

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL HARDWARE

NUMBER: MB-1SS-BM003-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	: DOCKING MECHANISM ASSEMBLY RSC-ENERGIA	33U.6316.003-09 ("SOFT" MECH.) 33U.6316.003-05-001-01 (PMA1 MECH.)
SRU	: ASSY, RIGHT BALLSCREW/NUT RSC-ENERGIA	33U.6421.009-02("SOFT") 33U.6421.009-01 (PMA1)
SRU	: ASSY, LEFT BALLSCREW/NUT RSC-ENERGIA	33U.6421.010-02("SOFT") 33U.6421.010-01 (PMA1)
SRU	: ASSY, RIGHT BALLSCREW/NUT RSC-ENERGIA	33U.6421.011-02("SOFT") 33U.6421.011-01 (PMA1)
SRU	: ASSY, LEFT BALLSCREW/NUT RSC-ENERGIA	33U.6421.012-02("SOFT") 33U.6421.012-01 (PMA1)
SRU	: ASSY, RIGHT BALLSCREW/NUT RSC-ENERGIA	33U.6421.013-02("SOFT") 33U.6421.013-01 (PMA1)
SRU	: ASSY, LEFT BALLSCREW/NUT RSC-ENERGIA	33U.6421.014-02("SOFT") 33U.6421.014-01 (PMA1)

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
LEFT/RIGHT BALLSCREW/NUT ASSEMBLY

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 6
SIX (3 LEFT AND 3 RIGHT)

FUNCTION:

THE BALLSCREW ASSEMBLY IS A KINEMATIC ELEMENT WHICH TRANSFERS THE MOTION FROM THE ACTUATOR TO THE RING (ON EXTENSION OR RETRACTION) AND FROM THE RING TO ELEMENTS OF THE ATTENUATION SYSTEM DURING DOCKING. IT CONSISTS OF (1) ROD SCREW OF 530 MM IN LENGTH (FOR THE "SOFT" MECH.)/475 MM IN LENGTH (FOR THE PMA1 MECH.) WITH LEFT-HAND (LEFT BALLSCREW/NUT ASSEMBLIES) AND RIGHT-HAND THREAD (RIGHT BALLSCREW/NUT ASSEMBLIES); (2) BALLSCREW/NUT ASSEMBLIES WHICH PROVIDES THE TRANSFORMATION OF THE ROTATIONAL MOTION OF THE NUT INTO THE LINEAR PROGRESSIVE MOTION OF THE SCREW AND VICE VERSA; AND (3) THREE DIMENSIONAL HINGE WITH CROSS AXIS GEARING TO TRANSFER THE ROTATION FROM THE SCREW NUT TO THE OUTPUT SHAFT.

SERVICE IN BETWEEN FLIGHT AND MAINTENANCE CONTROL:

VISUAL INSPECTION, SERVICEABILITY CONTROL, DOCKING WITH CALIBRATING DOCKING MECHANISM.

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL HARDWARE

NUMBER: M8-1SS-BM003-X
(DOESN'T APPLY TO PMA2/3
PASSIVE MECH.)

MAINTAINABILITY

REPAIR METHOD - NONE (REPAIRING IN MANUFACTURING CONDITIONS ONLY).

REFERENCE DOCUMENTS:

33U.6421.009-02 ("SOFT")
33U.6421.009-01 (PMA1)
33U.6421.010-02 ("SOFT")
33U.6421.010-01 (PMA1)
33U.6421.011-02 ("SOFT")
33U.6421.011-01 (PMA1)
33U.6421.012-02 ("SOFT")
33U.6421.012-01 (PMA1)
33U.6421.013-02 ("SOFT")
33U.6421.013-01 (PMA1)
33U.6421.014-02 ("SOFT")
33U.6421.014-01 (PMA1)
33U.6316.003-09 ("SOFT")
33U.6316.003-05-001-01 (PMA1)

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

NUMBER: M8-1SS-BM003- 01
 (DOESN'T APPLY TO PMA2/3
 PASSIVE MECHANISM)

REVISION# 1 DEC, 1996

SUBSYSTEM NAME: MECHANICAL - EDS
 LRU: DOCKING MECHANISM ASSEMBLY
 ITEM NAME: ASSEMBLY, BALLSCREW/NUT

CRITICALITY OF THIS
 FAILURE MODE: 1R2

FAILURE MODE:
 BROKEN (SHAFT/GEAR/TUBE BREAKAGE)

MISSION PHASE:
 OO ON-ORBIT

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

CAUSE:
 MATERIAL/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/NUT ASSEMBLY IS CONSIDERED VERY REMOTE.

