

## 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

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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-FAILS

**MISSION PHASE:**

OO ON-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY: 104 ATLANTIS

**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. SINCE ALL STRUCTURAL LATCH INDICATIONS ARE OBTAINED FROM THE ACTIVE LATCH, THE FLIGHT AND GROUND CREWS WOULD NOT BE MADE AWARE THAT THE REMAINING FIVE SLAVE LATCHES ARE NOT IN THEIR CLOSED POSITION. IF 7 CLOSED HOOKS PREVENTS VESTIBULE TUNNEL PRESSURIZATION CAPABILITIES, CREW WOULD BE AWARE OF A LOSS OF PRESSURE THROUGH THIS INTERFACE.

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 MIR.

**CORRECTING ACTION:** DURING DOCKING - IF LEAKAGE OCCURS DURING IVA, CREW COULD CLOSE APPROPRIATE HATCHES TO ISOLATE LEAKAGE. THEN MIR CREW CAN CLOSE 12 ACTIVE HOOKS ON MIR DOCKING MECHANISM TO THE OPPOSING 12 PASSIVE HOOKS ON ORBITER DOCKING MECHANISM TO INSURE STRUCTURAL/SEAL INTEGRITY BETWEEN BOTH VEHICLES.

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DURING UNDOCKING - 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. 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 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 SEAL/STRUCTURAL INTEGRITY DURING ORBITER/MIR DYNAMIC OPERATIONS FOLLOWING INITIAL DOCKING MECHANISM INTERFACE PRESSURIZATION.  
DURING UNDOCKING: LOSS OF CAPABILITY TO UNLATCH ORBITER FROM MIR USING NORMAL UNLATCHING OPERATIONS.

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

IF FAILURE OCCURS DURING LATCHING, POTENTIAL EXISTS FOR LOSS OF PRESSURE IN HABITABLE AREAS DURING IVA, WITH HATCHES OPEN, DUE TO LOSS OF STRUCTURAL/SEAL INTEGRITY AT THE DOCKING MECHANISM INTERFACE RESULTING FROM DYNAMIC MOVEMENT BETWEEN ORBITER AND MIR.

NO EFFECT ON INTERFACING ORBITER SUBSYSTEMS IF FAILURE OCCURS DURING UNLATCHING.

**(C) MISSION:**

IF SEAL INTEGRITY LOSS, FOLLOWING FIRST CABLE FAILURE, PREVENTS VESTIBULE TUNNEL PRESSURIZATION FOR ORBITER CREW ENTRY INTO THE MIR AND VICE VERSA, ORBITER/MIR OPERATIONS WOULD BE LOST. NO EFFECT DURING SEPARATION SINCE DOCKED MISSION OBJECTIVES ARE ACCOMPLISHED PRIOR TO NOMINAL UNDOCKING.

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

DURING DOCKING, FOLLOWING FIRST CABLE FAILURE - ORBITER/MIR DOCKING MECHANISM INTERFACE CAN BE INITIALLY PRESSURIZED WITH ONLY SEVEN HOOKS CLOSED. HOWEVER, DYNAMIC MOVEMENT BETWEEN ORBITER AND MIR COULD BREAK THIS SEAL RESULTING IN LOSS OF HABITABLE PRESSURE THROUGH THIS INTERFACE. DURING IVA, ORBITER/MIR CREW SAFETY IS JEOPARDIZED WITH LOSS OF HABITABLE PRESSURE.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

DURING UNDOCKING:

FIRST FAILURE - LOSS OF CAPABILITY TO OPEN ACTIVE HOOKS ASSOCIATED WITH THE FIVE CLOSED SLAVE HOOK ASSEMBLIES USING NORMAL UNLATCHING SYSTEM.

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SECOND FAILURE - FAILURE OF EMERGENCY ORBITER PYRO SYSTEM WOULD PRECLUDE MIR/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 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)): 1/1

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

DURING DOCKING:

SECOND FAILURE (INABILITY TO CLOSE TWELVE MIR HOOKS) - INABILITY TO STOP LEAKAGE AT THE ORBITER/MIR DOCKING MECHANISM INTERFACE.

THIRD FAILURE (INABILITY TO CLOSE APPROPRIATE HATCH(S)) - LOSS OF CAPABILITY TO ISOLATE LEAK FROM CREW CABIN. POSSIBLE LOSS OF CREW AND VEHICLE DUE TO INCREASED USE OF CONSUMABLES.

DURING UNDOCKING:

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

**- TIME FRAME -**

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 UTILIZE MIR'S TWELVE STRUCTURAL HOOKS TO TIGHTEN THE INTERFACE OR CLOSE APPROPRIATE HATCH(S) TO ISOLATE THE LEAK FROM THE CREW CABIN. DURING UNDOCKING, CREW HAS AMPLE TIME TO REMOVE 96 BOLTS HOLDING DOCKING BASE TO EXTERNAL AIRLOCK TO ENABLE ORBITER/MIR SEPARATION.

HAZARDS REPORT NUMBER(S): ORBI 401A, ORBI 511

**HAZARD(S) DESCRIPTION:**

INABILITY TO SEPARATE ORBITER FROM MIR (DURING UNDOCKING). LOSS OF PRESSURE IN HABITABLE VOLUME (DURING DOCKING).

**- APPROVALS -**

DESIGN ENGINEER  
DESIGN MANAGER

: M. NIKOLAYEVA  
: A. SOUBCHEV

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*[Signature]*