FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL HARDWARE
NUMBER: M8-1SS-BM004-X
(DOESN'T APPLY TO PMA2/3
PASSIVE MECH.)

SUBSYSTEM NAME: MECHANICAL - EDS

REVISION: 1 DEC, 1995

		PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	:	DOCKING MECHANISM ASSEMBLY	33U.6316.003-09("SOFT" MECH., 3A MISS.)
		RSC-ENERGIA	33U.6316.003-05-001-01 (PMA1 MECH.)
SRU	:	ASSY, ELECTRO-MAGNETIC DAMPER RSC-ENERGIA	33U.6661.006 33U.6661.006
SRU	:	ASSY, ELECTRO-MAGNETIC DAMPER RSC-ENERGIA	33U.6661.007 33U.6661.007

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
HIGH ENERGY ELECTRO-MAGNETIC DAMPER ASSEMBLY

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 3
THREE (ONE PER BALLSCREW PAIR)

FUNCTION:
A HIGH ENERGY ELECTRO-MAGNETIC DAMPER IS LOCATED BETWEEN EACH ROD OF THE BALLSCREW PAIRS AND IS ENGAGED BY A SOLENOID DRIVEN MECHANICAL LOCK (CLUTCH) DEVICE. ALL THREE DAMPER ASSEMBLIES ARE INTERCONNECTED THROUGH THE KINEMATIC CHAIN TO DAMP OUT RELATIVE PITCH AND YAW ROTATIONAL VELOCITIES OF THE RING FOLLOWING CAPTURE. THESE DAMPERS ARE AUTOMATICALLY ACTIVATED 5 SECONDS AFTER CAPTURE FOR 30SEC TO PMA1 MECHANISM AND ARE MANUALLY TURNED OFF PRIOR TO RING RETRACTION TO THE "SOFT" MECHANISM.

SERVICE IN BETWEEN FLIGHT AND MAINTENANCE CONTROL:
VISUAL INSPECTION, SERVICEABILITY CONTOL, DOCKING WITH CALIBRATING DOCKING MECHANISM.

PRINT DATE: 01/27/97

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: M8-1SS-BM004-X
(DOESN'T APPLY TO PMA2/3 PASSIVE MECH.)

MAINTAINABILITY
REPAIR METHOD - REPLACEMENT.

REFERENCE DOCUMENTS:

33U.6661.006
33U.6661.007
33U.6316.003-09 ("SOFT" MECH.)
33U.6321.004-09 ("SOFT" MECH.)
33U.6316.003-05-001-01 (PMA1 MECH.)
33U.6321.004-05 (PMA1 MECH.)

PRINT DATE: 01/27/97

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL FAILURE MODE NUMBER: M8-1SS-8M004- 03 (DOESN'T APPLY TO PMA2/3 PASSIVE MECH.)

REVISION# 2 JAN, 1997

SUBSYSTEM NAME: MECHANICAL - EDS
LRU: DOCKING MECHANISM ASSEMBLY
ITEM NAME: ASSEMBLY, HIGH ENERGY DAMPER

CRITICALITY OF THIS FAILURE MODE: 2R3

FAILURE MODE:
FAILS TO DISENGAGE

MISSION PHASE:
OO ON-ORBIT

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

CAUSE:
STRUCTURAL FAILURE DUE TO MECHANICAL/THERMAL SHOCK, VIBRATION, OR MANUFACTURE/MATERIAL DEFECT; CONTAMINATION

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

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

REDUNDANCY SCREEN
A) PASS
B) FAIL
C) PASS

PASS/FAIL RATIONALE:
A)

B)
SCREEN B FAILS BECAUSE A DAMPER BEING ENGAGE PRIOR TO DOCKING IS NOT DETECTABLE IN FLIGHT.

C)

METHOD OF FAULT DETECTION:
NONE

REMARKS/RECOMMENDATIONS:
DAMPING OCCURS BY ELECTRO-MAGNETIC MEANS AND IS ONLY ACTIVATED WHEN POWER IS APPLIED TO THE WINDINGS. AS SUCH, A FAILURE TO DISENGAGE A DAMPER IS MORE LIKELY TO OCCUR AS THE RESULT OF AN ELECTRICAL FAILURE RATHER THAN A MECHANICAL FAILURE. THIS FAILURE MODE ASSUMES THE DAMPERS ARE ON PRIOR TO DOCKING WHICH, MECHANICALLY, CAN ONLY OCCUR DURING A SECOND DOCKING.

