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PRINT DATE: 01/27/97

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL HARDWARE**

**NUMBER: M8-1SS-BM008-X  
(DOESN'T APPLY TO PMA2/3  
PASSIVE MECHANISM)**

**SUBSYSTEM NAME: MECHANICAL - EDS**

**REVISION: 1 DEC, 1986**

	<b>PART NAME VENDOR NAME</b>	<b>PART NUMBER VENDOR NUMBER</b>
LRU	: MECH, GUIDE RING BALLSCREW	33U.6365.011-09 ("SOFT" MECHANISM)
	RSC-ENERGIA	33U.6365.011-05 (PMA1 MECHANISM)
SRU	: FIXER	33Y.6662.003
	RSC-ENERGIA	33Y.6662.003

**PART DATA**

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

**REFERENCE DESIGNATORS:**

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

**FUNCTION:**

CONTAINED WITHIN EACH BALLSCREW INTERCONNECTING MECHANISM, THE FIXER LOCKS OR UNLOCKS BOTH RODS OF A SINGLE BALLSCREW PAIR. WHEN POWER IS APPLIED TO THE FIXER, A MAGNETIC FIELD IS CREATED THAT EXTENDS A LEVER TO ENGAGE A GEAR WHICH MECHANICALLY LOCKS BOTH BALLSCREW RODS OF A SINGLE PAIR BY LIMITING THEIR ROTATION. THIS ACTION PREVENTS ROLL AND TRANSLATION MOVEMENT OF THE DOCKING RING AT ONE OF THREE POINTS AROUND THE RING. WHEN POWER IS REMOVED FROM THE WINDINGS OF THE FIXER, A SPRING RETRACTS THE LEVER (THAT LOCKS THE MECHANICAL GEAR LINK BETWEEN THE RODS) AND ALLOWS BOTH RODS OF THE BALLSCREW PAIR TO ROTATE.

**SERVICE IN BETWEEN FLIGHT AND MAINTENANCE CONTROL:**

SERVICEABILITY CONTROL, DOCKING WITH CALIBRATING DOCKING MECHANISM.

**MAINTAINABILITY**

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

**REFERENCE DOCUMENTS:** 33U.6365.011-09 ("SOFT" MECH.)  
33U.6365.011-09 (PMA1 MECH.)  
33U.6662.003

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL FAILURE MODE**  
**NUMBER: M8-1SS-BM008- 02**  
**(DOESN'T APPLY TO PMA2/3**  
**PASSIVE MECHANISM)**

REVISION# 2 JAN, 1997

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

CRITICALITY OF THIS  
 FAILURE MODE: 2R3

**FAILURE MODE:**  
**FAILS TO UNLOCK**

**MISSION PHASE:**  
 OO ON-ORBIT

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

**CAUSE:**  
**MULTIPLE SPRING FAILURES DUE TO MECHANICAL/THERMAL SHOCK OR**  
**MANUFACTURE/MATERIAL DEFECT, JAMMED ROD DUE TO 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 SINGLE LOCKED RING FIXER PRIOR TO DOCKING IS NOT  
 DETECTABLE UNTIL AFTER CAPTURE.

C)

**METHOD OF FAULT DETECTION:**

NONE PRIOR TO CAPTURE. ANALYSIS OF TELEMETRY DATA TO EVALUATE A FAILURE TO  
 CAPTURE MAY IDENTIFY A LOCKED FIXER AS THE CAUSE. SENSORS WILL MONITOR  
 POWER TO ALL FIXERS AND PROVIDE THE INFORMATION FOR GROUND MONITORING  
 THROUGH TELEMETRY DATA.

**REMARKS/RECOMMENDATIONS:**

THE BALLSCREW INTERCONNECTING MECHANISM FIXERS CONTROL ROLL AND  
 TRANSLATION MOVEMENT OF THE RING ONLY. COIL SPRING IS PRELOADED TO 18 KG  
 TO ALLOW FIXER TO UNLOCK ONCE POWER IS REMOVED. THREE OR MORE BREAKS IN  
 THE COIL ARE REQUIRED BEFORE TOTAL FAILURE OF THE SPRING OCCURS. FIXER IS  
 NORMALLY IN UNLOCKED POSITION.

