

## 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: MB-1SS-BM001-05

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:**  
 CABLE BREAKS OR DE-RAILS

**MISSION PHASE:**  
 OO ON-ORBIT

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

**CAUSE:**  
 MECHANICAL/THERMAL SHOCK, VIBRATION, MATERIAL DEFECT, NUT AT END OF CABLE  
 BACKS OFF

**CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO**

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

**REDUNDANCY SCREEN** A) PASS  
 B) N/A  
 C) PASS

**PASS/FAIL RATIONALE:**

A)

B)

N/A - AT LEAST TWO REMAINING PATHS ARE DETECTABLE IN FLIGHT.

C)

**METHOD OF FAULT DETECTION:**

IF THE CABLE BREAKS DURING LATCHING ONLY THE DRIVE LATCH WILL BE CLOSED.  
 POSITION OF REMAINING FIVE HOOKS OBTAINED THROUGH TELEMETRY DATA WOULD  
 INDICATE THAT THEY ARE OPEN.

IF THE CABLE BREAKS DURING UNLATCHING THE CREW CAN DETECT THE INABILITY TO  
 OPEN THE STRUCTURAL HOOKS THROUGH PHYSICAL/VISUAL OBSERVATION - ORBITER  
 WILL NOT SEPARATE FROM ISSA AND THROUGH TELEMETRY DATA - FIVE OF SIX HOOKS  
 WOULD NOT INDICATE OPEN (NOMINAL UNDOCKING IS NOT PLANNED TO THE PMA1  
 ASSEMBLY).

**CORRECTING ACTION:** DURING DOCKING - ISS CREW CAN CLOSE 12 ACTIVE HOOKS ON  
 ISSA DOCKING MECHANISM TO THE OPPOSING 12 PASSIVE HOOKS ON ORBITER/PMA1  
 DOCKING MECHANISM TO INSURE STRUCTURAL/SEAL INTEGRITY BETWEEN BOTH  
 VEHICLES.

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DURING UNDOCKING (NOMINAL UNDOCKING IS NOT PLANNED TO THE PMA1 ASSEMBLY) - IN THE EVENT FIVE SLAVE HOOK ASSEMBLIES FAIL TO UNLATCH, ORBITER EMERGENCY PYRO SYSTEM CAN BE UTILIZED TO RELEASE ACTIVE HOOKS ASSOCIATED WITH THE CLOSED HOOK ASSEMBLIES (APPLIES ONLY TO THE MECHANISM WITH PYROS). 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:**

ONLY THE TWELVE HOOKS ON THE ORBITER DOCKING MECHANISM ARE CLOSED DURING NOMINAL OPERATIONS. ALL HOOKS MUST BE OPENED TO ENABLE SEPARATION.

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**- FAILURE EFFECTS -**

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**(A) SUBSYSTEM:**

INABILITY TO OPEN OR CLOSE ACTIVE HOOK ON FIVE SLAVE HOOK ASSEMBLIES USING NORMAL UNLATCHING OPERATIONS.

DURING DOCKING: FIRST CABLE FAILURE WOULD RESULT IN 7 OF 12 HOOKS CLOSED (1 SET OF 6 HOOKS AND ACTIVE HOOK ON THE REMAINING DRIVE HOOK ASSEMBLY). LOSS OF CAPABILITY TO MAINTAIN PRESSURE IN VESTIBULE TUNNEL DURING ORBITER/ISSA DYNAMIC OPERATIONS FOLLOWING INITIAL DOCKING MECHANISM INTERFACE PRESSURIZATION.

DURING UNDOCKING (NOMINAL UNDOCKING IS NOT PLANNED TO THE PMA1 ASSEMBLY): LOSS OF CAPABILITY TO UNLATCH ORBITER FROM ISSA USING NORMAL UNLATCHING OPERATIONS.

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

IF FAILURE OCCURS DURING LATCHING, POTENTIAL EXISTS FOR LOSS OF PRESSURE IN VESTIBULE TUNNEL RESULTING FROM DYNAMIC MOVEMENT BETWEEN ORBITER AND ISS.

