

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE

NUMBER: 03-3-2009-X

SUBSYSTEM NAME: ORBITAL MANEUVERING SYSTEM (OMS)

REVISION : 2 03/16/90

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

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

COUPLING, PROPELLANT FILL AND DRAIN, BLEED AND PURGE. MD225, 326, 461, 462, 469, 470, 479, 480, 561, 562, 569, 570, 579, 580, 673, 674, 679, 686).

QUANTITY OF LIKE ITEMS:

18 PER VEHICLE
7 PER POD
4 PER AFT FUSELAGE

FUNCTION:

POD PROPELLANT TANKS ARE FILLED AND DRAINED THROUGH THIS SERVICE CONNECTION. IT IS ALSO USED FOR BLEED AND PURGE OPERATIONS. THE FUEL FILL COUPLING IS LOCATED ON THE LEFT POD SIDE AND THE OXIDIZER FILL COUPLING IS LOCATED ON THE RIGHT POD SIDE. THE AIRBORNE HALF COUPLING (AHC) CONSISTS OF A SPRING LOADED POPPET, POPPET SEAL, AND FILTER. THE AHC CAP PROVIDES A REDUNDANT SEAL AND PROTECTS THE AHC WHEN NOT IN USE. FLIGHT FILL (1 PER POD), HORIZONTAL DRAIN (2 PER POD), LOW POINT DRAIN (2 PER POD), FEED LINE DRAIN (2 PER POD), CROSSFEED LINE DRAIN (4 PER VEHICLE)

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ITEM NAME: COUPLING, PROPELLANT CRITICALITY OF THIS FAILURE MODE: IR2

FAILURE MODE:
EXTERNAL LEAKAGE (SEAL LEAKAGE)

MISSION PHASE:
PL PRELAUNCH
LO LIFT-OFF
OO ON-ORBIT
DO DE-ORBIT
LS LANDING SAFING

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

CAUSE:
CONTAMINATION, SEAL DETERIORATION OR WEAR, PROPELLANT RESIDUE PRODUCTS,
NO GROUND HALF COUPLING LINE SUPPORT-SHAFT BENT, IMPROPER MAINTENANCE,
RETAINING NUT LOOSENS NEGATING CAP SEAL REDUNDANCY.

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN A) FAIL
B) FAIL
C) PASS

PASS/FAIL RATIONALE:

- A)
- B)
- C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
NO EFFECT UNLESS REDUNDANT SEALS FAIL.

(B) INTERFACING SUBSYSTEM(S):
NO EFFECT - POTENTIAL CORROSIVE DAMAGE TO ADJACENT HARDWARE/TPS FOR

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MULTIPLE FAILURES.

(C) MISSION:

LAUNCH DELAY IF DETECTED PREFLIGHT.

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

NO EFFECT UNLESS REDUNDANT SEALS LEAK.

(E) FUNCTIONAL CRITICALITY EFFECTS:

POSSIBLE CREW/VEHICLE LOSS IF LEAK RESULTS IN EXCESSIVE LOSS OF PROPELLANT (INADEQUATE PROPELLANT FOR DEORBIT BURN) OR STRUCTURAL/TPS DAMAGE. IF EFFECT REQUIRES LOSS OF POPPET AND CAP SEALS, CAP SEAL CANNOT BE VERIFIED AFTER INSTALLATION. NO INSTRUMENTATION AVAILABLE FOR DETECTION OF FAILURE OF CAP OR COUPLING SEAL IN FLIGHT.

