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**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL HARDWARE  
NUMBER: M8-1MR-5M011-X**

SUBSYSTEM NAME: MECHANICAL - EDS

REVISION: 1 9/1/95

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: DIFFERENTIAL ASSEMBLY NPO-ENERGIA	33U.6321.004 33U.6321.004
SRU	: ACTUATOR, EXTEND/RETRACT NPO-ENERGIA	33U.6121.035 33U.6121.035

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**PART DATA**


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**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 DOCKING RING. CONTAINED IN THE ACTUATOR IS A FRICTIONAL BRAKE. 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 CONTROL, DOCKING WITH CALIBRATING DOCKING MECHANISM.

**MAINTAINABILITY**

REPAIR METHOD - REPLACEMENT.

**REFERENCE DOCUMENTS:** 33U.6121.035  
33U.6321.004  
33U.6321.038-05



**RSC  
Energia**

**Proprietary Data**

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

NUMBER: M8-1MR-3M011-03

REVISION# 1 9/1/95

SUBSYSTEM NAME: MECHANICAL - EDS

LRU: DIFFERENTIAL ASSEMBLY

ITEM NAME: ACTUATOR, EXTEND/RETRACT

CRITICALITY OF THIS

FAILURE MODE: 2/2

**FAILURE MODE:**

FAILS TO ABSORB SHOCK

**MISSION PHASE:**

OO ON-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY: 104 ATLANTIS

**CAUSE:**HIGH SLIP FORCE ON FRICTIONAL BRAKE - 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/AB)  
N/AC)  
N/A**METHOD OF FAULT DETECTION:**NONE PRIOR TO CAPTURE. DURING CAPTURE A FAILURE OF THE FRICTIONAL BRAKE  
COULD BE DETECTED THROUGH PHYSICAL OBSERVATION - EXCESSIVE MECHANICAL  
SHOCKS.**- FAILURE EFFECTS -****(A) SUBSYSTEM:**NO INITIAL EFFECT. POSSIBLE EXCESSIVE LOADS ON ORBITER AND MIR DOCKING  
MECHANISMS DURING CAPTURE.**(B) INTERFACING SUBSYSTEM(S):**IF DOCKING LOADS ARE EXCESSIVE, ENERGY ASSOCIATED WITH THESE LOADS COULD  
PROPAGATE TO ORBITER AND MIR DOCKING MECHANISMS. ELEMENTS IN BOTH  
DOCKING MECHANISMS COULD BE OVERLOADED.RSC  
Energia*Proprietary Data*

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**(C) MISSION:**

EXCESSIVE LOADS INCURRED DURING CONTACT COULD PRECLUDE CAPTURE OR CAUSE DAMAGE TO ORBITER AND MIR DOCKING MECHANISMS RESULTING IN THE INABILITY TO EXTEND OR RETRACT DOCKING RING. THE INABILITY TO CAPTURE OR MOVE RING TO MATE BOTH MECHANISMS WILL RESULT IN LOSS OF DOCKING AND SUBSEQUENT LOSS OF ORBITER/MIR MISSION OBJECTIVES.

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

NO EFFECT ON CREW OR VEHICLE. POTENTIAL DAMAGE TO ORBITER AND MIR DOCKING MECHANISMS.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

N/A

DESIGN CRITICALITY (PRIOR TO OPERATIONAL DOWNGRADE, DESCRIBED IN F): 2/2

**(F) RATIONALE FOR CRITICALITY CATEGORY DOWNGRADE:**

N/A (THERE ARE NO WORKAROUNDS TO CIRCUMVENT THIS FAILURE.)

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**-DISPOSITION RATIONALE-**


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**(A) DESIGN:**

A FAILURE OF THE FRICTIONAL BRAKE TO SLIP IS CONSIDERED VERY REMOTE. THE IMPACT OF THE EXCESSIVE LOADS SHOULD OVERCOME THE BINDING BETWEEN RINGS DUE TO CONTAMINATION OR CORROSION. THE FRICTIONAL BRAKE IS COMPLETELY ENCASED AND SEALED, WITH LINERS AT THE STATIONARY POINT AROUND THE ACTUATOR ARMATURE TO PREVENT THE INTRODUCTION OF OUTSIDE CONTAMINATION. DUST TRAPS ARE PROVIDED TO TRAP PARTICLES CAUSED BY FRICTIONAL WEAR. THE FRICTIONAL BRAKE IS DESIGNED TO SLIP WHEN THE LOADS BETWEEN BOTH DOCKING MECHANISMS EXCEEDS 1000 KG. THE FRICTIONAL BRAKE IS UTILIZED TO PREVENT EXCESSIVE LOADS FROM PROPAGATING TO THE MIR.

