FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL HARDWARE
NUMBER: M8-1SS-BM007-X
(DOESN'T APPLY TO PMA2/3
PASSIVE MECHANISM)

SUBSYSTEM NAME: MECHANICAL - EDS

REVISION: 1 DEC. 1996

		PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	:	GUIDE RING ASSEMBLY RSC-ENERGIA	33U.6271.011-09 ("SOFT") 33U.6271.011-05 (PMA1)
SRU	:	MECH, GUIDE RING BALLSCREW RSC-ENERGIA	33U.6365.011-09 ("SOFT") 33U.6365.011-05 (PMA1)

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
GUIDE RING BALLSCREW INTERCONNECTING MECHANISM

REFERENCE DESIGNATORS:

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

FUNCTION:
LOCATED AT THE APEX OF EACH BALLSCREW PAIR, THE BALLSCREW INTERCONNECTING MECHANISM PROVIDES A KINEMATIC CONNECTION BETWEEN THE GUIDE RING AND THE REMAINING ELEMENTS OF THE DOCKING MECHANISM. THE MECHANISM PROVIDES LOCKING OF BOTH BALLSCREW RODS TO PREVENT THEM FROM ROTATING AND UNLOCKING OF BOTH BALLSCREW RODS TO ALLOW THEM TO OPERATE TOGETHER.

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.6365.011-09 ("SOFT")
33U.6365.011-05 (PMA1)
33U.6271.011-09 ("SOFT")
33U.6271.011-05 (PMA1)

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: M8-1SS-BM007-02
(DOESN'T APPLY TO PMA2/3
PASSIVE MECHANISM)

REVISION# 1 DEC, 1996

SUBSYSTEM NAME: MECHANICAL - EDS
LRU: GUIDE RING ASSEMBLY
ITEM NAME: MECHANISM, BALLSCREW INTERCONNECTING

CRITICALITY OF THIS FAILURE MODE: 1R2

FAILURE MODE:
BROKEN

MISSION PHASE:
OO ON-ORBIT

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

CAUSE:
GEAR/SHAFT FAILURE DUE TO MATERIAL DEFECT, MANUFACTURE DEFECT, EXCESSIVE EXTERNAL LOADS, VIBRATION, MECHANICAL SHOCK

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:
INSTRUMENTATION - THE CORRESPONDING DOCKING RING INDICATORS ON THE DOCKING CONTROL PANEL WILL ILLUMINATE TO INDICATE RING POSITION AND ALIGNMENT. VISUAL OBSERVATION - INABILITY TO MOVE THE DOCKING RING; POTENTIAL MOMENT CREATED BETWEEN VEHICLES ABOUT ONE POINT ON THE RING.

REMARKS/RECOMMENDATIONS:
A BROKEN BALLSCREW INTERCONNECTING MECHANISM IS CONSIDERED TO BE VERY REMOTE. ALL COMPONENTS HAVE SAFETY FACTOR > 1.4.

- FAILURE EFFECTS -

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL FAILURE MODE
NUMBER: M8-1SS-BM007- 02
(DOESN'T APPLY TO PMA2/3 PASSIVE MECHANISM)

(A) SUBSYSTEM:
ONE BALLSCREW OF THE PAIR IS ALLOWED TO ROTATE INDEPENDENTLY OF THE OTHER AND WILL NOT BE ABLE TO RESTRAIN AXIAL LOADS. LOSS OF CAPABILITY TO ALIGN THE DOCKING RING. LOADS EXPERIENCED DURING CAPTURE WILL COLLAPSE THE DOCKING RING AT THE POINT ON THE RING WHERE FAILURE OF THE BALLSCREW INTERCONNECTING MECHANISM OCCURRED.

(B) INTERFACING SUBSYSTEM(S):
POTENTIAL DAMAGE TO ORBITER/PMA1 STRUCTURE IF ORBITER(PMA1)/ISS COLLIDE DUE TO THIS FAILURE AND WORKAROUND IS NOT IMPLEMENTED:

(C) MISSION:
LOSS OF DOCKING RING ALIGNMENT WILL PRECLUDE DOCKING CAPABILITIES RESULTING IN LOSS OF ORBITER(PMA1)/ISS MISSION OBJECTIVES.

(D) CREW, VEHICLE, AND ELEMENT(S):
FIRST FAILURE (BROKEN BALLSCREW INTERCONNECTING MECHANISM) COLLAPSE OF THE DOCKING RING AT ONE POINT ON THE RING DURING CAPTURE COULD CAUSE A MOMENT BETWEEN ORBITER/PMA1 AND ISS.