- FAILURE EFFECTS -

PRINT DATE: 01/27/97

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL FAILURE MODE
NUMBER: M8-1SS-BM004- 03
(DOESN'T APPLY TO PMA2/3 PASSIVE MECH.)

(A) SUBSYSTEM:
RESISTANCE TO MOVEMENT OF KINEMATIC CHAIN ELEMENTS BETWEEN AFFECTED BALLNUT PAIRS. ROTATIONAL VELOCITIES OF THE DOCKING RING ARE LIMITED IN THE PITCH AND YAW DIRECTIONS. POSSIBLE HIGH DOCKING LOADS.

(B) INTERFACING SUBSYSTEM(S):
NONE UNTIL A FAILURE OF THE SLIP CLUTCH. THEN POTENTIAL EXCESSIVE LOADS INCURRED DURING DOCKING, AS THE RESULT OF A SINGLE HIGH ENERGY DAMPER BEING ACTIVATED PRIOR CAPTURE, COULD PROPAGATE TO EXTERNAL AIRLOCK AND ORBITER/PMA1 STRUCTURE.

(C) MISSION:
NO EFFECT ON CURRENT DOCKING. ONLY SUBSEQUENT DOCKINGS ARE AFFECTED - A SINGLE HIGH ENERGY DAMPER BEING ACTIVATED, ALONG WITH A FAILURE OF THE SLIP CLUTCH, PRIOR TO CAPTURE COULD DAMAGE ELEMENTS IN THE KINEMATIC CHAIN POTENTIALLY RESULTING IN LOSS OF CAPABILITY TO EXTEND OR RETRACT DOCKING RING. INABILITY TO MOVE RING TO MATE BOTH MECHANISMS WILL PRECLUDE DOCKING CAPABILITIES RESULTING IN LOSS OF ORBITER(PMA1)/ISS MISSION CAPABILITIES.

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT ON CREW AND VEHICLE. POTENTIAL DAMAGE TO ISS AND ORBITER/PMA1 DOCKING MECHANISMS IN CASE SECOND DOCKING.

(E) FUNCTIONAL CRITICALITY EFFECTS:
FIRST FAILURE (HIGH ENERGY DAMPER ENGAGED PRIOR TO DOCKING) - DOCKING LOADS HIGHER THAN NORMAL. SECOND FAILURE (SLIP CLUTCH FAILS TO ENGAGE) - EXCESSIVE DOCKING LOADS INCURRED DURING CONTACT COULD CAUSE DAMAGE TO ORBITER/PMA1 AND ISS DOCKING MECHANISMS RESULTING IN THE INABILITY TO EXTEND OR RETRACT DOCKING RING. WORST CASE, LOSS OF MISSION. - CRITICALITY 2R3 CONDITION.

DESIGN CRITICALITY (PRIOR TO OPERATIONAL DOWNGRADE, DESCRIBED IN F): N/A

(F) RATIONALE FOR CRITICALITY CATEGORY DOWNGRADE:
N/A (THERE ARE NO WORKAROUNDS TO CIRCUMVENT THIS FAILURE FOLLOWING SLIP CLUTCH FAILURE.)

- TIME FRAME -

TIME FROM FAILURE TO CRITICAL EFFECT: HOURS TO DAYS

TIME FROM FAILURE OCCURRENCE TO DETECTION: SECONDS TO MINUTES

TIME FROM DETECTION TO COMPLETED CORRECTIVE ACTION: N/A

IS TIME REQUIRED TO IMPLEMENT CORRECTIVE ACTION LESS THAN TIME TO EFFECT?
NO

RATIONALE FOR TIME TO CORRECTING ACTION VS TIME TO EFFECT:
THERE IS NO CORRECTIVE ACTION TO THIS FAILURE SINCE A HIGH ENERGY DAMPER BEING MECHANICALLY ENGAGED IS NOT DETECTABLE UNTIL AFTER CAPTURE, AT

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE NUMBER: M8-1SS-BM004- 03 (DOESN'T APPLY TO PMA2/3 PASSIVE MECH.)

WHICH TIME THE RESULTING HIGH LOADS COULD DAMAGE BOTH ORBITER/PMA1 AND ISS DOCKING MECHANISMS TO THE POINT OF PRECLUDING DOCKING.

HAZARDS REPORT NUMBER(S): ORBI 402B

HAZARD(S) DESCRIPTION:
DAMAGE TO BOTH ORBITER/PMA1 AND ISS DOCKING MECHANISMS.

