCURRENCE TO DETECTION: IMMEDIATE

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 HINGE ASSEMBLY COMPLETELY JAMS AND
 THE LW TSA DOOR CANNOT BE OPENED OR CLOSED.

HAZARD REPORT NUMBER(S): FF-09

HAZARD(S) DESCRIPTION:
 INABILITY TO SAFELY PERFORM EVA.

-DISPOSITION RATIONALE-

(A) DESIGN:

THE LW TSA DOOR CONTAINS A SINGLE HINGE ASSEMBLY. THIS HINGE ASSEMBLY IS MOUNTED ON THE LONGEST SIDE OF THE LW TSA. THE LW TSA AND DOOR ARE MADE OF 8 PLYS OF M46J/RS3 CARBON/EPOXY FACE SHEETS WITH OUTER LAYERS OF T300/RS3 FABRIC. THIS OUTER LAYER OF FABRIC HELPS IMPROVE THE DAMAGE TOLERANCE OF THE DOOR. THE HINGE IS MADE OF ALUMINUM ALLOY 2024-T3511. ONE HALF OF THE DOOR HINGE ASSEMBLY IS BOLTED TO THE LW TSA USING 19 FASTENERS AND THE SECOND HALF IS BOLTED TO THE DOOR ITSELF USING 19 FASTENERS.

STRUCTURAL LOAD ANALYSIS, PERFORMED ON THE LW TSA, HAS SHOWN THAT ALL COMPONENTS HAVE A 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 RADIATION (NUCLEAR) AND METEOROID PERFORMANCE REQUIREMENTS ARE VERIFIED THROUGH SIMILARITY TO THE TSA.

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(B) TEST:

DOOR HINGE CERTIFICATION - CERTIFICATION OF THE DOOR HINGE ASSEMBLY IS PERFORMED BY TEST, ANALYSIS, AND SIMILARITY. ANALYSIS/SIMILARITY DATA WAS PREVIOUSLY ADDRESSED IN THE "DESIGN" SECTION AND 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 DOOR/HINGE 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 - 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. DOOR/HINGE FUNCTIONAL TEST - IT IS VERIFIED THAT THE DOOR OPENS AND CLOSES SMOOTHLY WITHOUT HINGE BINDING OR INTERFERENCE. THE FORCE REQUIRED TO OPEN AND CLOSE THE DOOR IS LESS THAN 5.0 POUNDS, NOT INCLUDING THE DOOR HOLD-OPEN MECHANISM FORCES, OR THE WEIGHT OF THE DOOR.

LIFE CYCLE TESTING (TSA ONLY) - THE LW TSA DOOR HINGE IS SIMILAR IN DESIGN TO THE EXISTING TSA DOOR HINGES WITH THE EXCEPTION OF IT'S LENGTH. AS SUCH, LIFE CYCLE TESTING OF THE EXISTING TSA DOOR HINGES WOULD APPLY TO THE LW TSA DOOR HINGE. LIFE CYCLE TESTING OF THE EXISTING TSA DOOR HINGE IS DESCRIBED AS FOLLOWS:

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PRIOR TO PERFORMING THE LIFE CYCLE TEST OF THE TSA DOOR AND HINGES THE FOLLOWING FUNCTIONAL TEST IS PERFORMED: (A) WITH THE TSA RESTING HORIZONTALLY, THE DOORS ARE VERIFIED TO OPEN SMOOTHLY, WITHOUT INTERFERENCE, AND THAT WHEN THE DOORS ARE CLOSED, THEY REST EVENLY ON THE DOOR SUPPORTS; (B) LATCHES AND RECEIVERS FOR THE DOORS ARE VERIFIED TO BE IN ALIGNMENT WHEN THE DOORS ARE CLOSED. (C) EACH LATCH IS OPERATED TO VERIFY ALIGNMENT; AND (D) THE FORCE REQUIRED TO OPEN EACH DOOR IS VERIFIED TO BE WITHIN A 1 TO 5 LB RANGE. EACH DOOR IS CYCLED FROM ITS FULLY CLOSED POSITION TO ITS FULLY OPEN POSITION, AND THEN BACK TO ITS FULLY CLOSED POSITION. THIS CYCLE IS REPEATED A TOTAL OF 400 TIMES FOLLOWING THIS LIFE CYCLE TEST, VERIFICATION STEPS A, B, C, AND D, AS PREVIOUSLY ADDRESSED, ARE 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 LWTSAs WILL BE INSTALLED ON THE EXTERNAL AIRLOCK TRUSS ASSEMBLY AND THE FOLLOWING WILL BE VERIFIED: THE LWTSAs CONTAINS THE CORRECT TOOLS FOR THAT MISSION; THE TOOLS ARE INSTALLED PROPERLY; AND ALL DOORS ARE IN THEIR CLOSED AND LOCKED POSITION.

(C) INSPECTION:

RECEIVING INSPECTION

ALL RECEIVING DOOR HINGE ASSEMBLIES ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

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

ASSEMBLY/INSTALLATION

INSTALLATION OF HINGE ASSEMBLIES PER LWTSAs TOP LEVEL DRAWING V849-660300.

CRITICAL PROCESSES

ANODIZING OF ALUMINUM HINGES INSPECTED PER MIL-A-8625, TYPE II.

NON-DESTRUCTIVE EVALUATION

FLOURESCENT PENETRANT INSPECTION PER MIL-STD-6866, TYPE I, METHOD C, SENSITIVITY LEVEL 3.

TESTING

CERTIFICATION 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.

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(E) OPERATIONAL USE:

DURING DOOR OPENING - THERE IS NO CORRECTIVE ACTION IF A DOOR HINGE ASSEMBLY COMPLETELY JAMS. HOWEVER, AN INCREASE IN RESISTANCE CAN BE OVERCOME BY THE FORCE OF OPENING THE DOOR.

DURING DOOR CLOSING - AN INCREASE IN RESISTANCE CAN BE OVERCOME BY THE FORCE OF CLOSING THE DOOR. IN THE CASE WHERE THE HINGE ASSEMBLY COMPLETELY JAMS, CREW COULD REMOVE THE TOOLS, IN THE LWTSA AND STOW THEM WITHIN THE CREW CABIN AREA.

- APPROVALS -

SS & PAE ENGINEER
 SS & PAE MANAGER
 DESIGN ENGINEER
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 BNA SUBSYSTEM MANAGER
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