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FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE

NUMBER: MO-AA4-510-X

SUBSYSTEM NAME: STABILIZED PAYLOAD DEPLOYMENT SYSTEM

REVISION : 2 06/08/90

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
■ SRU :	RETRACTOR ASSEMBLY	MC325-0048

PART DATA

- EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
RETRACTOR ASSEMBLY - STABILIZED PAYLOAD DEPLOYMENT SYSTEM
THIS ITEM CONSISTS OF TWO MAJOR PARTS:
(1) HOUSING AND MOVABLE PISTON ASSEMBLY (CFE), AND
(2) MSI (GFE).
- REFERENCE DESIGNATORS:
V54X0816E
: V54X0826E
: V54X0813E
: V54X0823E
- QUANTITY OF LIKE ITEMS: 6
THREE PER PEDESTAL ASSEMBLY
- FUNCTION:
RETRACTORS ARE MSI INITIATED PYROTECHNIC DEVICES AND THREE OF THESE UNITS ARE USED ON EACH OF THE ORBITER DISCONNECTS. THE FUNCTIONING OF ANY ONE OF THE RETRACTORS WILL RELEASE THE SWIVEL ASSEMBLY AND SEPARATE THE ORBITER DISCONNECT ASSEMBLY FROM THE PAYLOAD DISCONNECT ASSEMBLY. THE OPERATION CONSISTS OF PISTON MOVEMENT IN RESPONSE TO PYROTECHNICALLY GENERATED GAS PRESSURE. IN EACH RETRACTOR, THE OPERATION CONSISTS OF PISTON MOVEMENT WHICH SHEARS ITS INDIVIDUAL RESTRAINING PIN WHICH ALSO REMOVES THE PISTON SHAFT FROM THE SWIVEL AND THUS RELEASES IT.
NOTE: FOR INADVERTANT OPERATION DUE TO A STRAY ELECTRICAL IMPULSE TO OCCUR, A SERIES OF EARLIER FAILURES WOULD BE NECESSARY. TYPICAL OF THESE IS THE NON-CREDIBLE EVENT OF A CIRCUIT BREAKER SHORTING CLOSED FROM AN INTENTIONALLY OPEN CONDITION.

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SHUTTLE CRITICAL ITEMS LIST - ORBITER NUMBER: MO-AA4-510-03

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

ITEM NAME: RETRACTOR ASSEMBLY CRITICALITY OF THIS FAILURE MODE: 1/1

- FAILURE MODE:
PREMATURE OPERATION OF ONE OR MORE RETRACTORS

MISSION PHASE:

PL PRELAUNCH
LO LIFT-OFF
RTLs RETURN TO LAUNCH SITE
TAL TRANS ATLANTIC ABORT
OO ON-ORBIT

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

- CAUSE:
VIBRATION, PIECE PART STRUCTURAL FAILURE, CORROSION, INADVERTENT NSI FIRING

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

PASS/FAIL RATIONALE:

- A)
PRELAUNCH CHECKOUT OF THE ORBITER DISCONNECT ASSEMBLED WITH THE PAYLOAD DISCONNECT ASSEMBLY INCLUDES AN X-RAY INSPECTION OF THE COMPLETED ACTION THAT WILL SHOW THE INDIVIDUAL RETRACTOR PISTONS RESTRAINING THE SWIVEL IN THE PAYLOAD HEAD.
- B)
PANEL INDICATION IS UNLIKELY IF THE PAYLOAD HAS NOT BEEN RELEASED FROM ITS LATCHES. FAILURE OCCURRENCE DURING PAYLOAD DEPLOYMENT WOULD REVEAL "RELEASED" ON THE A7 PANEL. RELEASE INDICATION IS AVAILABLE FOR BOTH PRIMARY AND SECONDARY PEDESTALS. THIS INFORMATION DOES NOT REVISE THE STATED CRITICALITY.
- C)

SHUTTLE CRITICAL ITEMS LIST - ORBITER NUMBER: MO-AA4-510-03

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- MASTER MEAS. LIST NUMBERS: V54X0813E
 - : V54X0823E
 - : V54X0816E
 - : V54X0826E
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- FAILURE EFFECTS -

