

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE  
 NUMBER: 03-3-1205-X

SUBSYSTEM NAME: ORBITAL MANEUVERING SYSTEM (OMS)  
 REVISION : 2 03/16/90

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
SRU :	COUPLING, TEST POINT LEAR SIEGLER	ME276-0032

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:  
 COUPLING, TEST POINT, HELIUM PRESSURIZATION SYSTEM (MD 401, 402, 407,  
 408, 409, 410, 411, 412, 413, 414, 501, 502, 507, 508, 509, 510, 511,  
 512, 513, 514).

QUANTITY OF LIKE ITEMS: 20  
 TEN PER POD

**FUNCTION:**  
 PROVIDES CONNECTION FOR GROUND CHECK-OUT OF THE PRESSURIZATION  
 SUBSYSTEM COMPONENTS. COUPLINGS FOR UNIT INPUTS & OUTPUTS ARE  
 PROVIDED. THIS INCLUDES COUPLINGS BETWEEN THE CHECK VALVE REDUNDANT  
 STAGES, BETWEEN HELIUM ISOLATION VALVE AND REGULATOR, BETWEEN REGULATOR  
 AND CHECK VALVE, AND BETWEEN THE BURST DISC AND RELIEF VALVE. THE END  
 CAP INSTALLED ON THE AIRBORNE HALF (AHC) PROVIDES REDUNDANCY FOR THE  
 EXTERNAL LEAK AND PROTECTS THE COUPLING WHEN NOT IN USE. THE AHC  
 CONSISTS OF SPRING LOADED POPPET, POPPET SEALS, AND FILTER.

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ITEM NAME: COUPLING, TEST POINT

CRITICALITY OF THIS  
FAILURE MODE:1R3

FAILURE MODE:  
EXTERNAL LEAKAGE (SEAL LEAK)

MISSION PHASE:  
LO LIFT-OFF  
OO ON-ORBIT  
DO DE-ORBIT

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

CAUSE:  
CONTAMINATION, EXCESS OR IMPROPER USE (EXCESS TORQUE, SEAL DAMAGE),  
INADEQUATE MAINTENANCE (OF GSE HALF), NO LINE SUPPORT-SHAFT OR BORE  
BENT.

CRITICALITY I/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN A) FAIL  
B) FAIL  
C) PASS

PASS/FAIL RATIONALE:

- A)
- B)
- C)

- FAILURE EFFECTS -

- (A) SUBSYSTEM:  
LOSS OF REDUNDANCY FOR OVERBOARD LEAKAGE. NO EFFECT UNLESS REDUNDANT  
SEALS FAIL.

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- (B) INTERFACING SUBSYSTEM(S):  
NO EFFECT UNLESS REDUNDANT SEALS FAIL.
- (C) MISSION:  
SAME AS (B)
- (D) CREW, VEHICLE, AND ELEMENT(S):  
SAME AS (B)
- (E) FUNCTIONAL CRITICALITY EFFECTS:  
POTENTIAL LOSS OF CREW/VEHICLE. LOSS OF HELIUM OVERBOARD RESULTS IN INABILITY TO UTILIZE PROPELLANT REQUIRED FOR DE-ORBIT OR MAY RESULT IN INABILITY TO CONTROL VEHICLE DURING ENTRY AND LANDING (WT. & C.G.). POTENTIAL PROPELLANT TANK STRUCTURAL FAILURE AT LANDING DUE TO EXCESSIVE PROPELLANT REMAINING. IR 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.

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- DISPOSITION RATIONALE -  
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**(A) DESIGN:**

FACTORS - PROOF (EACH UNIT), HIGH PRESSURE UNITS 1.5 X MAX OP (7500 PSI), LOW PRESSURE UNITS, 2 X MAX OP (700 PSI). BURST (QUAL) - HIGH PRESSURE, 2 X MAX OP (10,000 PSI), LOW PRESSURE - 4 X MAX OP (1400 PSI). TWO SEALS ON POPPET. COMPLETE STRESS ANALYSIS PERFORMED. GROUND HALF COUPLINGS/LINES SUPPORTED TO LIMIT STRESS ON COUPLINGS AND PREVENT DAMAGE TO SEALS AND WELD JOINTS. CAP MINIMIZES LEAKAGE POTENTIAL (PROVIDES REDUNDANT SEAL).

