FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE
NUMBER: 03-3-2102-X

SUBSYSTEM NAME: ORBITAL MANEUVERING SYSTEM (OMS)
REVISION : 2 04/10/90

		PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	:	FEED LINE, PROP X-FEED (OV102) MDAC	V070-435011
LRU	:	FEEDLINE, X-FEED (103 & SUBS) MDAC	V070-435021

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
FEED LINE, PROPELLANT CROSS-FEED (INCLUDING MECHANICAL FITTINGS).

QUANTITY OF LIKE ITEMS:
2 SETS

FUNCTION:
CROSSOVER LINES PROVIDE FOR OMS AND RCS PROPELLANT FEED BETWEEN THE PODS. A MACHINED FLANGE (V070-435047-001, 002, 003, 004) WELDED TO THE CROSSFEED LINE IS USED TO EFFECT CONNECTION BETWEEN VEHICLE AND POD. THE FLANGE MATES AT THE INTERFACE BY USE OF SIX RD 111-4009-0410 1/4 IN BOLTS ATTACHED AT THE POD BY NUT PLATES. THE FLANGED CONNECTION UTILIZES REDUNDANT SEALS (FLUOROCARBON PN RF00631-2 & -4). MATING ADJUSTMENT IS PROVIDED BY USE OF THREE GIMBAL JOINTS FOR OV-103 AND OV-104. MATING ADJUSTMENT FOR OV-102 IS PROVIDED BY A FLEX HOSE ASSEMBLY. CROSSFEED PROPELLANT LINE DESCRIPTION - OV-102, 21-6-9SS LINES 2.0 X .035 (POD) AND 2.5 X .035 (ORBITER). A MACHINED FLANGE WITH REDUNDANT SEALS IS USED TO EFFECT CONNECTION BETWEEN POD AND VEHICLE. MATING ADJUSTMENT IS PROVIDED BY A FLEX HOSE ASSEMBLY. OV-103 104, 21-6-9 SS LINES 2.0 X .035 (POD) AND 1.5 X 028 (ORBITER). A MACHINED FLANGE WITH REDUNDANT SEALS IS USED TO EFFECT CONNECTION BETWEEN POD AND VEHICLE. MATING ADJUSTMENT IS PROVIDED BY 3 GIMBAL JOINTS IN EACH LINE. DUAL SEAL FITTINGS ARE UTILIZED FOR INSTRUMENTATION.

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NUMBER: 03-3-2102-01

REVISION# 2 04/10/90

SUBSYSTEM: ORBITAL MANEUVERING SYSTEM (OMS)
LRU :FEED LINE, PROP X-FEED (OV102)
ITEM NAME: FEEDLINE, X-FEED (103 & SUBS)

CRITICALITY OF THIS FAILURE MODE:1/1

FAILURE MODE:
STRUCTURAL FAILURE, RUPTURE, EXTERNAL 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:
MATERIAL DEFICIENCY (SULPHIDE STRINGER), WELD DEFECT/CRACK, STRESS CORROSION, TEST/FAB/INSTALLATION DAMAGE, VIBRATION, MECHANICAL SHOCK, EXCESSIVE PRESSURE SURGE. FAILED CLOSE OF A.C. MOTOR VALVE RELIEF DEVICE.

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN A) N/A
B) N/A
C) N/A

PASS/FAIL RATIONALE:
A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
SUBSYSTEM DEGRADATION - LOSS OF PROPELLANT DURING INTERCONNECT OR CROSSFEED OPERATIONS.

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(B) INTERFACING SUBSYSTEM(S):
INABILITY TO USE CROSSFEED LINE (REQUIRED FOR ABORT DUMP), ALSO REQUIRED FOR REACTION TO OME FAILURES. CORROSION DAMAGE IN POD/ORBITER AFT COMPARTMENT. INABILITY TO INTERCONNECT TO RCS.

(C) MISSION:
ABORT DECISION.

(D) CREW, VEHICLE, AND ELEMENT(S):
POSSIBLE LOSS OF CREW/VEHICLE IF LEAK RESULTS IN EXCESSIVE PROPELLANT LOSS OR DAMAGE TO TPS/STRUCTURE.

(E) FUNCTIONAL CRITICALITY EFFECTS:

- DISPOSITION RATIONALE -

(A) DESIGN:
FACTOR OF SAFETY IS 1.5 X MAXIMUM OPERATING (SURGE) PRESSURE - 900 PSI (1 1/2"), 700 PSI (2 1/2" AND 1/4"). WELDED CONSTRUCTION ELIMINATES JOINTS & LEAK PATHS. ANNEALED AREA DUE TO WELDING BACKED UP BY SLEEVES. FASTENING CLAMPS ALLOW FREEDOM OF MOVEMENT. TUBING BENDS ARE CONTROLLED BETWEEN FIXED POINTS TO FACILITATE INSTALLATION & ACCOMMODATE VEHICLE GROWTH & MOVEMENT. INSTALLATION STRESS ANALYSIS PERFORMED. DUAL HEATER CIRCUITS AND INSULATED LINES MAINTAIN LINE TEMPERATURE WITHIN ACCEPTABLE LIMITS.

