

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE

NUMBER: 03-3-2602-X

SUBSYSTEM NAME: ORBITAL MANEUVERING SYSTEM (OMS)

REVISION : 2 03/16/90

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU :	ALIGNMENT BELLOWS, FLEX JOINT METAL BELLOWS	73P550003-1003

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
ALIGNMENT BELLOWS, FLEX JOINT, PROPELLANT

QUANTITY OF LIKE ITEMS: 2

FUNCTION:
A DUAL PLY (.008 IN. THICK) 304L BELLOWS EXTERNALLY CONSTRAINED BY AN INCONEL X 750 HOUSING WITH A MONOBALL END THAT IS FREE TO ROTATE IS USED AT THE ENGINE INTERFACE (FUEL SIDE) IN THE OMS TO FACILITATE SYSTEM ASSEMBLY AND AFFORD FLEXIBILITY. SIMILAR APPLICATIONS ARE COVERED ON FMEA 03-3-2601-1.

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
 NUMBER: 03-3-2602-01

SUBSYSTEM: ORBITAL MANEUVERING SYSTEM (OMS) REVISION# 2 03/16/90
 LRU :ALIGNMENT BELLOW, FLEX JOINT
 ITEM NAME: ALIGNMENT BELLOW, FLEX JOINT 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:

WELD DEFECT, CORROSION, PROPELLANT BY-PRODUCT EXPOSURE, INSTALLATION DAMAGE, PRESSURE SURGE, FLOW INDUCED OR FLIGHT VIBRATION, FAILED CLOSED 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:
 LOSS OR SUBSYSTEM DEGRADATION, LOSS OF PROPELLANT OR PRESSURANT.

(B) INTERFACING SUBSYSTEM(S):
 DEGRADATION OF INTERFACE SUBSYSTEM - DECREASED DELTA V CAPABILITY,

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INABILITY TO USE PROPELLANT IN AFFECTED POD. POTENTIAL C.G. OFFSET.
AFT RCS, OMS ENGINE, VEHICLE STRUCTURE OR CORROSION DAMAGE.

(C) MISSION:
ABORT DECISION.

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

(E) FUNCTIONAL CRITICALITY EFFECTS:

- DISPOSITION RATIONALE -

■ (A) DESIGN:

FACTOR OF SAFETY IS 1.5. MULTIPLE-PLY BELLOWS ARE USED. ONE PLY IS
ADEQUATE FOR PRESSURE LOAD. PROPELLANT COMPATIBLE MATERIALS ARE USED.
FLOW INDUCED VIBRATION AND STRESS ANALYSES PERFORMED. MECHANICAL STOPS
LIMIT EXCESSIVE ANGULATION.

■ (B) TEST:

QUALIFICATION TESTS

THERMAL CYCLES (-65 TO +190 DEG F). RANDOM VIBRATION, OPERATING LIFE
(SURGE PRESSURES, FLOW CYCLES, ANGULATION CYCLES), BURST (1140 PSI).
ALSO QUALIFIED AS PART OF POD ASSY, VIBRO-ACOUSTIC TESTING AT JSC, (131
EQUIVALENT MISSIONS), HOT-FIRE TEST PROGRAM AT WSTF - 617 TESTS (LINE
PRESSURE SURGE TESTING 24 EQUIVALENT MISSIONS). APPROX. 7 YEARS
PROPELLANT EXPOSURE AT WSTF.

ACCEPTANCE TESTS

EXAMINATION OF PRODUCT, WELD INSPECTIONS, PROOF PRESSURE, LEAKAGE,
FUNCTIONAL TESTS, AND CLEANLINESS.

GROUND TURNAROUND

V43CBO.140 PERFORMS TANK ISOLATION VALVE RELIEF DEVICE CHECKOUT EVERY
10 FLIGHTS.

V43CBO.210 PERFORMS FIRST FLIGHT EXTERNAL LEAK CHECKS.

V43CBO.230 AND .240 TOXIC VAPOR LEAK CHECK OF PROP TANK AND PROP FEED
SYSTEM FIRST FLIGHT AND CONTINGENCY.

V43CEO.030 PERFORMS DETAILED EXTERNAL AND VISIBLE INTERNAL INSPECTION
OF FLUID SYSTEM EVERY 5TH FLIGHT.

V43CEO.120 REQUIRES PERIODIC SAMPLING OF STATIC AIR IN VARIOUS POD
INTERNAL COMPARTMENTS FOR DETECTION OF MINOR PROPELLANT
LEAKAGE.

PROPELLANT TANK PRESSURE AND TEMPERATURE MONITORED EACH FLIGHT FOR

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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.

CONTAMINATION CONTROL

CLEANLINESS TO LEVEL 200 FOR MMH, 200A FOR NTD, 100A FOR PNEUMATIC COMPONENTS, 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 INSPECTION THROUGHOUT FABRICATION AND ASSEMBLY IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

INSPECTION VERIFIES STRUCTURAL WELDS ARE RADIOGRAPHIC, PENETRANT AND VISUAL INSPECTED. INSPECTION VERIFIES NON-STRUCTURAL WELDS ARE PENETRANT AND VISUALLY INSPECTED. INSPECTION VERIFIES TACK WELDS ARE VISUALLY INSPECTED

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.

HANDLING/PACKAGING

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

■ (D) FAILURE HISTORY:

NO FAILURES HAVE BEEN RECORDED FOR BELLOWS USED IN THE OMS SYSTEM. HOWEVER, EARLY IN THE PROGRAM, SEVERAL FAILURES DID OCCUR ON SIMILAR COMPONENTS USED IN THE RCS.

CAR A9809 & A85865 RECORD INSTANCES WHEREIN THE BELLOWS WERE TWISTED DURING INSTALLATION. CORRECTIVE ACTION INCLUDED REQUIREMENTS FOR X-RAY OF UNITS AFTER INSTALLATION AND DESIGN CHANGES REQUIRING USE OF

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LUBRICANT ON INNER SHOULDER OF DYNATUBE AND THE ADDITION OF DOUBLE
WRENCH FLATS TO CONTROL OVERTORQUING. (103 & SUBS).

(E) OPERATIONAL USE:

USE PERIGEE ADJUST BURN TO DEplete PROPELLANT FROM LEAKING POD (OUT OF
PLANE COMPONENT IF NECESSARY) AND REDUCE DELTA V REQUIREMENT FOR
DEORBIT. AFTER LEAKED PROPELLANT HAS DISPERSED, PERFORM DEORBIT WITH
GOOD POD.

- APPROVALS -

RELIABILITY ENGINEERING:	J. N. HART	:	<i>J. N. Hart</i>
DESIGN ENGINEERING	: D. W. CARLSON	:	<i>D. W. Carlson</i>
QUALITY ENGINEERING	: O. J. BUTTNER	:	<i>O. J. Buttner</i>
NASA RELIABILITY	:	:	<i>[Signature]</i>
NASA SUBSYSTEM MANAGER	:	:	<i>[Signature]</i>
NASA QUALITY ASSURANCE	:	:	<i>[Signature]</i>