- FAILURE EFFECTS -**(A) SUBSYSTEM:**

INABILITY OF AFFECTED BALLSCREW/NUT ASSEMBLY TO CARRY A LOAD. LOSS OF CAPABILITY TO ALIGN, CAPTURE, RETRACT, AND EXTEND THE DOCKING RING. LOADS

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL FAILURE MODE
NUMBER: MB-1SS-BM003- 01
(DOESN'T APPLY TO PMA2/3
PASSIVE MECH.)

EXPERIENCED DURING CAPTURE COULD COLLAPSE THE DOCKING RING AT THE POINT ON THE RING WHERE FAILURE OF THE BALLSCREW OCCURRED.

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

(C) MISSION:
WORST CASE, LOSS OF ALL FUNCTIONS ASSOCIATED WITH THE DOCKING RING (ALIGNMENT, CAPTURE, RETRACTION, EXTENSION) WILL PRECLUDE DOCKING CAPABILITIES RESULTING IN LOSS OF ORBITER/ISS (PMA1/ISS) MISSION OBJECTIVES.

(D) CREW, VEHICLE, AND ELEMENT(S):
FIRST FAILURE (BROKEN BALLSCREW/NUT ASSEMBLY) 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 AND FIRE RCS JETS (APPLIES ONLY TO THE ORBITER) TO AVOID A POTENTIAL COLLISION BETWEEN ORBITER AND ISSA.

HAZARDS REPORT NUMBER(S): ORBI 402B

HAZARD(S) DESCRIPTION:
UNCONTROLLED/INADVERTENT COLLISION BETWEEN ORBITER AND ISS.

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL FAILURE MODE
NUMBER: M8-1SS-BM003- 01
(DOESN'T APPLY TO PMA2/3
PASSIVE MECH.)

-DISPOSITION RATIONALE-

(A) DESIGN:

A BROKEN BALLSCREWNUT ASSEMBLY IS CONSIDERED VERY REMOTE BASED ON THE FOLLOWING: THE USE OF THE EXPERIENCE OF PREVIOUS DEVELOPMENTS; STRENGTH ANALYSIS OF STRUCTURAL ELEMENTS AND PARTS HAVING A SAFETY FACTOR NO LESS THAN 1.4; THE CHOICE OF MATERIALS THAT SHOWED A GOOD PERFORMANCE IN OPERATIONAL USE; THE CALCULATION OF TOLERANCES AND DIMENSIONAL CIRCUITS; AND THE CHOICE OF SPECIAL BEARINGS SUITABLE FOR OPERATIONAL CONDITIONS.

(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. GUIDE RING FUNCTIONAL PERFORMANCE TEST
2. VIBRATION TEST
3. AXIAL STIFFNESS IN INITIAL POSITION LOADS TEST
4. RETRACTION FORCE LOADS TEST
5. RESTRAINING FORCE LOADS TEST
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.

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, AND CHEMICAL PLATING VERIFIED BY INSPECTION.

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL FAILURE MODE

**NUMBER: M8-1SS-BM003- 01
(DOESN'T APPLY TO PMA2/3
PASSIVE MECH.)**

ASSEMBLY/INSTALLATION

ADJUSTMENTS AND TUNING ACCORDING TO TECHNICAL REQUIREMENTS OF THE DRAWINGS ARE VERIFIED BY INSPECTION. QUALITY CONTROL OF COATINGS AND FABRICATION OF BALLSCREW/NUT ASSEMBLY (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:

CREW COULD OPEN CAPTURE LATCHES AND FIRE APPROPRIATE ORBITER RCS JETS TO PERFORM SEPARATION IN THE EVENT A BROKEN BALLSCREW/NUT ASSEMBLY RESULTS IN A MOMENT BETWEEN ORBITER AND ISSA.

- APPROVALS -

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

:	<i>[Signature]</i>
:	<i>[Signature]</i>