LOAD ANALYSIS HAS SHOWN THAT THE MAXIMUM AXIAL TENSION LOAD INCURRED AS THE RESULT OF THE EXTEND/RETRACT ACTUATOR FAILING TO ABSORB SHOCK (FRICTIONAL BRAKE FAILS TO SLIP) DURING CAPTURE IS 3203 KGF ALONG THE Z-AXIS WHICH IS NOT HIGH ENOUGH TO CAUSE A CAPTURE LATCH TO DISENGAGE. (ANALYSIS HAS SHOWN THAT AN AXIAL LOAD OF 3698 KGF IS REQUIRED TO DISENGAGE A CAPTURE LATCH.) STRESS ANALYSIS HAS INDICATED THAT THE CAPTURE LATCH WILL NOT BE DAMAGED IN SUCH A WAY AS TO PREVENT IT FROM BEING ACTUATED, OPEN DUE TO THIS 3203 KGF TENSION AXIAL LOAD. THIS AXIAL LOAD WILL NOT EXCEED EXTERNAL AIRLOCK/ORBITER STRUCTURAL LIMITS.

**(B) TEST:**

THE FRICTIONAL BRAKE WAS TESTED AT THE COMPONENT LEVEL AND FOUND TO SLIP WHEN AXIAL LOADS WERE BETWEEN 1000 KGF AND 1100 KGF.

THE FRICTIONAL BRAKE IS PART OF THE EXTEND/RETRACT ACTUATOR DRIVE CHAIN. SINCE THIS FAILURE MODE RESULTS FROM A FAILED FRICTIONAL BRAKE, VERIFICATION OF PROPER FRICTIONAL BRAKE AND ACTUATOR OPERATION (IN RESPECT TO THIS FAILURE MODE) IS PROVIDED BY THE FOLLOWING QUALIFICATION TEST. IN ALL CASES THE FRICTIONAL BRAKE HAD SLIPPED WHEN AXIAL LOADS WERE BETWEEN 1000 KGF AND 1100 KGF:

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NUMBER: M8-1MR-8M011-03

APDS SERVICEABILITY TEST IN A SIX-DEGREE-OF-FREEDOM DYNAMIC TEST - THE SIX-DEGREE-OF-FREEDOM DYNAMIC TEST VERIFIES APDS DOCKING AND UNDOCKING OPERATIONS UNDER CLOSE-TO-FULL-SCALE CONDITIONS. STATIC MOTION OF ENTITIES IS SIMULATED UNDER SPECIFIC INERTIAL AND GEOMETRICAL PARAMETERS FOR VARIOUS INITIAL CONDITIONS FOR MIR/SHUTTLE DOCKING. A TOTAL OF 20 DOCKINGS IS PERFORMED. EXTEND/RETRACT ACTUATOR FRICTIONAL BRAKE VERIFIED BY ABSORPTION OF ENERGY OF RELATIVE MOVEMENT DURING EACH DOCKING. SUBSEQUENT TO THIS TEST AN ENGINEERING INSPECTION IS PERFORMED TO IDENTIFY BROKEN OR LOOSE HARDWARE.

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.

**(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.



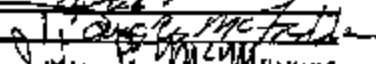
**(E) OPERATIONAL USE:**

NONE

**Proprietary Data**

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL FAILURE MODE  
NUMBER: M8-1MR-BM011-03

- APPROVALS -

DESIGN ENGINEER	:	M. NIKOLAYEVA	:	
DESIGN MANAGER	:	A. SOUBCHEV	:	
NASA SS/MA	:		:	
NASA SUBSYSTEM MANAGER	:		:	