-DISPOSITION RATIONALE-

(A) DESIGN:
DAMPING OCCURS BY ELECTRO-MAGNETIC MEANS AND IS ONLY ACTIVATED WHEN POWER IS APPLIED TO THE WINDINGS. AS SUCH, A FAILURE TO DISENGAGE A DAMPER IS MORE LIKELY TO OCCUR AS THE RESULT OF AN ELECTRICAL FAILURE RATHER THAN A MECHANICAL FAILURE. MECHANICAL FAILURES ARE ONLY POSTULATED BECAUSE A SECOND DOCKING MAY BE REQUIRED. ALL DAMPER PARTS HAVE A SAFETY FACTOR NO LESS THAN 1.4.

LOAD ANALYSES:
(1) LOADS ANALYSIS HAS INDICATED THAT A SINGLE HIGH ENERGY DAMPER BEING ACTIVATED PRIOR TO CAPTURE COULD RESULT IN MOMENTS OF 686 KGF-M WHICH EXCEEDS THE ODS LIMIT LOAD SPECIFICATION OF 500 KGF-M.
(2) ADDITIONAL ANALYSIS HAS SHOWN THAT THE MAXIMUM AXIAL LOADS INCURRED AS THE RESULT OF ALL THREE HIGH ENERGY DAMPERS BEING ACTIVATED PRIOR TO CAPTURE ARE 5097KGF (TENSION) AND 2906 KGF (COMPRESSION) IN THE Z-AXIS. ANALYSIS HAS INDICATED THAT THE CAPTURE LATCHES WILL DISENGAGE WHEN THE AXIAL LOAD ON THIS AXIS REACHES 3698 KGF. DAMAGE TO THE CAPTURE LATCH, THAT WOULD PREVENT IT FROM BEING ACTUATED OPEN, WILL NOT OCCUR PRIOR TO THE DISENGAGEMENT AXIAL LOAD OF 3698 KGF.
(3) THESE LOADS WILL NOT EXCEED EXT AIRLOCK/ORBITER STRUCTURAL LIMITS.

(B) TEST:
REFER TO "APPENDIX B" FOR DETAILS OF THE FOLLOWING ACCEPTANCE AND QUALIFICATION TESTS OF THE DOCKING MECHANISMS RELATIVE TO THIS FAILURE MODE.

DOCKING MECHANISM ACCEPTANCE TESTS:
1. HIGH ENERGY DAMPER FUNCTIONAL PERFORMANCE TEST
2. VIBRATION TEST
3. THERMAL VACUUM TEST

DOCKING MECHANISM QUALIFICATION TESTS:
1. TRANSPORTABILITY STRENGTH TEST
2. VIBRATION TEST
3. SHOCK-BASIC DESIGN TEST
4. THERMAL VACUUM TEST
5. SIX-DEGREE-OF-FREEDOM TEST
6. SERVICE LIFE TEST
7. DISASSEMBLY INSPECTION

PRINT DATE: 01/27/97

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE NUMBER: M8-1SS-BM004- 03 (DOESN'T APPLY TO PMA2/3 PASSIVE MECH.)

OMRSD - TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:
RECEIVING INSPECTION
COMPONENTS ARE SUBJECTED TO A 100% RECEIVING INSPECTION PRIOR TO INSTALLATION.

CONTAMINATION CONTROL
CORROSION PROTECTION PROVISIONS AND CONTAMINATION CONTROL VERIFIED BY INSPECTION. CHECK OF ROOM CLEANLINESS; PARTS WASHING AND OTHER OPERATIONS OF THE TECHNOLOGICAL PROCESS WHICH PROVIDES CLEANLINESS ARE VERIFIED BY INSPECTION.

CRITICAL PROCESSES
ANODIZING, HEAT TREATING, CHEMICAL PLATING, SOLDERING, AND CURING VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
TORQUE, ADJUSTMENTS AND TOLERANCES ACCORDING TO TECHNICAL REQUIREMENTS OF THE DRAWINGS ARE VERIFIED BY INSPECTION.

TESTING
ATP/QTP/OMRSD TESTING VERIFIED BY INSPECTION.

HANDLING/PACKAGING
HANDLING/PACKAGING PROCEDURES AND REQUIREMENT FOR SHIPMENT VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:
DATA ON TEST FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING OF ODS DOCKING MECHANISMS CAN BE FOUND IN PRACA DATA BASE.

(E) OPERATIONAL USE:
NONE

- APPROVALS -

PRODUCT ASSURANCE ENGR.	: M. NIKOLAYEVA	:
DESIGN ENGINEER	: E. BOBROV	:
NASA SS/MA	:	:
NASA SUBSYSTEM MANAGER	:	:
JSC MOD	:	: