

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE  
 NUMBER: 03-3-2101-X

SUBSYSTEM NAME: ORBITAL MANEUVERING SYSTEM (OMS)

REVISION : 2 03/16/90

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU :	FEED LINES, PROPELLANT MOAC	73A550000

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 PART DATA  
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## EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

FEED LINES, PROPELLANT TANK OUTLET INCLUDING MECHANICAL FITTINGS AND VALVE BODIES. (BI-PROP VALVE, A.C. MOTOR VALVE, AND PROPELLANT COUPLINGS).

## QUANTITY OF LIKE ITEMS:

4 SETS  
 2 SETS PER POD

## FUNCTION:

THE PROPELLANT FEED LINES PROVIDE PROPELLANT FEED TO THE ENGINE INTERFACE AND BETWEEN ENGINE COMPONENTS, AND ALSO PROVIDE PURGE, DRAIN, AND BLEED CAPABILITIES. BOLTED FLANGES WITH REDUNDANT SEALS ARE USED AT THE ENGINE FEED SYSTEM INTERFACES. BOLTED FLANGES WITH DUAL SEALS ARE USED AT THE ENGINE BI-PROP VALVE. DUAL SEAL FITTINGS ARE UTILIZED FOR INSTRUMENTATION. DETAILED LISTING OF LINES - FOR PODS 1 1/2 X .028 304L LINES PROVIDE PROPELLANT FEED FROM THE TANK TO THE OMS ENGINE INTERFACE. 2.0 X .035 21-6-9 CRES LINES PROVIDE PROPELLANT FEED FROM POD FEEDLINE TO CROSSFEED LINE INTERFACE. 1/2 X .020 304L LINES PROVIDE PURGE AND DRAIN CAPABILITY. 1/4 X .020 304L LINES PROVIDE PURGE AND DRAIN CAPABILITY. 1/4 X .020 304L LINES PROVIDE FOR PROPELLANT/GAS BLEED CAPABILITY. FOR ENGINE - 1 1/2 X .025 21-6-9 CRES LINE SUPPLIES OXIDIZER FROM THE ENGINE INLET TO THE ENGINE BI-PROP VALVE. 1 1/2 X .049 21-6-9 CRES LINE SUPPLIES FUEL FROM THE ENGINE INLET TO THE ENGINE BI-PROP VALVE. 1 1/2 X .025 21-6-9 CRES LINES SUPPLY PROPELLANT FROM THE ENGINE BI-PROP VALVE TO THE ENGINE INJECTOR/CHAMBER. 3/16 X .020 3AL-2.5V TITANIUM LINES PROVIDE HIGH-POINT BLEED CAPABILITY. 1/4 X .025 3AL - 2.5V TITANIUM LINES PROVIDE GN2 TO ENGINE FUEL DISCHARGE LINE FOR POST-FIRE PURGE OF RESIDUAL PROPELLANT. 1/4 X .020 304L CRES PRESSURE RELIEF LINE PROVIDES PRESSURE RELIEF BETWEEN ENGINE BI PROP VALVE CAVITY AND UPSTREAM INLET LINE (INCLUDES PRESSURE RELIEF VALVE).



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(B) INTERFACING SUBSYSTEM(S):

DEGRADATION OF INTERFACE FUNCTION - MAY INHIBIT CROSSFEED OPERATIONS, DECREASED DELTA V CAPABILITIES, INABILITY TO USE PROPELLANT IN AFFECTED POD, POSSIBLE CORROSION DAMAGE WITHIN POD.

(C) MISSION:

ABORT DECISION.

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

POSSIBLE CREW/VEHICLE LOSS IF LEAK RESULTS IN EXCESSIVE LOSS OF PROPELLANT OR STRUCTURAL/ TPS DAMAGE. POTENTIAL C.G. OFFSET.

(E) FUNCTIONAL CRITICALITY EFFECTS:

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- DISPOSITION RATIONALE -  
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(A) DESIGN:

THE FACTOR OF SAFETY IS 4.0 FOR LINES OF 1 1/2 IN. DIAMETER OR LESS AND IS 1.5 FOR LINES GREATER THAN 1 1/2 IN. DIAMETER. FACTOR OF SAFETY FOR VALVE BODIES IS 1.5 OR GREATER. AN INTEGRAL RELIEF DEVICE IS USED IN EACH A.C. MOTOR VALVE. THE INSTRUMENTATION INSTALLATION PROCEDURE ASSURES BOTH SEALS ARE EFFECTIVE. THE WELDED CONSTRUCTION ELIMINATES JOINTS AND POSSIBLE LEAK PATHS. THE ANNEALED AREA (DUE TO WELDING) IS BACKED UP BY A SLEEVE. DUAL SEALS ARE UTILIZED AT LINE FLANGE CONNECTIONS AND ON MECHANICALLY ATTACHED VALVE BODIES. GIMBAL AND ALIGNMENT BELLOW FASTENING CLAMPS ALLOW FREEDOM OF MOVEMENT. TUBING BENDS ARE CONTROLLED BETWEEN FIXED POINTS TO FACILITATE INSTALLATION & ACCOMMODATE VEHICLE GROWTH AND MOVEMENT.

■ (B) TEST:

QUALIFICATION TESTS

TUBING CERTIFICATION TESTS PER 50-75-SH-0205 INCLUDED PRESSURE CYCLING AND FATIGUE FOR TYPICAL SHUTTLE LINES, JOINTS, AND CLAMPING METHODS. LINE PRESSURE SURGE TESTING WAS CONDUCTED. ALSO QUALIFIED AS PART OF POD ASSEMBLY - VIBRO ACOUSTIC TESTING AT JSC (131 EQUIVALENT MISSIONS). APPROX 7 YEARS PROP EXPOSURE AT WSTF.

