

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL HARDWARE

NUMBER: 03-2F-102150 -X

SUBSYSTEM NAME: FORWARD REACTION CONTROL SYSTEM (RCS)

REVISION: 3 03/03/98

PART DATA

PART NAME	PART NUMBER
VENDOR NAME	VENDOR NUMBER
LRU : COUPLING, PROPELLANT FAIRCHILD STRATOS	MC276-0018 76301000 & 76306000

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

DISCONNECT, QUICK HELIUM/PROPELLANT, SPRING LOADED POPPET WITH STRUCTURAL CAP (1/4" & 1/2" AND 1"). FAIRCHILD P/N'S 76301000, 76306000 & 76311000. (MD123, 124, 125, 126)

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 4
TWO PER PROPELLANT

FUNCTION:

TO PROVIDE FOR VENTING AND BLEEDING PROPELLANT TANKS DURING SERVICING IN VERTICAL VEHICLE ORIENTATION. ITEM INCORPORATES SECONDARY INTERNAL SEALS AND HAS A PRESSURE CAP WHICH IS REDUNDANT SEAL. CAP INSTALLED PRIOR TO FLIGHT.

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SUBSYSTEM NAME: FORWARD REACTION CONTROL SYSTEM (RCS)

LRU: COUPLING, PROPELLANT

CRITICALITY OF THIS

ITEM NAME: COUPLING, PROPELLANT

FAILURE MODE: 1R2

FAILURE MODE:

FAILS OPEN CAP LEAKS IN EXCESS OF ACCEPTABLE RATE, POPPET FAILS OPEN

MISSION PHASE:

- PL PRE-LAUNCH
- LO LIFT-OFF
- OO ON-ORBIT
- DO DE-ORBIT
- LS LANDING/SAFING

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

- 102 COLUMBIA
- 103 DISCOVERY
- 104 ATLANTIS
- 105 ENDEAVOUR

CAUSE:

SEALS DAMAGED OR DETERIORATED, CONTAMINATION, VIBRATION, MECHANICAL SHOCK, PIECE-PART STRUCTURAL FAILURE, IMPROPER USE, INADEQUATE MAINTENANCE OF GSE HALF, INADEQUATE LINE SUPPORT, SHAFT OR BORE BENT, OVERPRESSURE OF PANEL, EXCESS TORQUE

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN

- A) FAIL
- B) FAIL
- C) PASS

PASS/FAIL RATIONALE:

A)

B)

C)

- FAILURE EFFECTS -

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(A) SUBSYSTEM:

LOSS OF SUBSYSTEM PROPELLANT AND REDUNDANT SEALS.

(B) INTERFACING SUBSYSTEM(S):

NO EFFECT

(C) MISSION:

NO EFFECT

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

NO EFFECT

(E) FUNCTIONAL CRITICALITY EFFECTS:

POTENTIAL CREW/VEHICLE LOSS IF PROPELLANT CANNOT BE UTILIZED OR DEPLETED. POSSIBLE LOSS OF VEHICLE CONTROL DURING ET SEP/ENTRY. DAMAGE TO STRUCTURE/TPS IF LEAKAGE OCCURS OR STRUCTURE AND ADJACENT HARDWARE IF CAP BLOWS OFF. LEAKAGE OF PROPELLANT VAPORS INTO POD. 1R EFFECT ASSUMES LOSS OF SEALS (POPPET AND CAP) BEFORE EFFECT IS MANIFESTED. CANNOT CHECK REDUNDANT SEALS WHEN CAP IS INSTALLED. REQUIRES BOTH SEALS TO LEAK ON ORBIT BEFORE FAILURE IS DETECTABLE.

-DISPOSITION RATIONALE-

(A) DESIGN:

THE PROOF FACTOR OF SAFETY IS 2X THE MAX OPERATING PRESSURE (1.1 X THE MAX SURGE PRESSURE) AND THE BURST FACTOR OF SAFETY IS 3X THE MAX OPERATING (1.6X MAX SURGE PRESSURE). THREE SIZES (1/4", 1/2", 1") WERE CERTIFIED BY TEST.

GROUND HALF COUPLINGS AND LINES ARE SUPPORTED TO LIMIT STRESS ON COUPLINGS AND PREVENT DAMAGE TO SEALS AND WELD JOINTS. A COMPLETE STRESS ANALYSIS WAS PERFORMED.

THE CAP PROVIDES A REDUNDANT SEAL AND MINIMIZES THE LEAKAGE POTENTIAL. THE DESIGN ALLOWS REPLACEMENT OF THE NOSE SEAL DURING NORMAL MAINTENANCE PROCEDURES. THE GSE HALF INCLUDES A 10 MICRON SEAL TO HELP PRECLUDE CONTAMINATION FAILURES. MATERIALS ARE SELECTED THAT ARE COMPATIBLE WITH PROPELLANTS.