■ (B) TEST:

QUALIFICATION TEST

(9 UNITS, ALL TESTS NOT PERFORMED ON ALL UNITS). PRIMARY QUALIFICATION METHOD WAS BY SIMILARITY TO APOLLO COUPLINGS - TESTING ADDRESSED SPECIFIC CONCERNS. RANDOM VIBRATION (POPPET OPEN AND CAP ON), ENDURANCE, 400 CYCLES, THERMAL, (+150 DEG F. TO -100 F.), PROPELLANT COMPATIBILITY, BURST. ALSO QUALIFIED AS PART OF POD ASSY. VIBRO-ACOUSTIC TESTING AT JSC, 131 EQUIVALENT MISSIONS. HOT-FIRE TESTS (24 EQUIVALENT MISSION DUTY CYCLES). APPROXIMATELY 7 YEARS PROPELLANT EXPOSURE.

ACCEPTANCE TEST

(EACH UNIT) - PROOF PRESSURE, FUNCTIONAL, CLEANLINESS.

GROUND TURNAROUND

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- V43C80.204 REQUIRES LEAK CHECK EVERY FIFTH FLIGHT AND CONTINGENCY (WHENEVER USED).
- V43C80.210 PERFORMS FIRST FLIGHT AND CONTINGENCY EXTERNAL LEAK CHECKS.
- V43C80.221 PERFORMS EACH FLIGHT PRESSURE DECAY CHECKS OF LOW PRESSURE HELIUM SYSTEM.
- ] V43GEN.110 PERFORMS INSPECTION FOR EACH CAP WHEN REMOVED. HELIUM TANK PRESSURE AND TEMPERATURE MONITORED EACH FLIGHT FOR LEAKAGE.

■ (C) INSPECTION:

RECEIVING INSPECTION

MATERIALS AND PROCESSES CERTIFICATIONS ARE VERIFIED BY INSPECTION.

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.

NONDESTRUCTIVE EVALUATION

EXAMINATION OF LIP SEALS UNDER 14X TO 30X MAGNIFICATION IS VERIFIED BY INSPECTION.

CRITICAL PROCESSES

THE WELDING PROCESS AND VERIFICATION THAT WELDS MEET SPECIFICATION REQUIREMENTS ARE VERIFIED BY INSPECTION.

TESTING

TEST EQUIPMENT AND TOOL CALIBRATION ARE VERIFIED BY INSPECTION. ACCEPTANCE TEST IS VERIFIED BY INSPECTION. VISUAL INSPECTION OF SEALING SURFACE IS PERFORMED IMMEDIATELY PRIOR TO ENGAGEMENT WITH MATING HALF. ENGAGING TORQUE IS VERIFIED BY INSPECTION. WELD SAMPLES ARE TESTED TO VERIFY PROCESS CONTROLS. INSPECTION VERIFIES THAT THE SAMPLES MEET SPECIFICATION REQUIREMENTS. WELDS ARE CHECKED FOR WELD PENETRATION ON A PLAN OF 1 SAMPLE PER 20 WELDS.

HANDLING/PACKAGING

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

■ (D) FAILURE HISTORY:

NO FAILURES RECORDED ON OMS COUPLING INSTALLED ON VEHICLE.

CONTAMINATION INDUCED LEAKAGE FAILURES HAVE OCCURRED ON RCS (REF CAR'S

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AC0519, AB5328, AND AB3434). LEAKAGE WAS RELATIVELY MINOR. CLEANLINESS CONTROLS OF MLO310-032 WERE RE-EMPHASIZED.

