FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: M8-1SS-BM014-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	:	DIFFERENTIAL ASSEMBLY RSC-ENERGIA	33U.6321.004-09 ("SOFT") 33U.6321.004-05 (PMA1)
SRU	:	ACTUATOR, EXTEND/RETRACT RSC-ENERGIA	33U.6121.035-09 ("SOFT") 33U.6121.035-05-001 (PMA1)

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
EXTEND/RETRACT ACTUATOR

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 1
ONE

FUNCTION:
PROVIDES THE ENERGY NECESSARY TO EXTEND AND RETRACT THE ORBITER/PMA1 DOCKING RING. CONTAINED IN THE ACTUATOR IS A FRICTIONAL BRAKE WHICH IS ONLY UTILIZED DURING A "HARD" DOCKING SINCE THE LOW LEVEL SLIP CLUTCH WILL LOCK OUT THIS DEVICE DURING A "SOFT" DOCKING. CURRENTLY, ONLY THE FIRST ISS MISSION (MISSION 2A) WILL UTILIZE A HARD DOCKING. THE FRICTIONAL BRAKE IS LOCATED ON THE SHAFT OF THE EXTEND/RETRACT ACTUATOR AND LIMITS DOCKING LOADS AND DISSIPATES ENERGY. DURING MATING WHEN LOADS ON THE ACTUATOR ARMATURE ARE HIGH, THE BRAKE ABSORBS THE AXIAL KINETIC ENERGY ASSOCIATED WITH THE RELATIVE CLOSING VELOCITY BY SLIPPING. BRAKE SLIPPAGE ALSO OCCURS DURING RING RETRACTION WHEN THE RING HAS BOTTOMED OUT.

SERVICE IN BETWEEN FLIGHT AND MAINTENANCE CONTROL:
SERVICEABILITY CONTOL, DOCKING WITH CALIBRATING DOCKING MECHANISM.

MAINTAINABILITY
REPAIR METHOD - REPLACEMENT.

REFERENCE DOCUMENTS: 33U.6121.035-09 ("SOFT")
33U.6121.035-05-001 (PMA1)
33U.6321.004-09 ("SOFT")
33U.6321.004-05 (PMA1)

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL FAILURE MODE
NUMBER: M8-1SS-BM014- 01
(DOESN'T APPLY TO PMA2/3 PASSIVE MECHANISM)

REVISION# 1 DEC, 1996

SUBSYSTEM NAME: MECHANICAL - EDS
LRU: DIFFERENTIAL ASSEMBLY
ITEM NAME: ACTUATOR, EXTEND/RETRACT

CRITICALITY OF THIS FAILURE MODE: 2/2

FAILURE MODE:
LOSS OF ROTATION

MISSION PHASE:
OO ON-ORBIT

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

CAUSE:
GEAR/SHAFT FAILURE DUE TO MECHANICAL/THERMAL SHOCK OR MANUFACTURE/MATERIAL DEFECT, DUAL MOTOR/CLUTCH FAILURE, JAMMING, FRICTIONAL BRAKE FAILURE

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 - RING FAILS TO EXTEND/RETRACT OR EXTENDS & RETRACTS SLOWLY. APPROPRIATE INDICATORS ON THE DOCKING CONTROL PANEL WILL INDICATE POSITION OF RING AT TIME OF FAILURE. TELEMETRY SENSORS MONITOR POWER TO THE ACTUATOR MOTORS.

REMARKS/RECOMMENDATIONS:
THE EXTEND RETRACT ACTUATOR IS USED TO EXTEND RING TO IT'S INITIAL POSITION PRIOR TO DOCKING AND TO IT'S FORWARD POSITION AFTER CAPTURE AND TO RETRACT RING FOR MATING AND STRUCTURAL LATCHING OF THE INTERFACE.

