

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

NUMBER: M8-1MR-BM001-X

SUBSYSTEM NAME: MECHANICAL - EDS

REVISION: 1 9/1/95

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: STRUCTURAL LATCH MECHANISM NPO-ENERGIA	33U.6365.010-05 33U.6365.010-05
SRU	: ASSY, STRUCTURAL HOOK (SLAVE) NPO-ENERGIA	33U.6366.007-05 33U.6366.007-05
SRU	: ASSY, STRUCTURAL HOOK (SLAVE) NPO-ENERGIA	33U.6366.008-05 33U.6366.008-05
SRU	: ASSY, STRUCTURAL HOOK (DRIVE) NPO-ENERGIA	33U.6366.009-05 33U.6366.009-05
SRU	: ASSY, STRUCTURAL HOOK (DRIVE) NPO-ENERGIA	33U.6366.010-05 33U.6366.010-05

## 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 GABLE. ROTATION OF THE DRIVE HOOK ASSEMBLY PROVIDES SIMULTANEOUS ROTATION OF THE FIVE SLAVE HOOK ASSEMBLIES. THE STRUCTURAL LATCH 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.

"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 LATCH ACTUATORS ONCE THE HOOKS HAVE CLOSED.

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**"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 ONE 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 FIXATORS. THE "HOOK-IN-BETWEEN" SIGNAL IS NOT UTILIZED FOR IN-FLIGHT OR GROUND MONITORING PURPOSES.

**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.6121.038-05  
33U.6201.008-05  
33U.6365.010-05  
33U.6366.007-05  
33U.6366.008-05  
33U.6366.009-05  
33U.6366.010-05

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

NUMBER: M8-1MR-BM001-04

REVISION# 2 9/1/95

SUBSYSTEM NAME: MECHANICAL - EDS

LRU: STRUCTURAL LATCH MECHANISM

ITEM NAME: ASSEMBLY, STRUCTURAL HOOK

CRITICALITY OF THIS

FAILURE MODE: 1R3

**FAILURE MODE:**

SINGLE HOOK FAILS TO UNLATCH

**MISSION PHASE:**

OO ON-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY: 104 ATLANTIS

**CAUSE:**

JAMMED LATCH DUE TO CONTAMINATION OR MECHANICAL/THERMAL SHOCK

BROKEN PULLEY-LATCH CONNECTION, BROKEN HOOK, OR SHEARED PYRO BOLT DUE TO MECHANICAL/THERMAL SHOCK, EXCESSIVE VIBRATION, OR MATERIAL DEFECT

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:**

PHYSICAL/VISUAL OBSERVATION - INABILITY OF ORBITER TO SEPARATE FROM MIR.

**CORRECTING ACTION:** IN THE EVENT ONE HOOK ASSEMBLY FAILS TO UNLATCH, ORBITER EMERGENCY PYRO SYSTEM CAN BE UTILIZED TO RELEASE ACTIVE HOOK ASSOCIATED WITH THE FAILED HOOK ASSEMBLY. 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 MIR 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 ACTUATE ONE HOOK OPEN. LOSS OF CAPABILITY TO UNLATCH ORBITER FROM MIR USING NORMAL UNLATCHING OPERATIONS.

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

NO EFFECT FIRST FAILURE. LOSS OF PRESSURE IN ORBITER HABITABLE AREAS FOLLOWING SIMILAR FAILURE OF SECOND HOOK WITH HATCHES OPEN.

**(C) MISSION:**

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

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

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

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

FIRST FAILURE (SINGLE HOOK FAILS TO UNLATCH) - INABILITY TO OPEN ONE HOOK USING NORMAL STRUCTURAL UNLATCHING SYSTEM.

SECOND FAILURE (A SINGLE PYRO FAILS TO FIRE) - INABILITY TO NOMINALLY RELEASE ONE STRUCTURAL HOOK RESULTING IN ORBITER AND MIR BEING STRUCTURALLY LATCHED. CREW WOULD BE AWARE OF THIS FAILURE SINCE THE ORBITER AND MIR 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 MIR 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**

**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.

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HAZARD(S) DESCRIPTION:

INABILITY TO SEPARATE ORBITER AND MIR.

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- APPROVALS -

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DESIGN ENGINEER  
DESIGN MANAGER

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