CAR AC9143:

FOUR HIGH PRESSURE TPC'S WERE REMOVED FROM OV102 BECAUSE OF LEAKAGE. ANALYSIS IDENTIFIED THE CAUSE OF LEAKAGE TO BE DUE TO POPPET (KYNAR 460) SEAL DEGRADATION. ALTHOUGH KYNAR 460 HAS BEEN RATED ACCEPTABLE FOR UNLIMITED MMH EXPOSURE AT 50 DEGREES F TO 160 DEGREE F, IT APPEARED THERE WAS SOME LONG TERM DEGRADATION. THERMAL ANALYSIS TO DATE HAS NOT PREDICTED THE TEMPERATURE AT THESE COUPLINGS TO EXCEED 150 DEGREE F. CORRECTIVE ACTION - OMRSD CHANGE PROPOSED TO ADD REQUIREMENT TO PERFORM LEAK CHECKS OF ALL TPC'S BACK-UP WIPER/LIP SEALS PERIODICALLY. THIS IS IN ADDITION TO THE EXISTING POPPET LEAK CHECK REQUIREMENT.

CAR AC9986:

THREE TPC'S WERE REMOVED FROM OV102 BECAUSE OF LEAKAGE. ONE COUPLING LEAK WAS DUE TO METALLIC CONTAMINATION, MOST PROBABLY CAUSED BY USE OF FREON IN CLEANING PROCEDURES. ONE LEAKED BECAUSE OF A LARGE PIECE OF ALUMINUM TAPE AND THE OTHER LEAKED BECAUSE OF SMALL METALLIC PARTICLES EMBEDDED IN THE POPPET SEAL. CORRECTIVE ACTION FOR CONTAMINATION WAS IMPLEMENTED AT KSC BY ADHERING TO THE OMRSD PARAGRAPHS SPECIFICALLY DETAILED TO PREVENT METALLIC NITRATE AND PARTICLE CONTAMINATION. ONLY IPA IS USED IN CLEANING MMH COMPONENTS.

CAR AB5360 (DOWNEY):

TPC LEAKED EXCESSIVELY DURING ENDURANCE TESTING. THE CAUSE WAS DUE TO METALLIC PARTICLES EMBEDDED IN THE POPPET SEAL. SINCE NO THREAD DAMAGE WAS OBSERVED, IT WAS CONCLUDED THAT THE CONTAMINATION WAS EXTRANEOUSLY INTRODUCED PRIOR TO BEING INSTALLED IN THE TEST SET-UP. NO CORRECTIVE ACTION WAS TAKEN. PROCEDURES FOR MAINTAINING CLEANLINESS OF OMS/RCS COUPLINGS ARE DELINEATED IN MLO310-032.

(E) OPERATIONAL USE:

NO ACTION FOR FIRST FAILURE (NOT DETECTABLE). FOR DETECTABLE LEAKAGE UPSTREAM OF CHECK VALVES OPERATE TWO ENGINES FROM FAILED POD TO MAXIMIZE GHE AVAILABLE FROM LEAKING POD, TO INCREASE ULLAGE VOLUME, AND MAXIMIZE BLOWDOWN. CYCLE HELIUM ISOLATION VALVES DURING BURN TO LIMIT OVERBOARD LEAKAGE. ULLAGE BLOWDOWN ADEQUATE FOR DEORBIT AFTER OMS-2 FOR TYPICAL MISSIONS (APPROX. 60% ULLAGE REQUIRED FOR MAX BLOWDOWN). PROPELLANT REQUIRED FOR DEORBIT TYPICALLY LESS THAN 30%. FOR DETECTABLE LEAKAGE DOWNSTREAM OF CHECK VALVE USE PERIGEE ADJUST BURN TO DEplete PROPELLANT FROM LEAKING POD AND REDUCE DELTA-V REQUIREMENTS FOR DEORBIT. AFTER LEAKED PROPELLANT HAS DISPERSED, PERFORM DEORBIT BURN WITH GOOD POD.

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- APPROVALS -

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

: ~~J. N. Hart~~ Ocho  
: ~~D. W. Carlson~~  
: ~~D. J. Buttner~~  
: ~~W. F. Rogers~~  
: ~~W. F. Rogers~~  
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