FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL HARDWARE
NUMBER: 03-3-2001 -X

SUBSYSTEM NAME: ORBITAL MANEUVERING SYSTEM (OMS)
REVISION: 3 03/03/98

PART DATA

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

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
COUPLING, PROPELLANT/HELIUM VENT, TEST AND BLEED COUPLING. MD 405, 406, 416, 417, 421, 422, 423, 424, 426, 427, 505, 506, 516, 517, 521, 522, 523, 524, 526, 527, 667, 668.

REFERENCE DESIGNATORS:
MD405
MD406
MD416
MD417
MD421
MD422
MD423
MD424
MD426
MD427
MD505
MD506
MD516
MD517
MD521
MD522
MD523
MD524
MD526
MD527
MD667
MD668

QUANTITY OF LIKE ITEMS: 22
22 TOTAL VEHICLE 10 PER POD, 2 CROSSFEED

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FUNCTION:
PROPELLANT TANK IS VENTED THRU THIS SERVICE CONNECTION TO RELIEVE PRESSURE BUILD-UP & FACILITATE FILLING. COUPLINGS ARE ALSO USED FOR REGULATOR FLOW CHECKOUT, PROP TANK VENT, ACQUISITION SYSTEM BUBBLE POINT TEST AND BLEED AND CROSSFEED LINE HIGH POINT BLEED. THE END CAP INSTALLED ON THE AIRBORNE HALF (AHC) PROVIDES REDUNDANCY FOR EXTERNAL LEAKAGE AND PROTECTS THE COUPLING WHEN NOT IN USE. THE AHC CONSISTS OF SPRING LOADED POPPET, POPPET SEALS, AND FILTER.

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE
NUMBER: 03-3-2001-01

REVISION#: 3 03/03/98

SUBSYSTEM NAME: ORBITAL MANEUVERING SYSTEM (OMS)
LRU: COUPLING, PROPELLANT
ITEM NAME: COUPLING, PROPELLANT

CRITICALITY OF THIS FAILURE MODE: 1R2

FAILURE MODE:
EXTERNAL LEAKAGE (SEAL LEAKAGE)

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:
PARTICULATE CONTAMINATION, PROPELLANT RESIDUE PRODUCTS, SEAL DETERIORATION (PROPELLANT EXPOSURE), NO 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

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

(C) MISSION:
NO EFFECT UNLESS REDUNDANT SEALS LEAK.

(D) CREW, VEHICLE, AND ELEMENT(S):
SAME AS C

(E) FUNCTIONAL CRITICALITY EFFECTS:
POTENTIAL CREW/VEHICLE LOSS IF LEAK RATE IS EXCESSIVE. LOSS OF PROPELLANT OR PRESSURANT MAY RESULT IN INABILITY TO DEORBIT DUE TO INADEQUATE PRESSURANT FOR PROPELLANT FEED OR INADEQUATE PROPELLANT FOR DEORBIT BURN. 1R 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, 2 X MAX OP PRESSURE (1.1 X MAX SURGE PRESS). BURST, 3 X MAX OP PRESSURE (1.6 X MAX SURGE PRESS). CERTIFIED BY ANALYSIS (1/4") AND CERTIFIED BY TEST; THREE SIZES (1/4", 1/2", AND 1").
A COMPLETE STRESS ANALYSIS WERE PERFORMED. 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:
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 UNCOUPED), THERMAL CYCLES (-30 TO +200

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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. ALSO QUALIFIED AS PART OF POD ASSEMBLY. VIBRO ACOUSTIC TESTING AT JSC, 101 EQUIVALENT MISSIONS. HOT FIRE TEST PROGRAM AT WSTF, 517 TESTS (24 EQUILVALENT MISSION DUTY CYCLES) APPROXIMATELY, 7 YEAR PROPELLANT EXPOSURE.

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.

GROUND TURNAROUND
V43CB0.202 AND V43CB0.206 REQUIRES LEAK CHECK FOR EACH COUPLING AND CAP USED DURING TURNAROUND OPERATIONS (NOT INCLUDING SERVICING).
COUPLINGS/CAPS NOT USED DURING TURNAROUND ARE CHECKED AT 5 FLIGHT INTERVALS.
V43CB0.210 PERFORMS FIRST FLIGHT EXTERNAL LEAK CHECKS.
V43CB0.230 TOXIC VAPOR LEAK CHECK OF PROPELLANT TANK FIRST FLIGHT AND ON CONTINGENCY BASIS.
V43CF0.010 PERFORMS PRESSURE CHECK ON EACH COUPLING USED IN SERVICING BEFORE GSE IS DISCONNECTED.

VERIFICATION OF THE PURITY OF PROPELLANTS ENTERING THE SYSTEM IS REQUIRED BY V43CF0.010 (REF SE-S-0073).
FOR GHE THIS IS SPECIFIED BY V43CF0.020

(C) INSPECTION:
RECEIVING INSPECTION
MATERIALS AND PROCESSES CERTIFICATION ARE VERIFIED BY INSPECTION. INCLUDING RESISTANCE WELDING OF THE FILTER ASSEMBLY, HEAT TREATMENT OF 6AL-4V TITANIUM AND 15-5PH RESC 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. 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:**
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 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 N_2O_4 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

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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 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 SRATCHED POPPET SEAT. CORRECTIVE ACTION - THE EXISTING CLEANLINESS CONTROLS WERE RE- EMPHASIZED (MIL00310-032).

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. 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. USE PERIGEE ADJUST BURN TO DEPLETE PROP 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.

- APPROVALS -

PAE MANAGER	: D. F. MIKULA	D F Mikula 08 JUL 98
PRODUCT ASSURANCE ENGR	: L. X. DANG	L X Dang 08 July 98
DESIGN ENGINEERING	: E. VERA	David L Perry for Ed Vera 7-7-98
BOEING SUBSYSTEM MANAGER	: D. PERRY	David L Perry 7-7-98
JSC MOD	: B. LUNNEY	B Lunney 8-4-98