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 CONTOL, 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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FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL FAILURE MODE
NUMBER: M8-1SS-BM013-01
(APPLIES ONLY TO THE "SOFT" MECHANISM)

REVISION# 1 JAN 1997

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

CRITICALITY OF THIS FAILURE MODE: 2/2

FAILURE MODE:
LOW SLIP FORCE

MISSION PHASE:
OO ON-ORBIT

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

CAUSE:
SHAFT/MULTIPLE RING FAILURES DUE TO MECHANICAL/ THERMAL SHOCK OR MANUFACTURE/MATERIAL DEFECT, EXCESSIVE LOADS, MULTIPLE BROKEN SPRINGS, LOOSE SHAFT NUT, OIL CONTAMINATION

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:
VISUAL OBSERVATION - (1) COLLAPSE OF DOCKING RING DURING CAPTURE; OR (2) INABILITY TO MOVE THE DOCKING RING FOLLOWING FAILURE OF LOCKING DEVICE.

REMARKS/RECOMMENDATIONS:
A STRUCTURAL FAILURE IS CONSIDERED TO BE VERY REMOTE. ALL COMPONENTS HAVE SAFETY FACTOR > 1.4.

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- FAILURE EFFECTS -

(A) SUBSYSTEM:
WORST CASE, A LOW SLIP FAILURE OF THE SLIP CLUTCH IS NOT DETECTED DURING DOCKING. THEN THERE WILL BE NO FORCE ACTING AGAINST AXIAL LOADS DURING CAPTURE. COLLAPSE OF THE DOCKING RING DURING CAPTURE WILL RESULT IN EXCESSIVE DOCKING LOADS.

(B) INTERFACING SUBSYSTEM(S):
EXCESSIVE LOADS INCURRED DURING DOCKING AS THE RESULT OF THIS FAILURE COULD PROPAGATE TO EXTERNAL AIRLOCK AND ORBITER STRUCTURE.

(C) MISSION:
POTENTIAL DAMAGE TO ORBITER DOCKING MECHANISM COULD PRECLUDE ORBITER/ISS DOCKING CAPABILITIES. THE INABILITY TO DOCK WILL RESULT IN LOSS OF ORBITER/ISS MISSION OBJECTIVES. IF FAILURE IS DETECTED PRIOR TO CAPTURE CREW DECISION TO ABORT DOCKING WILL RESULT IN THE SAME CRITICAL EFFECT - LOSS OF DOCKING.

(D) CREW, VEHICLE, AND ELEMENT(S):
A FAILURE TO ACTIVATE THE SLIP CLUTCH COULD ALLOW THE DOCKING RING TO COLLAPSE DURING CAPTURE POTENTIALLY CAUSING EXTENSIVE DAMAGE TO ORBITER AND ISS DOCKING MECHANISMS.

(E) FUNCTIONAL CRITICALITY EFFECTS:
DURING RING RETRACTION - A FAILURE TO ACTIVATE THE SLIP CLUTCH ACCOMPANIED WITH A FAILURE TO LOCK THE LOCKING DEVICE WILL PREVENT THE CAPABILITY TO MOVE THE RING. (FORCE TO MOVE THE RING IS DIVERTED TO FAILED SLIP CLUTCH.)

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 IF OCCURRED DURING CAPTURE.)

- TIME FRAME -

TIME FROM FAILURE TO CRITICAL EFFECT: HOURS TO DAYS

TIME FROM FAILURE OCCURRENCE TO DETECTION: MINUTES TO HOURS

TIME FROM DETECTION TO COMPLETED CORRECTIVE ACTION: N/A

IS TIME REQUIRED TO IMPLEMENT CORRECTIVE ACTION LESS THAN TIME TO EFFECT?
N/A

RATIONALE FOR TIME TO CORRECTING ACTION VS TIME TO EFFECT:
THERE IS NO CORRECTIVE ACTION TO CIRCUMVENT THIS FAILURE. A FAILURE TO ACTIVATE THE SLIP CLUTCH MAY NOT BE DETECTABLE UNTIL AFTER CAPTURE, AT

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

HAZARDS REPORT NUMBER(S): ORBI 402B

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

-DISPOSITION RATIONALE-

(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 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:
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. GUIDE RING FUNCTIONAL PERFORMANCE TEST
3. AXIAL STIFFNESS IN INITIAL POSITION LOADS TEST
4. RETRACTION FORCE LOAD TEST
5. RESTRAINING FORCE LOAD TEST
6. TRANSLATION CAPABILITY TEST - Y_T & Z_T AXES
7. ROTATIONAL CAPABILITY LOADS TEST - Y_T & Z_T AXES
8. ROTATIONAL CAPABILITY LOADS TEST - X_T AXIS
9. 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

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9. 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, AND CHEMICAL PLATING 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. CREW WOULD OPEN CAPTURE LATCHES AND FIRE ORBITER RCS JETS TO ENABLE SEPARATION.

- APPROVALS -

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