

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

NUMBER: M8-1SS-BM001-X

SUBSYSTEM NAME: MECHANICAL - EDS

REVISION: 1 DEC, 1996

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: STRUCTURAL LATCH MECHANISM RSC-ENERGIA	33U.6365.010-04 (PMA 2/3 33U.6365.010-04 ASSEMBLY) 33U.6365.010-07 ("SOFT" 33U.6365.010-07 MECH.) 33U.6365.010-08 (PMA 1 33U.6365.010-08 ASSEMBLY)
SRU	: ASSY, STRUCTURAL HOOK (SLAVE) RSC-ENERGIA	33U.6366.007-02
SRU	: ASSY, STRUCTURAL HOOK (SLAVE) RSC-ENERGIA	33U.6366.008-02
SRU	: ASSY, STRUCTURAL HOOK (DRIVE) RSC-ENERGIA	33U.6366.009-02
SRU	: ASSY, STRUCTURAL HOOK (DRIVE) RSC-ENERGIA	33U.6366.010-02

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
STRUCTURAL HOOK ASSEMBLY

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 12
TWELVE

FUNCTION:

PERFORMS OPENING AND CLOSING OF ONE ACTIVE HOOK ON ORBITER DOCKING MECHANISM TO OPPOSITE PASSIVE HOOK ON MIR DOCKING MECHANISM. TWELVE STRUCTURAL HOOK ASSEMBLIES ON ORBITER DOCKING MECHANISM ARE PROVIDED, TWO SETS OF SIX HOOK ASSEMBLIES. EACH SET IS CONTROLLED SIMULTANEOUSLY BY ONE ACTUATOR. EACH ACTUATOR IS MECHANICALLY LINKED TO ONE DRIVE STRUCTURAL HOOK ASSEMBLY. A PULLEY CONTAINED ON THE DRIVE ASSEMBLY IS MECHANICALLY LINKED TO A PULLEY ON EACH OF THE FIVE SLAVE HOOK ASSEMBLIES THROUGH A SINGLE MECHANICAL CABLE. ROTATION OF THE DRIVE HOOK ASSEMBLY PROVIDES SIMULTANEOUS ROTATION OF THE FIVE SLAVE HOOK ASSEMBLIES.

EACH STRUCTURAL HOOK ASSEMBLY CONTAINS A HOOK SENSOR OPEN SWITCH WHICH SENSES THE OPEN AND CLOSED POSITION OF THE HOOK. THIS INFORMATION IS DOWNLINKED FOR GROUND MONITORING OF EACH HOOK POSITION. THE STRUCTURAL HOOK ACTUATOR CONTAINS A "HOOK CLOSED" SENSOR, A "HOOK OPEN" SENSOR, AND A "HOOK-IN-BETWEEN" SENSOR TO MONITOR POSITION OF ONE SET OF SIX STRUCTURAL HOOKS. EACH IS DESCRIBED BELOW.

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***HOOK CLOSED* SENSOR.** THE "HOOK CLOSED" SENSOR IS USED TO ILLUMINATE ITS APPROPRIATE "HOOK 1 CLOSED" OR "HOOK 2 CLOSED" INDICATOR ON THE DOCKING CONTROL PANEL. THESE INDICATIONS ARE DOWNLINKED FOR GROUND MONITORING OF EACH SET OF LATCH HOOKS "CLOSED" POSITION. HOOK "CLOSED" SIGNAL IS ALSO UTILIZED BY THE DSCU TO TURN OFF THE STRUCTURAL HOOK ACTUATORS ONCE THE HOOKS HAVE CLOSED.

***HOOK OPEN* SENSOR.** THE "HOOK OPEN" SENSOR IS USED TO ILLUMINATE ITS APPROPRIATE "HOOK 1 OPEN" OR "HOOK 2 OPEN" INDICATOR ON THE DOCKING CONTROL PANEL. THESE INDICATIONS ARE DOWNLINKED FOR GROUND MONITORING OF EACH SET OF LATCH HOOKS "OPEN" POSITION. THESE SIGNALS ARE ALSO USED TO TURN OFF THE STRUCTURAL LATCH ACTUATOR ONCE THE HOOKS HAVE OPENED.