ACCEPTANCE TESTS

ALL WELDS X-RAY INSPECTED. PROOF & LEAK TESTS PERFORMED DURING ACCEPTANCE. LEAKAGE TESTS ARE PERFORMED IN PROCESS FOR TUBING SECTIONS. OPTICAL INSPECTIONS ARE ALSO PERFORMED AT THIS TIME.

GROUND TURNAROUND

V43C80.140 (ACVM RELIEF DEVICE C/O) VERIFIES PROPER FUNCTION OF RELIEF DEVICES AT 10 FLIGHT INTERVALS.

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- V43C80.210 PERFORMS FIRST FLIGHT EXTERNAL LEAK CHECKS.
- V43C80.213 PERFORMS MECHANICAL JOINT LEAKAGE CHECK EVERY 5TH FLIGHT.
- V43C80.215 PERFORMS PERIODIC LEAK CHECK OF FLANGE EVERY 5TH FLIGHT.
- V43C80.230,240 TOXIC VAPOR LEAK CHECK OF PROP TANK FEED SYSTEM FIRST FLIGHT AND CONTINGENCY.
- V43C80.275 PERFORMS 5-FLIGHT INTERVAL PRESSURE DECAY CHECK OF PROPELLANT FEED SYSTEM DOWNSTREAM OF BI-PROP VALVE (FEEDLINES DRAINED, BI-PROP VALVE CAVITY CHECKED).
- V43CE0.030 PERFORMS DETAILED INSPECTION OF POD FLUID SYSTEM EVERY 5TH FLIGHT.
- V43CE0.120 REQUIRES SAMPLING OF STATIC AIR IN VARIOUS POD INTERNAL COMPARTMENTS FOR DETECTION OF MINOR PROPELLANT LEAKAGE EVERY FLIGHT. PROPELLANT TANK PRESSURE AND TEMPERATURE MONITORED EACH FLIGHT FOR EVIDENCE OF LEAKAGE.

WHEN POD IS INSTALLED ON ORBITER POD PURGE REQUIREMENTS ARE DEFINED IN V05AGO.010 (OLF), V05AGO.020 (OPF), V05AGO.030 (VAB), AND V05AGO.040 (PAD).

**(C) INSPECTION:****RECEIVING INSPECTION**

MATERIALS AND PROCESSES CERTIFICATIONS ARE VERIFIED BY INSPECTION. RECORDS AND TEST REPORTS CERTIFYING MATERIALS AND PHYSICAL PROPERTIES ARE VERIFIED BY INSPECTION.

**CONTAMINATION CONTROL**

CLEANLINESS TO LEVEL 200 FOR MMH AND 200A FOR NTO 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, DIMENSIONAL AND VISUAL INSPECTIONS ARE PERFORMED DURING FABRICATION AND ASSEMBLY.

**NONDESTRUCTIVE EVALUATION**

RADIOGRAPHIC INSPECTION OF WELDS IS VERIFIED BY INSPECTION.

**CRITICAL PROCESSES**

THE WELDS 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.

**HANDLING/PACKAGING**

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

(D) FAILURE HISTORY:

SIX CASES TO DATE OF PROPELLANT VAPOR PERMEATION AT OME OXIDIZER BI-PROP VALVE FLANGES. (REFERENCE CAR A01622 AND 1698 FOR MOST RECENT OCCURRENCES OF THIS TYPE OF CONDITION). LEAKAGE WAS RELATIVELY MINOR (SEAL PERMEATION). FLANGE SEALS TYPICALLY MEET HELIUM LEAK RATE REQUIREMENTS. THIS CONDITION IS A LONG TERM PERMEATION EFFECT. PROPELLANT RESIDUE WAS NOTED ON ADJACENT COMPONENTS. THE EFFECTS OF THIS TYPE OF CONDITION HAVE BEEN LIMITED BY THE GROUND TURKAROUND PROCEDURES WHICH REQUIRE CONTINUOUS INTERNAL POD PURGE AND SAMPLING OF THE STATIC AIR IN THE VARIOUS POD INTERNAL COMPARTMENTS. THE AREA BETWEEN THE REDUNDANT FLANGE SEALS IS ALSO PURGED IF THERE IS EVIDENCE OF PROPELLANT. MCR 11439RI WAS APPROVED FOR AEROJET STUDY OF ALTERNATE SEAL CONFIGURATIONS. THIS TEST PROGRAM IS IN PROGRESS. REDESIGN WILL BE PURSUED WITH FIRST EFFECTIVITY ON OV-105 AND RETROFIT ON AN ATTRITION BASIS.

(E) OPERATIONAL USE:

USE PERIGEE ADJUST BURN TO DEplete PROPELLANT FROM LEAKING POD (OUT OF LANE COMPONENT IF NECESSARY) AND REDUCE DELTA V ROMTS FOR DEORBIT. AFTER LEAKED PROPELLANT HAS DISPERSED, PERFORM DEORBIT BURN WITH GOOD POD. CREW PROCEDURES ARE IN PLACE THAT REQUIRE SEQUENCING OF VALVES IN A MANNER TO PRECLUDE ANY EXCESSIVE PRESSURE SURGE.

POST FLIGHT PROCEDURES REQUIRE INSPECTION FOR LEAKS PRIOR TO CREW EGRESS. POST FLIGHT SAFING OPERATIONS ARE AVAILABLE FOR ANY LEAKAGE OR OTHER HAZARDOUS CONDITIONS INCLUDING POD PURGE.

- APPROVALS -

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