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NUMBER: 03-2F-102150-01

(B) TEST:

THE QUALIFICATION TEST PROGRAM INCLUDED THREE 1/4", THREE 1/2", AND TWO 1" UNITS. THE TESTING INCLUDED RANDOM VIBRATION (POPPET OPEN AND CAP ON), ENDURANCE (600 CYCLES COUPLED AND UNCOUPLED), THERMAL CYCLES (-30 TO +200 DEG F) FOR 1/2" AND 1" ONLY, BASIC AND BENCH HANDLING SHOCK FOR 1/2" AND 1", BENDING AND AXIAL LOADS (100 FT-LBS AND 100LBS) FOR 1/2" AND 1" ONLY, 2130 PSI BURST PRESSURE FOR 1/2" AND 1" ONLY, SURGE PRESSURE (190,000 CYCLES TO 1300 PSI) FOR 1/2" AND 1" ONLY, AND PROPELLANT COMPATIBILITY.

ACCEPTANCE TESTING INCLUDES EXAMINATION OF PRODUCT, 1420 PSIG GHE PROOF PRESSURE, LEAKAGE, OPERATION, CLEANLINESS AND TESTING OF THE CAP AS A SEPARATE ASSEMBLY.

ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD. THE OMRSD DATA PROVIDED BELOW IS NO LONGER BEING KEPT UP-TO-DATE. IF THERE IS ANY DISCREPANCY BETWEEN THE GROUND TESTING DATA PROVIDED BELOW AND THE OMRSD, THE OMRSD IS THE MORE ACCURATE SOURCE OF THE DATA.

OMRSD PERFORMS THE FOLLOWING: REGULATOR LEAK AND FUNCTIONAL TESTS EVERY FLIGHT AND ON A CONTINGENCY BASIS. A REGULATOR RESPONSE TEST EVERY FLIGHT AND ON A CONTINGENCY BASIS. A REGULATOR RESPONSE TEST (LOW PRESSURE) ON A CONTINGENCY BASIS. THE PROPELLANT LOADING FOR EACH FLIGHT. LEAK CHECKS ON THE PROPELLANT QD COUPLING EVERY FIFTH FLIGHT. LEAK CHECKS ON THE QD CAPS FOR THE FIRST FLIGHT. A PRESSURE DECAY CHECK ON THE LOW PRESSURE HELIUM SYSTEM EVERY MISSION. TOXIC VAPOR LEAK CHECK OF THE PROPELLANT TANK FOR THE FIRST FLIGHT AND ON A CONTINGENCY BASIS. A STATIC AIR SAMPLE THE 2ND FLIGHT AND EVERY FLIGHT THEREAFTER AND ON CONTINGENCY. AN EXTERNAL LEAK VERIFICATION OF THE SYSTEM FOR THE FIRST FLIGHT. A PROPELLANT SAMPLE FOR QUALITY THE SECOND FLIGHT WHEN TANKS OR MANIFOLDS ARE DRAINED. CANNOT CHECK REDUNDANT SEALS WHEN CAP IS ASSEMBLED.

(C) INSPECTION:

RECEIVING INSPECTION

TEST REPORTS AND MATERIAL CERTIFICATIONS CERTIFYING MATERIALS AND PHYSICAL PROPERTIES (WELDING, HEAT TREATMENT, AND PASSIVATION) ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

CLEANLINESS LEVEL OF 100A IS VERIFIED BY INSPECTION. CORROSION PROTECTION IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

TORQUING IS VERIFIED BY INSPECTION. SEALS ARE INSPECTED PER SNP 915. LOG OF CLEAN ROOM AND TOOL CALIBRATION IS VERIFIED BY INSPECTION. CRITICAL DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. ASSEMBLY IS VERIFIED BY INSPECTION. INSPECTION VERIFIES BRAYCOTE IS APPLIED TO THREADS, SEALS AND SLIDING SURFACES.

NONDESTRUCTIVE EVALUATION

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NUMBER: 03-2F-102150- 01

PENETRANT INSPECTION OF BODY ASSEMBLY TIG WELD AND FLANGE CASTING PER MIL-I-6855 TYPE I METHOD B IS VERIFIED BY INSPECTION. RADIOGRAPHIC INSPECTION OF THE FLANGE CASTING PER MIL-C-6021, CLASS 1A, GRADE C, IS VERIFIED BY INSPECTION.

CRITICAL PROCESSES

TIG WELD OF THE BODY ASSEMBLY PER MIL-W-8611 AND THE RESISTANCE WELD OF THE A.H.C. FILTER ASSEMBLY ARE VERIFIED BY INSPECTION.

TESTING

ATP PER ATP7631002 OR ATP7631002-1 IS WITNESSED AND VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING PROCEDURES ARE VERIFIED BY INSPECTION.