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- (A) SUBSYSTEM:
PREMATURE ACTUATION (RELEASE) OF ANY ONE OF THE RETRACTORS WILL PERMIT THE SWIVEL TO BE DISENGAGED. THE EXPULSION SPRING WILL TEND TO FORCE SEPARATION OF THE PAYLOAD AND ORBITER DISCONNECT ASSEMBLIES. THE RESULT OF PREMATURE ACTUATION IS AN UNSTABLE PAYLOAD - LOOSE FROM ONE PEDESTAL.
 - (B) INTERFACING SUBSYSTEM(S):
AN UNSTABLE PAYLOAD PRESENTS A POTENTIAL CONTACT BETWEEN THAT PAYLOAD AND ORBITER STRUCTURE. THE RANDOM NATURE OF THE EVENT DOES NOT ALLOW ACCURATE PREDICTION OF POSSIBLE PHYSICAL DAMAGE.
 - (C) MISSION:
POTENTIAL MISSION ABORT - POSSIBLE PAYLOAD JETTISON.
 - (D) CREW, VEHICLE, AND ELEMENT(S):
POTENTIAL PAYLOAD/VEHICLE IMPACT DUE TO UNSYMMETRICAL RELEASE; INABILITY TO REBERTH THE PAYLOAD OR CLOSE THE P/L BAY DOORS.
 - (E) FUNCTIONAL CRITICALITY EFFECTS:
PREMATURE ACTION OF THE RETRACTOR WILL RESULT IN POTENTIAL UNSYMMETRICAL RELEASE OF THE PAYLOAD.
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- DISPOSITION RATIONALE -

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- (A) DESIGN:
THE RETRACTOR 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 CONDUCTED BY THE SUPPLIER HAVE BEEN SUCCESSFULLY COMPLETED. DETAILS OF THESE TESTS ARE DOCUMENTED IN SPACE ORDINANCE SYSTEMS REPORT QTR9201, QUALIFICATION TEST REPORT FOR RETRACTOR ASSEMBLY, DATED MAY 30, 1989.

OMRSD: GROUND TURNAROUND

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FREQUENCY OF CHECKOUT IS MISSION DEPENDENT. X-RAY INSPECTION TO VERIFY CORRECT ASSEMBLY.

■ (C) INSPECTION:

ALL DIMENSIONAL CHARACTERISTICS ARE VERIFIED BY INSPECTION. PROCESSES ARE VERIFIED BY INSPECTION EITHER AT ROCKWELL OR AT SUPPLIER FACILITIES.

■ (D) FAILURE HISTORY:

