

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE  
NUMBER: 02-6-C05 -X**

**SUBSYSTEM NAME: HYDRAULICS**

**REVISION: 07/24/98**

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**PART DATA**

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<b>PART NAME</b>	<b>PART NUMBER</b>
<b>VENDOR NAME</b>	<b>VENDOR NUMBER</b>
LRU : ACTUATOR, UMBILICAL RETRACTOR PARKER BERTEA	MC287-0050

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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:  
ACTUATOR, UMBILICAL RETRACTOR**

**REFERENCE DESIGNATORS:** 50V58AC11  
50V58AC12  
50V58AC13  
50V58AC14  
50V58AC15  
50V58AC16

**QUANTITY OF LIKE ITEMS: 6**  
THREE ACTUATORS ATTACHED TO EACH OF 2 UMBILICALS

**FUNCTION:**

THREE ACTUATORS CONNECTED TO EACH ORBITER UMBILICAL HALF PROVIDE MEANS FOR DAMPING OF COMPRESSIVE LOAD DURING RETRACTION OF THE PROPELLANT LINE VALVE CLUSTER INTO THE ORBITER IMMEDIATELY PRIOR TO ORBITER/EXTERNAL TANK SEPARATION. ACTUATOR ASSIST IN RETRACTION DURING FINAL PORTION OF STROKE. EACH ACTUATOR OF EACH UMBILICAL IS POWERED BY A DIFFERENT ONE OF THE THREE HYDRAULIC POWER SYSTEMS.

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LRU: ACTUATOR, UMBILICAL RETRACTOR

ITEM NAME: ACTUATOR, UMBILICAL RETRACTOR

CRITICALITY OF THIS  
FAILURE MODE: 1R2FAILURE MODE:  
INSUFFICIENT DAMPINGMISSION PHASE: LO LIFT-OFF  
DO DE-ORBITVEHICLE/PAYLOAD/KIT EFFECTIVITY: 102 COLUMBIA  
103 DISCOVERY  
104 ATLANTIS  
105 ENDEAVOURCAUSE:  
ADVERSE TOLERANCES/WEAR, CONTAMINATION PIECE PART FAILURE

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN A) PASS  
B) FAIL  
C) PASS

PASS/FAIL RATIONALE:

A)

B)

"B" SCREEN IS FAILED SINCE NO INSTRUMENTATION EXISTS DURING FLIGHT TO  
MONITOR INDIVIDUAL ACTUATOR RETRACTION.

C)

## - FAILURE EFFECTS -

(A) SUBSYSTEM:

LOSS OF ONE OF THREE UMBILICAL RETRACT ACTUATOR FUNCTIONS.

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**(B) INTERFACING SUBSYSTEM(S):**

FIRST FAILURE - NO EFFECT. FUNCTION CAN BE PERFORMED BY TWO OF THE THREE UMBILICAL RETRACT ACTUATORS. HOWEVER, SINGLE ACTUATOR RETRACT HAS NOT BEEN CERTIFIED. WITH LOSS OF SECOND ASSOCIATED ACTUATOR, ORBITER TO ET UMBILICAL PLATE MAY COCK AT SEPARATION DUE TO GUIDE PIN HANGUP. GUIDE PINS ARE CLOSE TOLERANCE SO THE PLATE MUST PULL BACK STRAIGHT FOR FIRST QUARTER OF AN INCH OF TRAVEL. DAMAGE OF THE 17 INCH QD FLAPPER/LINKAGE COULD RESULT AND PREVENT QD CLOSURE. SHOULD ET SIDE FLAPPER FAIL TO CLOSE, ET AND VEHICLE CONTACT COULD OCCUR (CRITICALITY 1). SHOULD VEHICLE SIDE FLAPPER FAIL TO CLOSE, SYSTEM WOULD GO TO DELAYED ET SEPARATION, RESULTING IN TILE DEBONDING AND ET UMBILICAL DOOR SEAL DAMAGE (CRITICALITY 1). ADDITIONALLY, LOSS OF SECOND ASSOCIATED ACTUATOR COULD CAUSE EXCEEDANCE OF MAXIMUM ALLOWABLE PLATE RETRACT VELOCITY OF 1.1 IN/SEC. THIS COULD LEAD TO DAMAGED OR BROKEN REDUNDANT VALVE CLOSURE LINKAGE AND INTERFERENCE WITH ET UMBILICAL DOOR CLOSURE. IMPROPER DOOR CLOSURE WOULD RESULT IN CRITICAL HEATING DURING REENTRY (CRITICALITY 1).

**(C) MISSION:**

FIRST FAILURE - NO EFFECT. POSSIBLE LOSS OF CREW/VEHICLE WITH LOSS OF SECOND ASSOCIATED ACTUATOR.

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

SAME AS (C).

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

POSSIBLE LOSS OF CREW/VEHICLE WITH TWO FAILURES: THIS FAILURE PLUS LOSS OF UNASSOCIATED HYDRAULIC SYSTEM OR SECOND ACTUATOR DURING ASCENT, RESULTING IN IMPROPER RETRACTION OF ET UMBILICAL PLATE.

