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FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE

NUMBER: MO-AA4-605-X

SUBSYSTEM NAME: STABILIZED PAYLOAD DEPLOYMENT SYSTEM

REVISION : 2 06/08/90

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	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
■ SRU :	COUPLER ASSEMBLY, DRIVE MECH	V790-544005

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PART DATA

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■ EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

■ QUANTITY OF LIKE ITEMS: 2

V790-544005-001 IS INSTALLED ON THE PRIMARY PEDESTAL ASSEMBLY

V790-544005-002 IS INSTALLED ON THE SECONDARY PEDESTAL ASSEMBLY

FUNCTION:

THE COUPLER ASSEMBLY SERVES AS AN INTERFACE BETWEEN THE PAYLOAD ROTARY DRIVE ACTUATOR AND THE RELEASE HEAD. IN THE PRIMARY PEDESTAL, THE COUPLER IS ENGAGED ALLOWING THE ACTUATOR TO DRIVE THE HEAD TO THE DEPLOY POSITION. THIS INITIAL CONFIGURATION ALLOWS THE ACTUATOR IN THE PRIMARY PEDESTAL TO MOVE THE PAYLOAD WHILE THE SECONDARY PEDESTAL MERELY PROVIDES SUPPORT TO THE PAYLOAD. SHOULD THE PRIMARY SYSTEM MALFUNCTION, THIS ENGAGED/DISENGAGED ARRANGEMENT CAN BE CHANGED BY FIRING PYROS IN THE THRUSTERS. THIS ACTION, WHICH IS NOT REVERSIBLE, WILL DISENGAGE THE PRIMARY PEDESTAL AND ENGAGE THE SECONDARY PEDESTAL. THIS CONFIGURATION PERMITS THE SECONDARY PEDESTAL TO MOVE THE PAYLOAD WHILE THE PRIMARY PEDESTAL PROVIDES SUPPORT TO THE PAYLOAD. THIS PRIMARY/SECONDARY PEDESTAL COUPLER CONFIGURATION IS CLASSIFIED AS SWITCHABLE REDUNDANCY.

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SHUTTLE CRITICAL ITEMS LIST - ORBITER NUMBER: MO-AA4-605-02

SUBSYSTEM: STABILIZED PAYLOAD DEPLOYMENT SYSTEM REVISION# 2 03/01/90

ITEM NAME: COUPLER ASSEMBLY, DRIVE MECH CRITICALITY OF THIS FAILURE MODE: 1R2

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- FAILURE MODE:  
FAILS TO DISENGAGE (ON PRIMARY PEDESTAL)

MISSION PHASE:  
OO ON-ORBIT

- VEHICLE/PAYLOAD/KIT EFFECTIVITY: 102 COLUMBIA  
: 103 DISCOVERY  
: 104 ATLANTIS  
: 105 ENDEAVOUR

- CAUSE:  
LOSS OF INPUT, PIECE-PART STRUCTURAL FAILURE, CONTAMINATION

- CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO
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- REDUNDANCY SCREEN A) PASS  
B) FAIL  
C) PASS

PASS/FAIL RATIONALE:

- A)  
GROUND INSTALLATION AND CHECKOUT.
  - B)  
CANNOT CONFIRM COUPLER FAILURE.
  - C)  
SEPARATION OF REDUNDANT ELEMENTS.
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- FAILURE EFFECTS -

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- (A) SUBSYSTEM:  
PAYLOAD ROTATION CANNOT BE ACCOMPLISHED BY THE SECONDARY PEDESTAL BECAUSE THE COUPLER DOES NOT RELEASE FROM THE PRIMARY PEDESTAL ACTUATOR.
- (B) INTERFACING SUBSYSTEM(S):  
NO EFFECT.

## SHUTTLE CRITICAL ITEMS LIST - ORBITER NUMBER: MO-AA-605-02

- (C) MISSION:  
LOSS OF MISSION. PAYLOAD ROTATION CANNOT BE ACCOMPLISHED BY THE SECONDARY PEDESTAL BECAUSE THE COUPLER DOES NOT RELEASE FROM THE PRIMARY PEDESTAL ACTUATOR. THE MOTOR BRAKES ON THE PRIMARY PEDESTAL ROTARY ACTUATOR ARE ENGAGED AND CANNOT BE RELEASED. LOSS OF MISSION.
- (D) CREW, VEHICLE, AND ELEMENT(S):  
POTENTIAL LOSS OF CREW/VEHICLE. PAYLOAD ROTATION CANNOT BE ACCOMPLISHED BY THE SECONDARY PEDESTAL BECAUSE THE COUPLER DOES NOT RELEASE FROM THE PRIMARY PEDESTAL ACTUATOR.
- (E) FUNCTIONAL CRITICALITY EFFECTS:  
IF THE PRIMARY PAYLOAD ROTARY ACTUATOR CANNOT MOVE, THE EFFECT WILL BE NO MOVEMENT OF THE SECONDARY PEDESTAL.

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- DISPOSITION RATIONALE -

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- (A) DESIGN:  
THE COUPLER ASSEMBLY IS MADE OF HIGH STRENGTH CORROSION RESISTANT MATERIAL FOR SPACE ENVIRONMENT USE. THE DESIGN SHOWS POSITIVE STRUCTURAL MARGIN BY ANALYSIS AND MEETS 1.4 MINIMUM FACTOR OF SAFETY.
- (B) TEST:  
QUALIFICATION TESTS PER DTP4779-801 WERE SUCCESSFULLY COMPLETED JANUARY 5, 1990 AND WILL BE DOCUMENTED IN TEST REPORT STS9000115.  
  