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**- FAILURE EFFECTS -**


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**(A) SUBSYSTEM:**

AFFECTED RODS OF ONE BALLSCREW PAIR ARE NOT PERMITTED TO ROTATE FREELY. ROLL AND TRANSLATION MOVEMENT IS RESTRICTED AT ONE POINT ON THE DOCKING RING. CAPTURE CAPABILITIES ARE IMPEDED SIGNIFICANTLY UPON A FAILURE TO UNLOCK A SINGLE FIXER PRIOR TO CAPTURE. NO EFFECT ON MATING OF THE TWO DOCKING MECHANISMS IF FAILURE OCCURS AFTER RING RETRACTION FOLLOWING CAPTURE.

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

NONE UNTIL A FAILURE OF THE SLIP CLUTCH. THEN EXCESSIVE LOADS INCURRED DURING DOCKING, AS THE RESULT OF A SINGLE RING FIXER BEING LOCKED PRIOR CAPTURE, COULD PROPAGATE TO EXTERNAL AIRLOCK AND ORBITER/PMA1 STRUCTURE.

**(C) MISSION:**

NONE UNTIL A FAILURE OF THE SLIP CLUTCH. THEN WORST CASE, A SINGLE RING FIXER FAILING TO UNLOCK FOLLOWING RING EXTENSION TO THE INITIAL POSITION. SINCE A MECHANICAL FAILURE OF THE FIXER IS NOT DETECTABLE, DOCKING WITH A LOCKED RING FIXER COULD RESULT IN EXCESSIVE LOADS. THESE LOADS COULD PREVENT CAPTURE RESULTING IN LOSS OF DOCKING AND SUBSEQUENT LOSS OF MISSION OBJECTIVES.

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

NO EFFECT ON CREW AND ORBITER/PMA1 STRUCTURE. HOWEVER, EXCESSIVE LOADS COULD CAUSE DAMAGE TO BOTH ORBITER/PMA1 AND ISS DOCKING MECHANISMS.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

FIRST FAILURE (FIXER FAILS TO UNLOCK) - 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 OR PERFORM CAPTURE. 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 A SLIP CLUTCH FAILURE.)

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**- TIME FRAME -**


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**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

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**RATIONALE FOR TIME TO CORRECTING ACTION VS TIME TO EFFECT:**

THERE IS NO CORRECTIVE ACTION TO THIS FAILURE SINCE A SINGLE FIXER BEING LOCKED IS NOT DETECTABLE UNTIL AFTER CAPTURE AND FOLLOWING A SLIP CLUTCH FAILURE, AT 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.

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**

THE BALLSCREW INTERCONNECTING MECHANISM FIXERS CONTROL ROLL AND TRANSLATION MOVEMENT OF THE RING ONLY. COIL SPRING IS PRELOADED TO 18 KG TO ALLOW FIXER TO UNLOCK ONCE POWER IS REMOVED. THREE OR MORE BREAKS IN THE COIL ARE REQUIRED BEFORE TOTAL FAILURE OF THE SPRING OCCURS. FIXER IS NORMALLY IN UNLOCKED POSITION. A RING FIXER FAILING TO UNLOCK CAN OCCUR MECHANICALLY DURING RING MOVEMENT TO IT'S INITIAL POSITION PRIOR TO CAPTURE. FIXERS ARE LOCKED WHENEVER THE RING IS MOVED.

LOAD ANALYSIS HAS SHOWN THAT THE MAXIMUM MOMENT IN THE Z DIRECTION AND A MAXIMUM LOAD IN THE X DIRECTION IS EXCEEDED GIVEN A SINGLE RING FIXER IS LOCKED PRIOR TO CAPTURE. HOWEVER THIS LOAD AND MOMENT WOULD NOT EXCEED THE LIMITS ON THE EXTERNAL AIRLOCK OR ORBITER STRUCTURE. IN TWO OF THE FIFTEEN DOCKING CASES MODELED, THE RING DID NOT CAPTURE GIVEN A SINGLE LOCKED RING FIXER PRIOR TO CAPTURE.

**(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. TRANSLATION CAPABILITY TEST -  $Y_T$  &  $Z_T$  AXES
4. ROTATIONAL CAPABILITY LOADS TEST -  $Y_T$  &  $Z_T$  AXES
5. ROTATIONAL CAPABILITY LOADS TEST -  $X_T$  AXIS
6. 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

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- 7. FIXER ULTIMATE LOAD TEST
- 8. DISASSEMBLY INSPECTION

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, SOLDERING, CHEMICAL PLATING, 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. :  
 DESIGN ENGINEER :  
 NASA SSMA :  
 NASA SUBSYSTEM MANAGER :  
 JSC MOD :

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*[Handwritten signatures and initials over approval lines]*