- DISPOSITION RATIONALE -

(A) DESIGN:

DESIGN FACTORS - PROOF PRESSURE, 2 X MAX OP PRESSURE (1.1 X MAX SURGE PRESSURE). BURST, 3 X MAX OP PRESSURE (1.6 X MAX SURGE PRESS). CERTIFIED BY ANALYSIS (1/4") & CERTIFIED BY TEST FOR TWO SIZES (1/2", 1"). COMPLETE STRESS ANALYSIS. GROUND HALF COUPLINGS/LINES SUPPORTED TO LIMIT STRESS ON COUPLINGS AND PREVENT DAMAGE TO SEALS AND WELD JOINTS. CAP PROVIDES A REDUNDANT SEAL, MINIMIZES LEAKAGE POTENTIAL AND PROTECTS COUPLING FROM EXTERNAL CONTAMINATION. FLUID ENTERING THE COUPLINGS IS FILTERED THROUGH A 25 MICRON GSE FILTER AND THE FLIGHT HALF COUPLINGS ALSO INCORPORATE AN INTERNAL 200 MICRON FILTER. A SERVICING SAFETY FEATURE IS PROVIDED WHEREBY A BLEED SCREW CAN BE USED TO VENT PROPELLANT VAPOR OVERBOARD PRIOR TO REMOVAL OF THE END CAP.

■ (B) TEST:

QUALIFICATION TEST

(4 UNITS, 2 EA. 1/2", 1") - RANDOM VIBRATION (POPPET OPEN AND CAP ON), SHOCK-BENCH AND BASIC, THERMAL CYCLE (-30 TO +200 DEG F), ENDURANCE (600 CYCLES, BENDING AND AXIAL LOADS (100 FT-LB, AND 100 LB), SURGE PRESSURE (190,000 CYCLES TO 1300 PSI), BURST PRESSURE (2130 PSI), PROPELLANT COMPATIBILITY. ALSO QUALIFIED AS PART OF POD ASSEMBLY. VIBRO ACOUSTIC TESTING AT JSC, 131 EQUIVALENT MISSIONS. HOT-FIRE TEST PROGRAM AT WSTF, 517 TESTS (24 EQUIVALENT MISSION DUTY CYCLES). APPROX. 7 YEARS PROPELLANT EXPOSURE.

ACCEPTANCE TEST

(EACH UNIT) - PROOF, FUNCTIONAL, LEAKAGE.

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GROUND TURNAROUND

V43CBO.202 AND V43CBO.206 REQUIRE EXTERNAL LEAK CHECK ON EACH COUPLING AND CAP USED DURING TURNAROUND OPERATIONS (NOT INCLUDING SERVICING). COUPLINGS/CAP NOT USED DURING TURNAROUND ARE CHECKED AT 5 FLIGHT INTERVALS.

V43CBO.210 PERFORMS FIRST FLIGHT EXTERNAL LEAK CHECKS.

V43CBO.230 TOXIC VAPOR LEAK CHECK OF PROP TANK FIRST FLIGHT AND CONTINGENCY.

V43CBO.240 TOXIC VAPOR LEAK CHECK OF PROP FEEDSYSTEM FIRST FLIGHT AND CONTINGENCY.

V43CBO.260 TOXIC VAPOR LEAK CHECK OF CROSSFEED LINES FIRST FLIGHT AND CONTINGENCY.

V43CFO.010 PERFORMS PRESSURE CHECK ON EACH COUPLING USED IN SERVICING OPERATIONS BEFORE GSE IS DISCONNECTED.

VERIFICATION OF THE PURITY OF PROPELLANT ENTERING THE SYSTEM IS REQUIRED BY V43CFO.010. (REF. SE-S-0073.)

(C) INSPECTION:

RECEIVING INSPECTION

MATERIALS AND PROCESSES CERTIFICATIONS ARE VERIFIED BY INSPECTION, INCLUDING RESISTANCE WELDING OF THE FILTER, ASSEMBLY HEAT TREATMENT OF GAL-4V TITANIUM AND 15-5PH CRES PARTS, AND PASSIVATION PER QQ-P-635.