(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. THE FAILURE HISTORY DATA PROVIDED BELOW IS NO LONGER BEING KEPT UP-TO-DATE

A TOTAL OF 265 FAILURES HAVE BEEN RECORDED FOR ALL APPLICATIONS OF THIS COUPLING FOR THE EXTERNAL (SEAL) LEAKAGE MODE. OF THESE, 214 OCCURRED DURING ACCEPTANCE, 7 DURING SUPPLIER QUAL TEST, 20 AT WSTF, 23 AT KSC AND 2 DURING TEST AT DOWNEY. THE CAUSES FOR THESE FAILURES INCLUDED INSTALLATION/HANDLING DAMAGE, INSTALLATION TECHNIQUE, INSUFFICIENT TORQUE ON THE POPPET SEAL RETAINER, IMPROPER TEST, O-RING FLASH, INADEQUATE LUBE, SEAT FINISH, MISSING SEALS, CONTAMINATION, PROPELLANT RESIDUE, IRON NITRATE LEVEL, GALLING AND BINDING BETWEEN POPPET AND PROBE. CORRECTIVE ACTION - THESE FAILURES WERE CORRECTED BY DRAWING AND DESIGN CHANGES, INSTALLATION/ASSEMBLY/PROCEDURE CHANGES, OPERATIONAL USE (MATING) REQUIREMENTS, CAUTION NOTES, CORROSION PROTECTION, IMPROVED SURFACE FINISHES, CHANGED TORQUE VALUES, INSPECTION CHANGES, CONTAMINATION CONTROL, PREVENTIVE MAINTENANCE PROCEDURES, CONTROL OF N2O4 IRON NITRATE LEVEL AND GSE CHANGES TO PROTECT THE VEHICLE.

A TOTAL OF TEN FAILURES WERE RECORDED AGAINST THE OMS SYSTEM. OF THESE 7 OCCURRED DURING ACCEPTANCE, 1 AT WSTF AND 2 AT KSC. THE CAUSES OF THE OMS FAILURES INCLUDED CONTAMINATION, SEAL MISSING, O-RING DAMAGE, O-RING FLASH AND ASSEMBLY/HANDLING DAMAGE.

CAR AC0985: ONE CASE OF A STUCK OPEN POPPET AT WSTF ATTRIBUTED TO CONTAMINATION. CORRECTIVE ACTION - EXISTING CLEANLINESS CONTROLS WERE RE-EMPHASIZED (ML00310-032).

CAR AC8625: DURING THE CHECKOUT OF OV-099 RCS (STS41-G) THE CAP PRESSURE BLEED WOULD NOT STOP. THE FAILURE WAS ATTRIBUTED TO CONTAMINATION, IMBEDDED PARTICLES AND A SCRATCHED POPPET SEAT.

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CORRECTIVE ACTION - THE EXISTING CLEANLINESS CONTROLS WERE RE-EMPHASIZED (ML00310-032).

CAR AC4955: A CASE OF A POPPET PROBE STUCK OPEN WAS REPORTED DURING WSTF TESTING. THIS WAS ATTRIBUTED TO OUT OF PRINT PARTS AND MISHANDLING DURING ASSEMBLY.

CAR AC0550: THE MOST SIGNIFICANT FAILURE OF THIS COUPLING OCCURRED WITH THE GROUND HALF DURING CHECKOUT OF THE OV-102 FRCS FOR STS-2. THIS FAILURE RESULTED IN A PROPELLANT SPILL ONTO THE VEHICLE CAUSED BY BINDING BETWEEN THE POPPET/PROBE AND DYNAMIC HEAD. THIS WAS ATTRIBUTED TO CLEARANCES WITHIN THE COUPLING AND EXCESS IRON NITRATE IN THESE AREAS. CORRECTIVE ACTION - COMPONENT DESIGN CHANGES WERE IMPLEMENTED AND THE IRON NITRATE LEVEL IS BEING CONTROLLED.

THIS FAILURE REVEALED THE EXISTENCE OF A LEAK PATH FOR PROPELLANT INTO THE ORBITER. CORRECTIVE ACTION FOR THIS WAS ADDRESSED IN CAR AC0646. MCR10409 WAS ISSUED TO PROVIDE GSE CHANGES TO PREVENT LEAK INTO THE ORBITER THROUGH VENT HOLES AND OTHER PANEL CLEARANCES. PREVENTIVE MAINTENANCE AND HANDLING/TEST PROCEDURES WERE IMPLEMENTED AND CAUTION NOTES ADDED TO CHECK OUT PROCEDURES.

(E) OPERATIONAL USE:

REQUIRES TWO SEAL FAILURE BEFORE ACTION IS REQUIRED. SECURE THE SYSTEM AND ISOLATE THE LEAK.

DURING ASCENT IF LEAK RATE DOES NOT PERMIT ET-SEP, A CONTINGENCY AFT ONLY SEPARATION WILL BE PERFORMED.

- APPROVALS -

PAE MANAGER : D. F. MIKULA
 PRODUCT ASSURANCE ENGR : L. X. DANG
 DESIGN ENGINEERING : E. VERA
 BOEING SUBSYSTEM MANAGER: D. PERRY
 JSC MOD : B. LUNNEY

D.F. Mikula 08 JUL 98
L. X. Dang 08 July 98
Daniel Perry for Ed Vera 7-7-98
Daniel Perry 7-7-98
B. Lunney 8-4-98