- FAILURE EFFECTS -

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(A) SUBSYSTEM:
SINGLE MOTOR, CLUTCH, OR DRIVE CHAIN FAILURE WILL RESULT IN AN INCREASED OPERATING TIME OF THE ACTUATOR WITH RING MOVEMENT TAKING TWICE AS LONG TO COMPLETE. WORST CASE, FAILURE OF ENTIRE ACTUATOR WILL RESULT IN LOSS OF MOVEMENT IN THE KINEMATIC CHAIN. COMPLETE ACTUATOR FAILURE WILL LOSE ALL FUNCTIONS ASSOCIATED WITH RING EXTENSION/RETRACTION - LOSS OF CAPABILITY TO CAPTURE (EXTENSION) AND INABILITY TO MATE ORBITER/PMA1 DOCKING MECHANISM WITH ISS (PMA2/FGB) DOCKING MECHANISM (RETRACTION).

(B) INTERFACING SUBSYSTEM(S):
NO EFFECT ON INTERFACING SUBSYSTEMS.

(C) MISSION:
WORST CASE, DOCKING BETWEEN ORBITER/PMA1 AND ISS IS IMPOSSIBLE IF EXTEND/ RETRACT ACTUATOR FAILS TO ROTATE RESULTING IN LOSS OF ORBITER(PMA1)/ISS MISSION OBJECTIVES.

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT ON CREW OR VEHICLE.

(E) FUNCTIONAL CRITICALITY EFFECTS:
N/A

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.)

- TIME FRAME -

TIME FROM FAILURE TO CRITICAL EFFECT: DAYS TO HOURS

TIME FROM FAILURE OCCURRENCE TO DETECTION: SECONDS

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 A ROTATION FAILURE OF THE EXTEND/RETRACT ACTUATOR.

HAZARDS REPORT NUMBER(S): NONE

HAZARD(S) DESCRIPTION:
N/A

-DISPOSITION RATIONALE-

PRINT DATE: 01/24/97

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(A) DESIGN:
ACTUATOR DESIGN PROVIDES FOR DUAL MOTOR CONTROL, EITHER OF WHICH IS SUFFICIENT TO EXTEND OR RETRACT THE DOCKING RING. REDUNDANT POWER IS SUPPLIED TO THESE MOTORS. TWO CLUTCHES AND A NO-BACK DEVICE PROVIDE ISOLATION BETWEEN EACH MOTOR/GEAR CHAIN AND THE OUTPUT OF THE ACTUATOR. A FAILURE OF THE ACTUATOR SHAFT OR FRICTIONAL BRAKE IS CONSIDERED VERY REMOTE.

(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. ELECTRICAL CIRCUIT VERIFICATION TEST
2. INSULATION ELECTRICAL RESISTANCE TEST
3. GUIDE RING FUNCTIONAL PERFORMANCE TEST
4. AXIAL STIFFNESS IN INITIAL POSITION LOADS TEST
5. RETRACTION FORCE LOAD TEST
6. RESTRAINING FORCE LOAD TEST
7. TRANSLATION CAPABILITY TEST - Y_T & Z_T AXES
8. ROTATIONAL CAPABILITY LOADS TEST - Y_T & Z_T AXES
9. ROTATIONAL CAPABILITY LOADS TEST - X_T AXIS
10. VIBRATION TEST
11. THERMAL VACUUM TEST

DOCKING MECHANISM QUALIFICATION TESTS:

1. ELECTRICAL CIRCUIT VERIFICATION TEST
2. INSULATION ELECTRICAL RESISTANCE TEST
3. TRANSPORTABILITY STRENGTH TEST
4. VIBRATION TEST
5. SHOCK-BASIC DESIGN TEST
6. THERMAL VACUUM TEST
7. SIX-DEGREE-OF-FREEDOM TEST
8. SERVICE LIFE TEST
9. EXTEND/RETRACT MECHANISM LIMIT LOAD TEST
10. EXTEND/RETRACT MECHANISM ULTIMATE LOAD TEST
11. 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

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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/OTP/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:
NO WORKAROUND TO RESTORE A FAILED EXTEND/RETRACT ACTUATOR. 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	:		: