

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE

NUMBER: 03-3-2601-X

SUBSYSTEM NAME: ORBITAL MANEUVERING SYSTEM (OMS)

REVISION : 2 03/16/90

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU :	GIMBAL BELLOWS SSP	73P550015-1002
LRU :	GIMBAL BELLOWS SSP	73P550015-1003
LRU :	GIMBAL BELLOWS SSP	73P550015-1005
LRU :	GIMBAL BELLOWS SSP	73P550015-1007

PART DATA

QUANTITY OF LIKE ITEMS: 32

FUNCTION:

DUAL PLY (.006, .007 OR .008 IN. THICK PER PLY) 304L S.S. BELLOWS EXTERNALLY CONSTRAINED BY A GIMBALLED INCONEL X 750 HOUSING IS USED AT VARIOUS LOCATIONS IN THE OMS GAS AND LIQUID FEED SYSTEMS TO FACILITATE SYSTEM ASSEMBLY AND AFFORD FLEXIBILITY.

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SUBSYSTEM: ORBITAL MANEUVERING SYSTEM (OMS) REVISION# 2 03/16/90
LRU :GIMBAL BELLWS CRITICALITY OF THIS
ITEM NAME: GIMBAL BELLWS 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:
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 LOSS OF
PROPELLANT OR PRESSURANT OR RESULTS IN STRUCTURAL/TPS DAMAGE.

(E) FUNCTIONAL CRITICALITY EFFECTS:

- DISPOSITION RATIONALE -

(A) DESIGN:
A SINGLE BELLOWS PLY IS ADEQUATE FOR THE PRESSURE LOAD. PROPELLANT
COMPATIBLE MATERIALS ARE USED. MECHANICAL STOPS LIMIT EXCESSIVE
ANGULATION. FACTOR OF SAFETY IS 1.5. FLOW INDUCED VIBRATION ANALYSIS
PERFORMED, FLOW-INDUCED OSCILLATION TESTING CONDUCTED, BELLOWS NOT
EXCITED THROUGHOUT FLOW RANGE. COMPLETE STRESS ANALYSIS.

- (B) TEST:
QUALIFICATION TESTS
(ONE UNIT FOR EACH SIZE USED) - THERMAL (-70 TO +190 DEG F), VIBRATION
UNDER SIMULATED MISSION USAGE CONDITIONS OPERATING LIFE - 2000
ANGULATION CYCLES (3 UNITS), 50,000 PRESSURE CYCLES, FLOW-INDUCED
OSCILLATION (-1007 ONLY). BURST (ACTUAL) -1002/3 - 4.4 X MAX
OPERATING PRESSURE, -1005 - 14.7 X MAX OPERATING PRESSURE, -1007 - 5.9
X MAX OPERATING PRESSURE. ALSO QUALIFIED AS PART OF POD ASSEMBLY -
VIBRO-ACOUSTIC TESTING AT JSC, 131 EQUIVALENT MISSIONS. HOT-FIRE TEST
PROGRAM AT WSTF - 517 TESTS (24 EQUIVALENT MISSIONS). APPROX 7 YEARS
PROPELLANT EXPOSURE.

ACCEPTANCE TESTS
EXAMINATION OF PRODUCT, WELD INSPECTIONS. PROOF PRESSURE, -1002/3 -
1.5 X MAX OP, -1005 - 2.0 X MAX OP, -1007 - 2.6 X MAX OP. PRESSURE
DROP, FUNCTIONAL AND LEAKAGE TESTS, 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 & 240 TOXIC VAPOR LEAK CHECK OF PROP TANKS AND FEED SYSTEM
ON FIRST FLIGHT AND CONTINGENCY BASIS.
V43CEO.030 PERFORMS DETAILED EXTERNAL AND VISIBLE INTERNAL INSPECTION
OF FLUID SYSTEM, EFFECTIVITY IS WHENEVER POD IS REMOVED, NOT

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TO EXCEED 5 FLIGHT INTERVAL.

V43CE0.120 PERFORMS STATIC AIR SAMPLE OF POD FOR DETECTION OF MINOR PROPELLANT LEAKAGE THE SECOND FLIGHT AND EVERY FLIGHT THEREAFTER.

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)

PROPELLANT TANK PRESSURE AND TEMPERATURE MONITORED EACH FLIGHT FOR EVIDENCE OF LEAKAGE.

(C) INSPECTION:

RECEIVING INSPECTION

MATERIALS AND PROCESSES CERTIFICATIONS ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

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

NONDESTRUCTIVE EVALUATION

PENETRANT AND RADIOGRAPHIC INSPECTION OF WELDS ARE 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.

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 AFT RCS. CAR A9808 & AB5865 RECORD INSTANCES

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WHERE IN THE BELLOWS WAS TWISTED DURING INSTALLATION. CORRECTIVE ACTION INCLUDED X-RAY REQMT'S OF UNITS AFTER INSTALLATION AND DESIGN CHANGES REQUIRING USE OF LUBRICANT ON INNER SHOULDER OF DYNATUBE & 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
DESIGN ENGINEERING : D. W. CARLSON
QUALITY ENGINEERING : O. J. BUTTNER
NASA RELIABILITY :
NASA SUBSYSTEM MANAGER :
NASA QUALITY ASSURANCE :

: J. N. Hart
: D. W. Carlson
: O. J. Buttner 4/12/90
: Samuel G. ... 5-25-90
: ...