

**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.6121.038-07  
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  
33U.6365.010-02

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

NUMBER: M8-1SS-BM001- 02  
(DOESN'T APPLY TO THE PMA1 MECH.)

REVISION# 1 DEC, 1996

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

CRITICALITY OF THIS  
FAILURE MODE: 1R3

FAILURE MODE:  
HOOK GANG FAILS TO UNLATCH

MISSION PHASE:  
OO ON-ORBIT

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

CAUSE:  
HOOK ASSEMBLY FAILURE - JAMMED/BROKEN PULLEY

ACTUATOR FAILURE - JAMMED, BROKEN SHAFT, DUAL MOTOR/CLUTCH/DRIVE FAILURE

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

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

REDUNDANCY SCREEN A) PASS  
B) PASS  
C) PASS

## PASS/FAIL RATIONALE:

A)

B)

C)

## METHOD OF FAULT DETECTION:

"HOOKS 1 CLOSED" OR "HOOKS 2 CLOSED" INDICATOR ON DOCKING CONTROL PANEL WILL REMAIN LIT AND "HOOKS 1 OPEN" OR "HOOKS 2 OPEN" INDICATOR WILL BE OFF. TELEMETRY DATA IS DOWNLINKED FOR GROUND MONITORING OF EACH SET OF SIX HOOKS AND MONITORING OF INDIVIDUAL HOOK POSITION. PHYSICAL/VISUAL OBSERVATION - INABILITY OF ORBITER TO SEPARATE FROM ISSA.

CORRECTING ACTION: IN THE EVENT ONE GANG OF SIX HOOKS FAIL TO UNLATCH ORBITER, EMERGENCY PYRO SYSTEM CAN BE UTILIZED TO RELEASE ACTIVE HOOKS ASSOCIATED WITH THE CLOSED HOOK ASSEMBLIES. A FAILURE OF THE PYRO SYSTEM WOULD REQUIRE CREW TO EVA TO REMOVE THE 96 BOLTS HOLDING THE DOCKING BASE TO THE EXTERNAL AIRLOCK. ONCE RELEASED THE ISSA AND ORBITER CAN BE SEPARATED.

REMARKS/RECOMMENDATIONS:

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ONLY THE TWELVE HOOKS ON THE ORBITER DOCKING MECHANISM ARE CLOSED TO THEIR OPPOSING TWELVE PASSIVE HOOKS ON PMA 2 OR PMA 3 DOCKING MECHANISM DURING NOMINAL OPERATIONS. ALL TWELVE HOOKS ON BOTH THE ISSA FGB AND PMA 1 DOCKING MECHANISMS ARE CLOSED. FAILURE OF A SINGLE ACTUATOR OR HOOK ASSEMBLY AS DESCRIBED IN THE CAUSE SECTION AFFECTS OPERATION OF SIX STRUCTURAL HOOKS (ONE DRIVE AND FIVE SLAVE). ALL HOOKS MUST BE OPENED TO ENABLE SEPARATION.

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**- FAILURE EFFECTS -**

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**(A) SUBSYSTEM:**

A SINGLE MOTOR, CLUTCH, OR DRIVE CHAIN FAILURE WILL RESULT IN AN INCREASED OPERATING TIME OF THE ACTUATOR. WORST CASE, FAILURE OF ENTIRE ACTUATOR WILL RESULT IN LOSS OF CAPABILITY TO ACTUATE ACTIVE HOOK ON ONE STRUCTURAL HOOK GANG.

**(B) INTERFACING SUBSYSTEM(S):**

NO EFFECT ON INTERFACING ORBITER SUBSYSTEMS.

**(C) MISSION:**

NO EFFECT ON DOCKED MISSION OBJECTIVES. HOOKS ARE NOT COMMANDED OPENED UNTIL END OF THE MISSION. USE OF EMERGENCY PYRO SYSTEM TO OPEN HOOK MAY PRECLUDE CREW FROM ATTEMPTING SUBSEQUENT DOCKINGS. HOWEVER, SECOND DOCKING CAN BE ACCOMPLISHED USING THE TWELVE ISSA ACTIVE HOOKS.

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

NO EFFECT FIRST FAILURE. FAILURE OF ORBITER PYRO SYSTEM WOULD PRECLUDE NOMINAL ORBITER/ISSA SEPARATION.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

FIRST FAILURE (HOOK GANG FAILS TO UNLATCH) - INABILITY TO OPEN HOOKS USING NORMAL STRUCTURAL UNLATCHING SYSTEM.  
 SECOND FAILURE (A SINGLE PYRO FAILS TO FIRE) - INABILITY TO NOMINALLY RELEASE ONE STRUCTURAL HOOK RESULTING IN ORBITER AND ISSA BEING STRUCTURALLY LATCHED. CREW WOULD BE AWARE OF THIS FAILURE SINCE THE ORBITER AND ISSA WOULD NOT SPRING AWAY FROM EACH OTHER AS THE MECHANISM IS DESIGNED TO CAUSE THEM TO DO.

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

**(F) RATIONALE FOR CRITICALITY DOWNGRADE:**

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

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**- TIME FRAME -**

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**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 96 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.**

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**- APPROVALS -**

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