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

NUMBER: M8-1SS-BM013-X  
{APPLIES ONLY TO THE "SOFT"  
MECHANISM}

SUBSYSTEM NAME: MECHANICAL - EDS

REVISION: 1 JAN, 1997

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: ASSY, LOW LEVEL DIFFERENTIAL RSC-ENERGIA	33U.6321.005 33U.6321.005
SRU	: SLIP CLUTCH RSC-ENERGIA	33U.6635.053 33U.6635.053

**PART DATA**

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**  
LOW LEVEL AXIAL SLIP CLUTCH

**REFERENCE DESIGNATORS:**

**QUANTITY OF LIKE ITEMS:** 1  
ONE

**FUNCTION:**

CONTAINED WITHIN THE LOW LEVEL DIFFERENTIAL ASSEMBLY, THE SLIP CLUTCH IS USED DURING DOCKING TO LIMIT THE AMOUNT OF AXIAL DOCKING LOADS TO 300 +/- 50 KG. THIS IS ACCOMPLISHED BY ABSORBING THE AXIAL KINETIC ENERGY ASSOCIATED WITH THE RELATIVE CLOSING VELOCITY BY SLIPPING. DURING RING RETRACTION, FOR MATING OF THE ORBITER AND ISS DOCKING MECHANISMS, THIS CLUTCH IS LOCKED OUT TO ALLOW SUFFICIENT AXIAL COMPRESSION LOADS AT THE INTERFACE TO STRUCTURALLY LATCH THE TWO DOCKING MECHANISMS.

**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.6321.005  
33U.6635.053

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MECHANISM)

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SUBSYSTEM NAME: MECHANICAL - EDS  
LRU: LOW LEVEL DIFFERENTIAL ASSEMBLY  
ITEM NAME: CLUTCH, LOW LEVEL SLIP

CRITICALITY OF THIS  
FAILURE MODE: 2/2

FAILURE MODE:  
HIGH SLIP FORCE

MISSION PHASE:  
OO ON-ORBIT

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

CAUSE:

PARTICULATE CONTAMINATION, CORROSION, EXCESSIVE TIGHTENING OF SHAFT NUT

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) N/A

PASS/FAIL RATIONALE:

A)  
N/A

B)  
N/A

C)  
N/A

METHOD OF FAULT DETECTION:

A FAILURE OF THE SLIP CLUTCH IS NOT DETECTABLE UNTIL AFTER DOCKING THROUGH  
PHYSICAL OBSERVATION - EXCESSIVE MECHANICAL SHOCKS

REMARKS/RECOMMENDATIONS:

A FAILURE OF THE CLUTCH TO SLIP IS CONSIDERED VERY REMOTE. THE IMPACT OF  
THE EXCESSIVE LOADS SHOULD OVERCOME THE BINDING BETWEEN RINGS DUE TO  
CONTAMINATION OR CORROSION.

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**- FAILURE EFFECTS -**

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- (A) SUBSYSTEM:  
DOCKING LOADS ARE HIGHER THAN NORMAL.
- (B) INTERFACING SUBSYSTEM(S):  
NO EFFECT ON INTERFACING ORBITER SUBSYSTEMS.
- (C) MISSION:  
POTENTIAL DAMAGE TO SPACE STATION RESULTING IN LOSS OF MISSION.
- (D) CREW, VEHICLE, AND ELEMENT(S):  
NO EFFECT ON ORBITER CREW AND VEHICLE. HIGHER DOCKING LOADS COULD POTENTIALLY DAMAGE SPACE STATION ELEMENTS.
- (E) FUNCTIONAL CRITICALITY EFFECTS:  
N/A
- DESIGN CRITICALITY (PRIOR TO DOWNGRADE, DESCRIBED IN (F)): 2/2
- (F) RATIONALE FOR CRITICALITY DOWNGRADE:  
NONE. THERE ARE NO WORKAROUNDS TO CIRCUMVENT THIS 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
- RATIONALE FOR TIME TO CORRECTING ACTION VS TIME TO EFFECT:  
THIS FAILURE IS NOT DETECTED UNTIL AFTER DOCKING AND THERE IS NO CORRECTIVE ACTION TO CIRCUMVENT THIS FAILURE.

HAZARDS REPORT NUMBER(S): NONE

HAZARD(S) DESCRIPTION:  
N/A

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**-DISPOSITION RATIONALE-**

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- (A) DESIGN:  
WITH SLIP CLUTCH ENGAGED, CLUTCH WILL SLIP WHEN AXIAL DOCKING LOADS EXCEED 300 +/-50KG. LOW LEVEL SLIP CLUTCH IS MADE UP OF MANY SOLID RINGS. EACH RING IS MADE OF STEEL WITH A THICKNESS OF 1.5 MM AND IMPREGNATED WITH

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A SUBSTANCE THAT PROVIDES HIGH FRICTION. HALF OF THE RINGS ARE ATTACHED TO THE HOUSING WHICH IS MOUNTED TO THE SHAFT THAT DRIVES THE LOW LEVEL DIFFERENTIAL AND THE OTHER HALF ARE ATTACHED TO THE ARMATURE OF THE SLIP CLUTCH. THESE RINGS ARE POSITIONED SIDE BY SIDE WITH EVERY OTHER RING ATTACHED TO THE SAME POINT (DIFFERENTIAL SHAFT AND CLUTCH ARMATURE). SPRINGS FORCE THESE RINGS TOGETHER TO PROVIDE MAXIMUM FRICTION BETWEEN THEM. A SINGLE NUT IS SAFETY WIRED AT THE END OF THE CLUTCH ARMATURE TO HOLD ALL COMPRESSED SPRINGS INTO PLACE. THIS CLUTCH IS SIMILAR IN DESIGN TO THE EXTEND/RETRACT ACTUATOR FRICTIONAL BRAKE.

**B) TEST:**

THE SLIP CLUTCH WAS TESTED AT THE COMPONENT LEVEL AND FOUND TO SLIP WHEN AXIAL LOADS WERE BETWEEN 250 KGF AND 350 KGF.

VERIFICATION OF PROPER SLIP CLUTCH OPERATION (IN RESPECT TO THIS FAILURE MODE) IS PROVIDED BY THE FOLLOWING QUALIFICATION TEST. IN ALL CASES THE FRICTIONAL BRAKE HAD SLIPPED WHEN REQUIRED;

APDS SERVICEABILITY TEST IN A SIX-DEGREE-OF-FREEDOM DYNAMIC TEST  
(REFER TO "APPENDIX B" FOR DETAILS.)

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

**(C) INSPECTION:****RECEIVING INSPECTION**

EXTEND/RETRACTION ACTUATOR AND FRICTIONAL BRAKE 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 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**

TESTING VERIFIED BY INSPECTION.

**HANDLING/PACKAGING**

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

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(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 SS/MA :  
NASA SUBSYSTEM MANAGER :  
JSC MOD :

M. NIKOLAYEVA  
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*[Handwritten signatures and initials over the approval lines]*