AD6079 - IN PREPARATION FOR CONDUCTING ACCEPTANCE TESTS (MLO 108-0119 AND DEVELOPMENT OPERATION TESTS (TR S144025C), THE PAYLOAD DISCONNECT ASSEMBLY (V790-544003) WERE ASSEMBLED IN ACCORDANCE WITH L&T STD 80378. THE PROCESS REQUIRES THAT THESE DISCONNECTS BE ASSEMBLED USING THE MC325-0048-0001 RETRACTORS. A RESTRAINING FIXTURE, REQUIRED BY L&T STD 80378, COMPRESSES THE EXPULSION SPRING IN THE ORBITER DISCONNECT ASSEMBLY. L&T STD 80378 REQUIRES A ONE-HOUR "HOLD", FOLLOWING ASSEMBLY AND PRIOR TO FURTHER OPERATIONS, FOR PRELOAD STABILIZATION. WHEN THE ONE-HOUR HOLD HAD BEEN COMPLETED, THE RESTRAINING FIXTURE WAS REMOVED. AT THAT POINT, THE TWO DISCONNECT ASSEMBLIES SEPARATED. FOLLOWING THE SEPARATION OF THESE TWO DISCONNECT ASSEMBLIES, INSPECTION DISCLOSED THAT THE PISTONS IN ALL THREE RETRACTORS HAD BEEN DISPLACED AND THEIR SHEAR PINS HAD BEEN SHEARED. THERE WERE NO GAS GENERATORS OR OTHER PYROTECHNIC DEVICES INSTALLED IN THESE RETRACTORS; THE APPROPRIATE PORTS WERE CLOSED WITH PROTECTIVE PLUGS. THESE THREE RETRACTORS WERE THE SAME COMPONENTS USED IN ALL EARLIER TESTING OF THE SECONDARY SPDS PEDESTAL. THE UNITS HAD BEEN ASSEMBLED AND PRELOADED (TO 1800 POUNDS) TWELVE TIMES THEN EXPOSED TO RANDOM VIBRATION AND LOAD CYCLING. THE EVENTS AND EVIDENCE INDICATE THAT THE ASSEMBLY AND RIGGING PROCEDURES WERE IMPROPERLY PERFORMED. SCRATCH MARKS ON THE HARDWARE, SWIVEL AND RETRACTOR PISTONS, INDICATE THAT PRELOADING HAD BEEN APPLIED ON THE CORNERS OF THE PISTONS. A PRELOAD APPLIED AT THIS POINT WOULD RESTRICT THE RETRACTOR ASSEMBLIES FROM ROTATING ON THEIR MOUNTING SURFACE TO A POSITION THAT WOULD BE A NATURAL ALIGNMENT OF THE PISTON AND THE TOGGLE. AN ORAL REVIEW OF THE PROCESS DISCLOSED THAT ASSEMBLY HAD ACCURRED WITH THE SEPARATION BETWEEN THE PAYLOAD AND ORBITER DISCONNECTS IN A VERTICAL PLANE. THIS ACTION IS IN CONTRADICTION WITH STEP 1.2 OF L&T STD 80378 APPENDIX A. WHEN THE PRELOADING WAS APPLIED THERE WAS A SUDDEN LOSS OF 1000 POUNDS; THE RELOAD WENT TO ZERO. THE PRELOADING CONTINUED TO 1800 POUNDS WITH NO EVALUATION FOR A CAUSE OF THE LOAD DROP. SUBCAR AD6079-001 WAS PREPARED AND RELEASED TO AUTHORIZE DETAIL EXAMINATION OF THE RETRACTORS UNDER LABORATORY CONDITIONS. THE FINDINGS OF THIS INVESTIGATION NOTE THAT THE SHEAR PINS IN THE RETRACTOR PISTONS WERE FRACTURED APPARENTLY BY A FORCE ACTING ALONG THE LINEAR DIMENSION OF THE PISTON ITSELF. THESE FRACTURES ARE CLOSELY SIMILAR TO THOSE THAT WOULD BE EXPECTED IF THE PISTON HAD BEEN DISPLACED DUE TO PYROTECHNIC ACTION IN THE RETRACTOR ITSELF. REPLACEMENT RETRACTORS WERE OBTAINED, INSTALLED, AND THE ASSEMBLY/RIGGING PROCEDURE CAREFULLY IMPLEMENTED. SUBSEQUENT TESTING OF THE PEDESTAL WITH THE DISCONNECTS INSTALLED WAS CONDUCTED WITHOUT

SHUTTLE CRITICAL ITEMS LIST - ORBITER NUMBER: MO-AA-510-03

INCIDENT. RIGGING SPECIFICATION MLO308-0199 IS THE DOCUMENT ON WHICH THE L&T STD 8037B IS BASED. MLO308-0199 HAS BEEN REVISED TO CLARIFY AND IMPROVE THE INSTALLATION PROCEDURE AND ENGINEERING ORDER A 03 APPLIES. THERE WERE NO FAULTS FOUND WITH THE PROCEDURE AS RELEASED. THIS CHANGE PROVIDES ONLY AN ENHANCEMENT OF THE PROCESS. AN ADDITIONAL PROCEDURE HAS BEEN ADDED TO THE SPECIFICATION FOR X-RAY INSPECTION FOLLOWING ASSEMBLY AND PRIOR TO FLIGHT; ENGINEERING ORDER B 01 APPLIES.

AN EMPHASIS HAS BEEN MADE TO ASSURE THAT PERSONNEL PERFORMING THIS ASSEMBLY PROCESS ARE FULLY INSTRUCTED AND CORRECTLY FOLLOW THE PRESCRIBED PROCEDURES. IN THIS VEIN, FURTHER EMPHASIS IS MADE THAT THE ASSEMBLY ACTIONS BE TAKEN ONLY WHEN THE SEPARATION PLANE IS HORIZONTAL.

- (E) OPERATIONAL USE:
NONE.

- APPROVALS -

RELIABILITY ENGINEERING:	W. R. MARLOWE	<i>WRM</i>	<i>W. R. Marlowe 3-6-90</i>
DESIGN ENGINEERING :	G. CAMPBELL	<i>G.C.</i>	<i>G. Campbell 3/1/90</i>
QUALITY ENGINEERING :	M. F. MERGEN	<i>MFM</i>	<i>M. F. Mergen 3/1/90</i>
NASA RELIABILITY :		<i>G-E</i>	<i>[Signature] 3/25/90</i>
NASA SUBSYSTEM MANAGER :			<i>[Signature] 3/1/90</i>
NASA QUALITY ASSURANCE :			<i>[Signature] 3/1/90</i>