NO EFFECT ON INTERFACING SUBSYSTEMS IF FAILURE OCCURS DURING UNLATCHING (NOMINAL UNDOCKING IS NOT PLANNED TO THE PMA1 ASSEMBLY).

**(C) MISSION:**

IF SEAL INTEGRITY LOSS, FOLLOWING FIRST CABLE FAILURE, PREVENTS VESTIBULE TUNNEL PRESSURIZATION FOR ORBITER CREW ENTRY INTO THE ISSA AND VICE VERSA, ORBITER/ISSA OPERATIONS WOULD BE LOST. NO EFFECT DURING SEPARATION SINCE DOCKED MISSION OBJECTIVES ARE ACCOMPLISHED PRIOR TO NOMINAL UNDOCKING (NOMINAL UNDOCKING IS NOT PLANNED TO THE PMA1 ASSEMBLY).

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

DURING UNDOCKING (NOMINAL UNDOCKING IS NOT PLANNED TO THE PMA1 ASSEMBLY), FOLLOWING FIRST CABLE FAILURE - POTENTIAL LOSS OF CREW/VEHICLE IF FIVE CLOSED HOOKS CANNOT BE RELEASED BY PYRO FIRING OR INTERFACE CANNOT BE SEPARATED BY PERFORMING AN EVA TO REMOVE THE 96 BOLTS (APPLIES ONLY TO THE ORBITER MECHANISM).

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**(E) FUNCTIONAL CRITICALITY EFFECTS:**

DURING UNDOCKING (APPLIES ONLY TO THE ORBITER MECHANISM):  
FIRST FAILURE - LOSS OF CAPABILITY TO OPEN ACTIVE HOOKS ASSOCIATED WITH THE FIVE CLOSED SLAVE HOOK ASSEMBLIES USING NORMAL UNLATCHING SYSTEM.  
SECOND FAILURE - FAILURE OF EMERGENCY ORBITER PYRO SYSTEM WOULD PRECLUDE ISSA/ORBITER SEPARATION. POSSIBLE LOSS OF CREW AND VEHICLE DUE TO THE INABILITY TO NOMINALLY SEPARATE BOTH VEHICLES. CREW WOULD BE AWARE OF THESE FAILURES 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:**

DURING DOCKING:

SECOND FAILURE (INABILITY TO CLOSE TWELVE ISSA HOOKS) - INABILITY TO SEAL INTERFACE RESULTING IN LOSS OF CAPABILITY TO PRESSURIZE VESTIBULE TUNNEL FOR CREW ENTRY INTO ISSA. LOSS OF PRIMARY MISSION OBJECTIVES. - CRIT 2R3 CONDITION

DURING UNDOCKING (APPLIES ONLY TO THE ORBITER MECHANISM):

THIRD FAILURE (INABILITY TO EVA TO REMOVE 96 BOLTS) - LOSS OF CAPABILITY TO SEPARATE ORBITER FROM ISSA RESULTING IN POTENTIAL LOSS OF CREW AND VEHICLE. - CRIT 1R3 CONDITION

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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**

**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:**

DURING DOCKING, CREW HAS AMPLE TIME TO CLOSE ISSA'S STRUCTURAL HOOKS TO TIGHTEN THE INTERFACE. DURING UNDOCKING (NOMINAL UNDOCKING IS NOT PLANNED TO THE PMA1 ASSEMBLY), CREW HAS AMPLE TIME TO FIRE PYROS OR REMOVE 96 BOLTS HOLDING DOCKING BASE TO EXTERNAL AIRLOCK TO ENABLE ORBITER/ISSA SEPARATION (APPLIES ONLY TO THE ORBITER MECHANISM).

**HAZARDS REPORT NUMBER(S): ORBI 401A**

**HAZARD(S) DESCRIPTION:**

INABILITY TO SEPARATE ORBITER FROM ISS (DURING UNDOCKING)

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- APPROVALS -

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