OMRSD: GROUND TURNAROUND  
FREQUENCY OF CHECKOUT IS MISSION DEPENDENT. PEDESTAL DRIVE TRANSFER INDICATIONS S0790A.130
- (C) INSPECTION:  
ALL DIMENSIONAL CHARACTERISTICS ARE VERIFIED BY INSPECTION. PROCESSES ARE VERIFIED BY INSPECTION EITHER AT ROCKWELL OR AT SUPPLIER FACILITIES. CLEANLINESS AND MATERIAL CERTIFICATION ARE VERIFIED BY INSPECTION.
- (D) FAILURE HISTORY:  
A05957-010.- DURING TESTS FOR QUALIFICATION OF THE MC325-0047-0003 THRUSTER, THE ATTACHED COUPLER, V790-544005-002 S/M P16639, FAILED TO ENGAGE MECHANICALLY WHEN THE THRUSTER WAS FIRED. TESTING WAS BEING CONDUCTED AT THE SUPPLIER'S (SPACE ORDNANCE SYSTEMS) FACILITIES AND IN ACCORDANCE WITH THE SUPPLIER'S DOCUMENT QTP 9151, PARAGRAPH 6.4.1 (MC325-0047 PARAGRAPH 4.2.4.1.14). WHEN OPERATED DURING THE TEST, THRUSTER ACTUATION OCCURRED WITHOUT THE ACCOMPANYING MECHANICAL ENGAGEMENT OF THE COUPLER. A PRIMARY INVESTIGATION OF THIS ANOMALY IS NOTED IN CAR A05858-010. THAT INVESTIGATION DETERMINED THAT THE THRUSTER OPERATED CORRECTLY AND THAT THE COUPLER RESPONDED WITH

## SHUTTLE CRITICAL ITEMS LIST - ORBITER NUMBER: MO-AA-605-02

INSUFFICIENT MOVEMENT. THIS MOVEMENT RESTRICTION WAS CAUSED BY AN ACCUMULATION OF CADMIUM PLATING PARTICLES BETWEEN THE BELLEVILLE SPRINGS IN THE COUPLER. THE LACK OF FULL COUPLER SHAFT MOVEMENT PRECLUDED THE THRUSTER PISTON FROM ACCOMPLISHING FULL TRAVEL AND A "LOCKED" CONDITION. WHEN ACTIVATED, THIS LOCKED CONDITION WILL PREVENT THE COUPLER PISTON FROM BACKING OUT OF ITS POSITION AND DISENGAGING THE BALL-LOCK MECHANISM. THE ACCUMULATION OF CADMIUM PLATING PARTICLES BETWEEN THE BELLEVILLE WASHERS IS ATTRIBUTED TO REPETITIVE (SIX) OPERATIONS OF THE COUPLER DURING ITS TEST EXPERIENCE. THIS IS A UNIQUE CONDITION CAUSED BY THE PECULIARITIES OF TESTING. REPETITIVE OPERATIONS ARE NOT ANTICIPATED IN SERVICE. THE COUPLER HAS BEEN DESIGNED, DEVELOPED, MANUFACTURED, AND ASSEMBLED FOR A ONE-TIME SERVICE USE. THE COUPLER IS A CLOSE-TOLERANCE MECHANISM WHOSE FAILURE ANALYSIS HAS CONSISTED OF PRECISE MEASUREMENTS OF LENGTH AND OF FORCE LEVELS REQUIRED TO ACHIEVE STROKE CONDITIONS. THESE MEASUREMENTS DETERMINED THAT CERTAIN ADVERSE DIMENSIONAL ACCUMULATIONS WERE POSSIBLE AND THAT SPECIFIC "RIGGING PROCEDURES" MUST BE FOLLOWED TO AVOID THEM. NO ACTION IS TAKEN IN REGARD TO THE CADMIUM PLATING FINISH ON THE BELLEVILLE WASHERS OTHER THAN INSPECTION TO ASSURE INCOMING HARDWARE CONFORMANCE TO DRAWING REQUIREMENTS. DURING BUILDUP OF THE SPOS A 'LOAD-STROKE' TEST IS PERFORMED TO ASSURE COUPLER VIABILITY. A REVISED 'RIGGING PROCEDURE' HAS BEEN DEVELOPED AND IS REQUIRED FOR ASSEMBLY OF V790-544005 COUPLER ASSEMBLIES. ENGINEERING ORDER V790-544005 B 02 HAS BEEN RELEASED TO AUTHORIZE THE PROCEDURE. BENCH BUILDUP AND TEST FIXTURE OPERATIONS USING THE PROCEDURE HAVE BEEN SUCCESSFULLY DEMONSTRATED.

- (E) OPERATIONAL USE:  
NONE.

## - APPROVALS -

RELIABILITY ENGINEERING:	W. R. MARLOWE	<i>W. R. Marlowe 1/16/90</i>
DESIGN ENGINEERING :	G. CAMPBELL	<i>G. Campbell 1/16/90</i>
QUALITY ENGINEERING :	M. F. Mergen	<i>M. F. Mergen 1/16/90</i>
NASA RELIABILITY :	G.E.	<i>G.E. 1/16/90</i>
NASA SUBSYSTEM MANAGER :		<i>[Signature] 1/16/90</i>
NASA QUALITY ASSURANCE :		<i>[Signature] 1/16/90</i>