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**

BURST FACTOR OF 2.5. CYLINDER IS 7075-T73 ALUMINUM WHICH PROVIDES GOOD PHYSICAL PROPERTIES FOR HIGH ALLOWABLE STRESS. ALLOWABLE STRESS IS 40,000 PSI AT 275 DEG F. ACTUAL CALCULATED CYLINDER HOOP STRESS (BURST) IS 39,084 PSI. THE MARGIN OF SAFETY IS 0.029. CYLINDER DESIGN AVOIDS STRESS RISERS AND SUDDEN CHANGES IN SECTION IN CRITICAL AREAS. HYDRAULIC SYSTEM FILTRATION IS 5 MICRONS UPSTREAM OF ACTUATOR. TWO OF THREE ACTUATORS CAN SUCCESSFULLY RETRACT THE UMBILICAL PLATE (TEST REPORT STS 82-0076). DYNAMIC ROD SEALS ARE OF DUAL ELASTOMERIC TYPE WITH BACKUP RINGS.

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**(B) TEST:**

**QUALIFICATION:**

- **ENDURANCE CYCLING** - 1,500 FULL STROKE CYCLES, 1,000 AT 0 DEGREES F AND 500 AT 160 DEGREES F WITH SIMULATED LOADS AND VELOCITIES APPLIED. PASS/FAIL CRITERIA: PASSAGE OF SUBSEQUENT PERFORMANCE RECORD TEST.
- **IMPULSE CYCLING**, 50,000 CYCLES, 3,000-4,500-3,000 PSI AT SUPPLY PORT AND 750-1,500-750 PSI AT RETURN PORT. RATE OF 2.0 HZ. PASS/FAIL CRITERIA: PASSAGE OF SUBSEQUENT PERFORMANCE RECORD TEST.
- **PERFORMANCE RECORD TEST** - INCLUDES APPLIED FORCE/ACTUATOR PISTON VELOCITY TEST, FREE FLOAT, RETRACT AND EXTEND.
- **BURST TEST** - 7,500 PSI AT BOTH PORTS, AT 275 DEG F. PASS/FAIL CRITERIA: NO EVIDENCE OF EXTERNAL LEAKAGE OR RUPTURE.
- **RUPTURE TEST** - INCREASE TO RUPTURE OR 125 PERCENT OF BURST PRESSURE (7,500 PSI).
- **SALT FOG TEST** - TESTED IN ACCORDANCE WITH MIL-STD-810.
- **SAND/DUST TEST** - TESTED IN ACCORDANCE WITH MIL-STD-810. **THERMAL CYCLE TEST** - TESTED 5 TIMES AT -65 DEG F TO 70 DEG F TO 275 DEG F.

**ACCEPTANCE:**

- **EXAMINATION OF PRODUCT** - WEIGHT, WORKMANSHIP, FINISH, DIMENSIONS AND CONSTRUCTION.
- **PROOF PRESSURE** - 4,500 PSI FOR TWO MINUTES AT 275 DEG F AND REPEATED AT AMBIENT TEMPERATURE AT BOTH PORTS FOR TWO CYCLES EACH. PASS/FAIL CRITERIA: NO EXTERNAL LEAKAGE OR PERMANENT DEFORMATION.
- **PERFORMANCE RECORD TEST** - INCLUDES APPLIED FORCE/ACTUATOR PISTON VELOCITY TEST (7 SEC MAX, 2 SEC MIN), FREE FLOAT, RETRACT AND EXTEND.
- **CLEANLINESS TEST** - LEVEL 190 PER MAO110-301.

**GROUND TURNAROUND TEST**

ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

**(C) INSPECTION:**

**RECEIVING INSPECTION**

RECORDS AND TEST REPORTS ARE MAINTAINED CERTIFYING MATERIAL AND PHYSICAL PROPERTIES (RAW MATERIAL, ANNEALING, AND ULTRASONIC INSPECTION).

**CONTAMINATION CONTROL**

CLEANLINESS LEVEL OF 190 PER MAO110-301 IS VERIFIED BY INSPECTION.

**CRITICAL PROCESSES**

HEAT TREATMENT AND ANODIZATION PROCESSES ARE VERIFIED BY INSPECTION.

**NDE**

PENETRANT PROCESS IS VERIFIED BY INSPECTION.

**ASSEMBLY/INSTALLATION**

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EXAMINATION TESTS PERFORMED TO VERIFY THAT ALL QUALITY ASSURANCE DOCUMENTATION IS COMPLETE. VISUALLY INSPECT ASSEMBLY TO ASSURE COMPLIANCE WITH 281600 DRAWING, AND VERIFY THAT NO OBVIOUS DEFECTS ARE EVIDENT. FINAL INSPECTION OF ALL DIMENSIONS IS PERFORMED. MANIFOLD BLANK IS INSPECTED TO LAYOUT PATTERN AND DRAWING. MANIFOLD IS NUMERICAL CONTROL MACHINE INSPECTED TO DRAWING PRIOR TO ANODIZE (THREADS ARE INSPECTED). CYLINDER HONED TO DETAILED INSTRUCTIONS ON OPERATIONS SHEETS AND VERIFIED BY INSPECTION. STRICT COMPLIANCE WITH MACHINING SPECIFICATION (BMF 5115) AND CORROSION CONTROL PLAN (BMF 5110) REQUIRED AND VERIFIED BY INSPECTION.

TESTING  
ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING  
INSPECTION VERIFIES PACKAGING PRIOR TO SHIPMENT.

**(D) FAILURE HISTORY:**  
CURRENT DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATA BASE.

**(E) OPERATIONAL USE:**  
NONE

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**- APPROVALS -**

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EDITORIALLY APPROVED : BNA : J. Kamura 7-30-98  
TECHNICAL APPROVAL : VIA APPROVAL FORM : 95-CIL-009\_02-6