CONTAMINATION CONTROL

CLEANLINESS TO LEVEL 100A AND CORROSION PROTECTION PROVISIONS ARE VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

MANUFACTURING, ASSEMBLY AND INSTALLATION PROCEDURES ARE VERIFIED BY INSPECTION. CRITICAL DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. SEALS ARE INSPECTED PER SNP 915. BRAYCOTE APPLICATION TO THREADS, SEALS AND SLIDING SURFACES IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

PENETRANT INSPECTION OF THE BODY ASSEMBLY TIG WELD AND THE FLANGE CASTING PER MIL-I-6866 TYPE I METHOD B IS VERIFIED BY INSPECTION. RADIOGRAPHIC INSPECTION OF THE FLANGE CASTING PER MIL-C-602, CLASS IA, GRADE C, IS VERIFIED BY INSPECTION.

CRITICAL PROCESS

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

TESTING

TEST EQUIPMENT AND TOOL CALIBRATION ARE VERIFIED BY INSPECTION.

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ACCEPTANCE TEST PER ATP7631002 OR ATP7631002-1 IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

HANDLING, PACKAGING, STORAGE AND SHIPPING REQUIREMENTS ARE VERIFIED BY INSPECTION.

■ (D) FAILURE HISTORY:

A TOTAL OF 266 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 #204 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 AB5074 RECORDS AN INSTANCE OF EXCESSIVE LEAKAGE ON THIS COUPLING IN THE MD476 APPLICATION DURING CHECKOUT AT KSC. THE POPPET SEAL WAS MISSING. ER 75380-33 WAS EXPANDED TO INCLUDE VERIFICATION OF INSTALLATION SIGN-OFF.

CAR AC0985:

ONE CASE OF A STUCK OPEN POPPET AT WSTF ATTRIBUTED TO CONTAMINATION. CORRECTIVE ACTION - EXISTING CLEANLINESS CONTROLS WERE RE-EMPHASIZED (MLO0310-032).

CAR AC8625:

DURING CHECK OUT OF THE OV-099 RCS (STS41-G) THE CAP PRESSURE BLEED WOULD NOT STOP. THIS FAILURE WAS ATTRIBUTED TO CONTAMINATION, IMBEDDED PARTICLES AND A SCRATCHED POPPET SEAT. CORRECTIVE ACTION - THE EXISTING CLEANLINESS CONTROLS WERE RE-EMPHASIZED (MLO0310-032).

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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, THE IRON NITRATE LEVEL WAS CONTROLLED AND A GSE (TROUGH) WAS PROVIDED TO PROTECT THE VEHICLE.

CAR AC0646 RESULTED IN MCR10409 WITH ADDITIONAL GSE CHANGES TO PREVENT LEAK ONTO THE VEHICLE THROUGH VENT HOLES AND OTHER CLEARANCES. - PREVENTIVE MAINTENANCE AND HANDLING/TEST PROCEDURES WERE IMPLEMENTED AND CAUTION NOTES ADDED TO THE CHECK OUT PROCEDURES.

(E) OPERATIONAL USE:

NO ACTION FOR FIRST FAILURE - NOT DETECTABLE. FOR NOTICEABLE LEAKS UPSTREAM OF CROSSFEED VALVES USE PERIGEE ADJUST BURN TO DEplete PROPELLANT FROM LEAKING POD (OUT OF PLANE COMPONENT IF NECESSARY) AND REDUCE DELTA V REQUIREMENTS FOR DEORBIT. AFTER LEAKED PROPELLANT HAS DISPERSED, PERFORM DEORBIT BURN WITH GOOD POD. NEXT PLS ENTRY IS REQUIRED FOR NOTICEABLE LEAKS DOWNSTREAM OF CROSSFEED VALVES. DO NOT USE CROSSFEED OR INTERCONNECT.

- APPROVALS -

RELIABILITY ENGINEERING: J. M. HART
DESIGN ENGINEERING : D. W. CARLSON
QUALITY ENGINEERING : O. J. BUTTNER
NASA RELIABILITY :
NASA SUBSYSTEM MANAGER :
NASA QUALITY ASSURANCE :

: SA W. O. Ochoa
: W. J. Raper
: W. J. Raper 4/14/90
: W. J. Raper
: Samuel L. Gordo 5-25-90
: W. J. Raper