(E) FUNCTIONAL CRITICALITY EFFECTS:
N/A

DESIGN CRITICALITY (PRIOR TO OPERATIONAL DOWNGRADE, DESCRIBED IN F): 1/1

(F) RATIONALE FOR CRITICALITY CATEGORY DOWNGRADE:
SECOND FAILURE - INABILITY TO OPEN CAPTURE LATCHES OR PERFORM SEPARATION (NOMINAL UNDOCKING IS NOT PLANNED TO PMA1 ASSEMBLY). INABILITY TO CIRCUMVENT THE MOMENT CREATED BETWEEN ORBITER/PMA1 AND ISS. POTENTIAL COLLISION BETWEEN BOTH VEHICLES RESULTING IN POSSIBLE LOSS OF CREW AND VEHICLE.

- TIME FRAME -

TIME FROM FAILURE TO CRITICAL EFFECT: MINUTES

TIME FROM FAILURE OCCURRENCE TO DETECTION: SECONDS

TIME FROM DETECTION TO COMPLETED CORRECTIVE ACTION: SECONDS

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 OPEN CAPTURE LATCHES (NOMINAL UNDOCKING IS NOT PLANNED TO PMA1 ASSEMBLY) AND FIRE RCS JETS (APPLIES ONLY TO THE ORBITER) TO AVOID A POTENTIAL COLLISION BETWEEN ORBITER/PMA1 AND ISS.

HAZARDS REPORT NUMBER(S): ORBI 402A

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NUMBER: M8-1SS-BM007- 02
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HAZARD(S) DESCRIPTION:
UNCONTROLLED/INADVERTENT COLLISION BETWEEN ORBITER AND ISSA.

-DISPOSITION RATIONALE-

(A) DESIGN:
A BROKEN BALLSCREW INTERCONNECTING MECHANISM IS CONSIDERED TO BE VERY REMOTE BASED ON THE FOLLOWING: THE USE AND EXPERIENCE OF THIS MECHANISM ON PREVIOUS DEVELOPMENTS; PRELIMINARY STRENGTH ANALYSIS OF STRUCTURAL ELEMENTS AND PARTS; THE CHOICE OF STAINLESS STEELS AS THE MATERIAL HAD PERFORMED WELL IN OPERATIONAL USE; THE CALCULATION OF TOLERANCES AND DIMENSIONAL CIRCUITS; THE CHOICE OF SPECIAL BEARINGS SUITABLE FOR OPERATIONAL CONDITIONS; AND THE USE OF A SPRING MECHANISM TO REDUCE SPACING BETWEEN GEARS TO REDUCE THE POSSIBILITY OF GEAR TEETH DAMAGE OR BREAKAGE DUE TO EXCESSIVE LOADS.

(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. VIBRATION TEST
2. AXIAL STIFFNESS IN INITIAL POSITION LOADS TEST
3. RETRACTION FORCE LOADS TEST
4. RESTRAINING FORCE LOADS TEST
5. TRANSLATION CAPABILITY TEST - Y_T & Z_T AXES
6. ROTATIONAL CAPABILITY LOADS TEST - Y_T & Z_T AXES
7. ROTATIONAL CAPABILITY LOADS TEST - X_T AXIS
8. 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. EXTEND/RETRACT MECHANISM LIMIT LOAD TEST
8. EXTEND/RETRACT MECHANISM ULTIMATE LOAD TEST
9. DISASSEMBLY INSPECTION

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

(C) INSPECTION:
RECEIVING INSPECTION
RAW MATERIAL IS VERIFIED BY INSPECTION TO ASSURE COMPLIANCE WITH THEIR SPECIFICATIONS ON A CERTAIN % OF THE BATCH AT THE INPUT CONTROL.

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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, AND SOLDERING VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
ADJUSTMENTS AND TUNING ACCORDING TO TECHNICAL REQUIREMENTS OF THE DRAWINGS ARE VERIFIED BY INSPECTION. QUALITY CONTROL OF COATINGS AND FABRICATION OF BALLSCREW INTERCONNECTING MECHANISM (INCLUDING GEAR/BEARING MATING) IS 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:
CENTERING SPRING MECHANISM WILL LIMIT ROTATION OF ONE BALLSCREW, PROVIDING SOME RESTRAINT AGAINST RING COLLAPSE. HOWEVER, IF A BROKEN BALLSCREW INTERCONNECTING MECHANISM RESULTS IN A MOMENT BETWEEN BOTH VEHICLES, DURING DOCKING, CREW COULD OPEN CAPTURE LATCHES AND FIRE APPROPRIATE ORBITER RCS JETS TO PERFORM SEPARATION.

- APPROVALS -

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