■ (B) TEST:
QUALIFICATION TEST
TUBING CERTIFICATION TESTS PERFORMED PER SD-H-0205 INCLUDED PRESSURE CYCLING AND FATIGUE FOR TYPICAL SHUTTLE LINES AND JOINTS. LINE PRESSURE SURGE TESTING WAS CONDUCTED. POD PORTION OF CROSSFEED LINES TESTED AS PART OF POD ASSEMBLY VIBRO ACOUSTIC TESTING AT JSC (131 EQUIVALENT MISSIONS). APPROX 7 YEARS PROPELLANT EXPOSURE AT WSTF. SIMULATED CROSSFEED LINE INCLUDED AS PART OF WSTF TEST ARTICLE FOR DEFINITION OF PRESSURE SURGE & TEMPERATURE EFFECTS.

ACCEPTANCE TEST
ALL WELDS X-RAY INSPECTED. PROOF AND LEAK TESTS PERFORMED DURING ACCEPTANCE.

GROUND TURNAROUND
V42BB0.130 PERFORMS FUNCTIONAL TEST OF RCS INTERCONNECT VALVE RELIEF DEVICE AT TEN FLIGHT INTERVALS.
V42BE0.130 REQUIRES CONTINUOUS INTERNAL POD PURGE TO LIMIT CORROSION FROM MINOR PROPELLANT LEAKAGE WHEN POD IS OFF ORBITER.

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V43CB0.160 PERFORMS FUNCTIONAL TEST OF CROSSFEED VALVE RELIEF DEVICE ON CONTINGENCY.
V43CB0.210 PERFORMS FIRST FLIGHT EXTERNAL LEAK CHECKS.
V43CB0.215 PERFORMS PERIODIC LEAK CHECK OF FLANGE SEALS EVERY FIFTH FLIGHT.
V43CB0.260 TOXIC VAPOR LEAK CHECK OF CROSSFEED LINE FIRST FLIGHT AND CONTINGENCY.
V43CE0.120 PERFORMS STATIC AIR SAMPLE OF POD THE SECOND FLIGHT AND EVERY FLIGHT THEREFORE.

WHEN POD IS INSTALLED ON ORBITER POD PURGE REQUIREMENTS ARE DEFINED IN V05AG0.010 (OLF), V05AG0.020 (OPF), V05AG0.030(VAB), AND V05AG0.040 (PAD).

MONITORING OF LINE PRESSURES IN FLIGHT FOR EVIDENCE OF LEAKAGE WILL BE POSSIBLE WHEN PRESSURE TRANSDUCER INSTALLATION IN CROSSFEED LINE (MCR 11110) IS ACCOMPLISHED.

(C) INSPECTION:
RECEIVING INSPECTION
MATERIALS AND PROCESSES CERTIFICATIONS AND MECHANICAL PROPERTIES OF MATERIALS 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
HANDLING, PACKAGING, STORAGE AND SHIPPING REQUIREMENTS ARE VERIFIED BY INSPECTION.

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(D) FAILURE HISTORY:
CAR AD0513 RECORDED A WELD LEAK DETECTED AT KSC ON THE OV-102 RH OMS FUEL CROSSFEED LINE THAT HAD BEEN WELDED AT PALMDALE DURING THE OV-102 AA MCD. THE FAILURE WAS ATTRIBUTED TO WORKMANSHIP AND IS UNIQUE TO OV-102. THE DEFECTIVE WELDS WERE CUT OUT AND REWELDED. ALL PALMDALE WELD X-RAYS WERE REVIEWED. ONE ADDITIONAL DEFECTIVE WELD WAS REPAIRED AND X-RAY ACCEPTED.

(E) OPERATIONAL USE:
PROCEDURE IN PLACE FOR VERIFICATION OF CROSSFEED LINE PRESSURE PRIOR TO PERFORMING INTERCONNECT OR NON-CRITICAL CROSSFEED OPERATION TO AVOID POTENTIALLY DAMAGING PRESSURE SURGES. EVIDENCE OF LEAKAGE WOULD RESULT IN ISOLATION OF CROSSFEED LINE AND NEXT PLS ENTRY.

- APPROVALS -

RELIABILITY ENGINEERING	J. N. HART	
DESIGN ENGINEERING	D. W. CARLSON	
QUALITY ENGINEERING	O. J. BUTTNER	4/12/90
NASA RELIABILITY		
NASA SUBSYSTEM MANAGER		5-25-90
NASA QUALITY ASSURANCE		