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 33U.6366.007-02
SRU	:	ASSY, STRUCTURAL HOOK (SLAVE) RSC-ENERGIA	33U.6366.008-02 33U.6366.008-02
SRU	:	ASSY, STRUCTURAL HOOK (DRIVE) RSC-ENERGIA	33U.6366.009-02 33U.6366.009-02
SRU	:	ASSY, STRUCTURAL HOOK (DRIVE) RSC-ENERGIA	33U.6366.010-02 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 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 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 CONTOL, 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.6201.008-06 (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.6366.007-02
33U.6366.008-02
33U.6366.009-02
33U.6366.010-02

PRINT DATE: 01/27/97

FAILURE MODES EFFECTS ANALYSIS (FMEA) – NON-CIL FAILURE MODE
NUMBER: M8-1SS-BM001- 12
(APPLIES ONLY TO THE ORBITER "SOFT" MECHANISM)

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:
FAILURE OF PYRO SUBSYSTEM TO SEPARATE

MISSION PHASE:
OO ON-ORBIT

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

CAUSE:
PRYO BOLT FAILS TO FRACTURE DUE TO: INADEQUATE OUTPUT ENERGY OF EXPLOSIVE MIX; OVER-STRENGTH MATERIAL; DUAL BRIDGEWIRE FAILURE

HOOK RE-ENGAGED DUE TO LEAF SPRING ACTUATED LOCK PIN FAILS TO EXTEND AS THE RESULT OF: EXCESSIVE FRICTION ON LOCK PIN; INSUFFICIENT SPRING FORCE; EXCESSIVE RELEASE ENERGY; INSUFFICIENT ENERGY ATTENUATION

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

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

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

PASS/FAIL RATIONALE:
A)
N/A - PYROTECHNIC DEVICES ARE NOT CHECKED DURING GROUND OPERATIONS.

B)
N/A - PYROTECHNIC DEVICES ARE NOT CHECKED IN-FLIGHT.

C)

METHOD OF FAULT DETECTION:
PHYSICAL OBSERVATION - ORBITER/SSA FAILS TO SEPARATE.

CORRECTING ACTION: NONE. ORBITER EMERGENCY PYRO SYSTEM NOT UTILIZED UNTIL LOSS OF NORMAL UNLATCHING CAPABILITIES. IN THE EVENT THE PYRO SYSTEM FAILS TO RELEASE A CLOSED STRUCTURAL HOOK, CREW COULD PERFORM CONTINGENCY EVA TO REMOVE THE 96 BOLTS HOLDING THE DOCKING BASE TO THE EXTERNAL AIRLOCK. THIS WILL ALLOW ORBITER/SS SEPARATION TO OCCUR.

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REMARKS/RECOMMENDATIONS:
EMERGENCY PYRO SYSTEM IS NOT UTILIZED UNTIL LOSS OF NORMAL UNLATCHING CAPABILITIES.

- FAILURE EFFECTS -

(A) SUBSYSTEM:
LOSS OF CAPABILITY TO RELEASE ACTIVE (OR PASSIVE) HOOK USING ORBITER EMERGENCY PYRO SYSTEM.

(B) INTERFACING SUBSYSTEM(S):
NO EFFECT ON INTERFACING ORBITER SUBSYSTEMS.

(C) MISSION:
NO EFFECT ON DOCKED MISSION OBJECTIVES AS THE RESULT OF PYRO SEPARATION FAILURE. PYRO SEPARATION SYSTEM IS ONLY UTILIZED WHEN THERE IS A NEED TO PERFORM EMERGENCY ORBITER/ISSA SEPARATION. HOWEVER THIS FAILURE WILL PRECLUDE SUBSEQUENT DOCKINGS.

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT UNTIL LOSS OF NORMAL UNLATCHING OPERATIONS. THEN FAILURE TO RELEASE ACTIVE (OR PASSIVE) HOOK USING ORBITER EMERGENCY PYRO SYSTEM WILL RESULT IN LOSS OF NOMINAL ORBITER/ISS SEPARATION CAPABILITY.

(E) FUNCTIONAL CRITICALITY EFFECTS:
FIRST FAILURE - LOSS OF NOMINAL UNLATCHING.
SECOND FAILURE - FAILURE WITHIN PYRO SUBSYSTEM (PYRO BOLT FAILS TO FRACTURE OR LEAF SPRING ACTUATED LOCK PIN FAILS TO EXTEND), WHEN REQUIRED, RESULTING IN LOSS OF ORBITER/ISSA SEPARATION CAPABILITY. INABILITY TO NOMINALLY SEPARATE ORBITER FROM ISSA.

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.

- 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: HOURS

IS TIME REQUIRED TO IMPLEMENT CORRECTIVE ACTION LESS THAN TIME TO EFFECT?
YES

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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 ISS.

- APPROVALS -

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