***HOOK-IN-BETWEEN* SENSOR.** THE "HOOK IN-BETWEEN" SENSOR IS USED TO SENSE WHEN EACH SET OF SIX LATCH HOOKS ARE IN A POSITION BETWEEN FULLY OPENED AND FULLY CLOSED. WHEN THE SENSOR IS CLOSED REDUNDANT SIGNALS ARE SENT TO THE DSCU TO STOP MOVEMENT OF THE RING AND TO DE-ENERGIZE THE FIXERS. THE "HOOK-IN-BETWEEN" SIGNAL IS NOT UTILIZED FOR IN-FLIGHT OR GROUND MONITORING PURPOSES. (IT DOESN'T APPLY TO THE PMA 2/3 PASSIVE MECHANISM).

HOOK FINAL POSITION SENSOR. A SENSOR IS CONTAINED IN EACH STRUCTURAL HOOK ASSEMBLY TO INDICATE WHEN THE HOOK HAS REACHED ITS FINAL (CLOSED) POSITION. THE DATA FROM THESE SENSORS IS NOT UTILIZED IN-FLIGHT BUT IT IS DOWNLINKED FOR GROUND MONITORING OF EACH HOOK'S POSITION.

SERVICE IN BETWEEN FLIGHT AND MAINTENANCE CONTROL:
VISUAL INSPECTION, SERVICEABILITY CONTROL, DOCKING WITH CALIBRATING DOCKING MECHANISM.

MAINTAINABILITY

REPAIR METHOD - NONE (REPAIRING IN MANUFACTURING CONDITIONS ONLY).

REFERENCE DOCUMENTS: 33U.6121.036-07
33U.6201.008-05-004 (PMA 1 ASSEMBLY)
33U.6201.008-08 (PMA 2/3 ASSEMBLY)
33U.6201.008-09 ("SOFT" MECHANISM)
33U.6365.010-04 (PMA 2/3 ASSEMBLY)
33U.6365.010-07 (PMA 1 ASSEMBLY)
33U.6365.010-08 ("SOFT" MECHANISM)
33U.6365.007-02
33U.6365.008-02
33U.6365.009-02
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NUMBER: M8-1SS-BM001- 09

REVISION# 1 DEC, 1986

SUBSYSTEM NAME: MECHANICAL - EDS
 LRU: STRUCTURAL LATCH MECHANISM
 ITEM NAME: ASSEMBLY, STRUCTURAL HOOK

CRITICALITY OF THIS
 FAILURE MODE: 1R3

FAILURE MODE:
 ONE HOOKS "OPEN" SENSOR CONTACT SET FAILS CLOSED

MISSION PHASE:
 OO ON-ORBIT

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

CAUSE:
 CONTAMINATION, PIECE PART STRUCTURAL FAILURE DUE TO MECHANICAL/THERMAL
 SHOCK, VIBRATION, OR MANUFACTURER/MATERIAL DEFECT

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

CRITICALITY 1R2 DURING INTACT ABORT ONLY (AVIONICS ONLY)? NO

REDUNDANCY SCREEN A) PASS
 B) PASS
 C) PASS

PASS/FAIL RATIONALE:

A)

B)

C)

METHOD OF FAULT DETECTION:

"HOOK 1 OPEN" OR "HOOK 2 OPEN" INDICATION ON THE DOCKING CONTROL PANEL.
 REMAINS LIT OR INADVERTENTLY ILLUMINATES WHEN NOT REQUIRED. FAILURE TO
 OPEN ONE SET OF SIX HOOKS AS THE RESULT OF THIS FAILURE COULD BE DETECTED
 BY THE INABILITY TO SEPARATE OR THROUGH TELEMETRY DATA ON INDIVIDUAL HOOK
 POSITION STATUS (NOMINAL UNDOCKING IS NOT PLANNED FROM THE PMA1 ASSEMBLY).

MASTER MEAS. LIST NUMBERS: V53X0761E
 V53X0762E

CORRECTING ACTION: CREW COULD DROP A SINGLE LOGIC BUS AND ALLOW
 AUTOMATIC HOOKS OPENING SEQUENCE TO CONTINUE (NOMINAL UNDOCKING IS NOT
 PLANNED FROM THE PMA1 ASSEMBLY). IF HOOKS CANNOT BE OPENED CREW COULD
 PERFORM AN IFM TO DRIVE HOOKS OPEN OR FIRE PYROS TO RELEASE CLOSED HOOKS
 (APPLIES ONLY TO THE MECHANISMS WITH PYROS). FAILURE OF THE PYRO SYSTEM
 WOULD REQUIRE THE CREW TO PERFORM CONTINGENCY EVA AND REMOVE THE 96

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BOLTS THAT ATTACHES THE DOCKING BASE TO THE EXTERNAL AIRLOCK (APPLIES ONLY TO THE ORBITER MECHANISM).

REMARKS/RECOMMENDATIONS:

SWITCH CONTAINS THREE CONTACT SETS ONLY ONE OF WHICH WOULD HAVE TO SHORT TO GET A "HOOK 1 OR 2 "OPEN" INDICATION ON THE DCP. THE THIRD CONTACT SET PROVIDES FOR TELEMETRY DATA.

- FAILURE EFFECTS -

(A) SUBSYSTEM:

INADVERTENT "HOOK OPEN" SIGNAL TO DSCU. "HOOK 1 OPEN" OR "HOOK 2 OPEN" INDICATION ON THE DOCKING CONTROL PANEL REMAINS LIT OR INADVERTENTLY ILLUMINATES WHEN NOT REQUIRED. WORST CASE, DISABLES STRUCTURAL HOOK ACTUATOR PRIOR TO OPENING HOOKS DURING SEPARATION (NOMINAL UNDOCKING IS NOT PLANNED FROM THE PMA1 ASSEMBLY).

(B) INTERFACING SUBSYSTEM(S):

NO EFFECT ON INTERFACING ORBITER SUBSYSTEMS.

(C) MISSION:

NO EFFECT ON INITIAL MISSION SINCE HOOKS ARE NOT OPENED UNTIL SEPARATION IS REQUIRED. HOWEVER, SENSOR AND PYRO (APPLIES ONLY TO THE MECHANISMS WITH PYROS) FAILURES MAY PRECLUDE SUBSEQUENT DOCKINGS.

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

POTENTIAL LOSS OF CREW AND VEHICLE IF SENSOR AND PYRO (APPLIES ONLY TO THE MECHANISMS WITH PYROS) FAILURES PREVENT NOMINAL ORBITER/ISSA SEPARATION AND CREW CANNOT EVA TO REMOVE 96 BOLTS (APPLIES ONLY TO ORBITER MECHANISM).

(E) FUNCTIONAL CRITICALITY EFFECTS:

FIRST FAILURE (CONTACT SET FAILS CLOSED) - INADVERTENT "HOOK OPEN" SIGNAL TO DSCU. WORST CASE, STRUCTURAL HOOK ACTUATOR IS DISABLED PRIOR TO OPENING HOOKS DURING SEPARATION (NOMINAL UNDOCKING IS NOT PLANNED FROM THE PMA1 ASSEMBLY).

THIRD FAILURE (PYRO FAILS TO FIRE APPLIES ONLY TO ORBITER MECHANISM) - INABILITY TO RELEASE A SINGLE CLOSED STRUCTURAL HOOK, USING EMERGENCY PRYO SYSTEM, RESULTING IN LOSS OF NOMINAL ORBITER/ISSA SEPARATION.

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

(F) RATIONALE FOR CRITICALITY DOWNGRADE:

SECOND FAILURE (INABILITY TO DROP ONE LOGIC BUS) - UNABLE TO RESTORE SYSTEM TO CONTINUE UNLATCHING PROCESS.

FOURTH FAILURE (INABILITY TO EVA TO REMOVE 96 BOLTS) - WORST CASE, INABILITY TO SEPARATE ORBITER FROM ISSA RESULTING IN LOSS OF CREW/VEHICLE

- TIME FRAME -

TIME FROM FAILURE TO CRITICAL EFFECT: HOURS TO DAYS

TIME FROM FAILURE OCCURRENCE TO DETECTION: SECONDS

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TIME FROM DETECTION TO COMPLETED CORRECTIVE ACTION: SECONDS 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 HAS AMPLE TIME TO PERFORM AN EVA TO REMOVE THE 98 BOLTS HOLDING THE
DOCKING BASE TO THE EXTERNAL AIRLOCK BEFORE CREW/VEHICLE ARE LOST.

HAZARDS REPORT NUMBER(S): ORBI 401A

HAZARD(S) DESCRIPTION:
INABILITY TO SEPARATE ORBITER AND ISSA.

- APPROVALS -

PRODUCT ASSURANCE ENGR. : M. NIKOLAYEVA : 
DESIGN ENGINEER : E. BOBROV : 