

PAGE: 1

PRINT DATE: 04/10/90

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE
NUMBER: 03-3-4601-X

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

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU :	FLEX JOINT, PROPELLANT LINE AEROJET/RESISTO FLEX	1186408 SAME

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
FLEX JOINT, PROPELLANT LINE, ENGINE GIMBAL CONNECTOR.

QUANTITY OF LIKE ITEMS: 12
3 FUEL AND 3 OXYGEN FOR EACH INLET LINE/PER POD

FUNCTION:
A FOUR-PLY STAINLESS STEEL BALL-STRUT TYPE-INTERNALLY CONSTRAINED BELLOWS IS PROVIDED TO ACCOMMODATE ENGINE MOVEMENT ASSOCIATED WITH GIMBALLING FOR THRUST VECTOR CONTROL. UNIT IS LOCATED UPSTREAM OF BI-PROP VALVE. CONVOLUTES ARE CRES 321 AND THE STRUT IS INCONEL 718.

PAGE: 2

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LRU :FLEX JOINT, PROPELLANT LINE CRITICALITY OF THIS
ITEM NAME: FLEX JOINT, PROPELLANT LINE FAILURE MODE:1/1

FAILURE MODE:
STRUCTURE 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:

EXCESS GIMBALLING TORQUE DUE TO GALLING, WELD DEFECT, CORROSION,
PROPELLANT BY-PRODUCT EXPOSURE, INSTALLATION DAMAGE, PRESSURE SURGE,
FLOW INDUCED OR FLIGHT VIBRATION.

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. PROPELLANT LOSS MAY PROHIBIT DEORBIT.

(B) INTERFACING SUBSYSTEM(S):

DEGRADATION OF INTERFACE SUBSYSTEM - DECREASED DELTA V CAPABILITY,

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

(C) MISSION:

POSSIBLE EARLY MISSION TERMINATION. ABORT DECISION.

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

POSSIBLE LOSS OF CREW/VEHICLE IF LEAK RESULTS IN EXCESSIVE C. G.
OFFSET, LOSS OF PROPELLANT OR FIRE WITHIN POD.

(E) FUNCTIONAL CRITICALITY EFFECTS:

NONE

- DISPOSITION RATIONALE -

(A) DESIGN:

PROPELLANT COMPATIBLE MATERIALS ARE USED. FACTOR OF SAFETY IS 1.5.
MULTI-PLY BELLOWS WITH INTERNAL CONSTRAINT ARE UTILIZED. FLOW INDUCED
VIBRATION AND STRESS ANALYSIS WERE CONDUCTED TO VERIFY ACCEPTABLE
DESIGN. PROTECTIVE COVERS ARE INSTALLED OVER BELLOWS DURING ENGINE
INSTALLATION OR WHENEVER AREA IS OPEN FOR MAINTENANCE.

■ (B) TEST:

QUALIFICATION TESTS

RANDOM VIBRATION AT ENGINE LEVEL, ENDURANCE PRESSURE CYCLING (2400
CYCLES), ENDURANCE GIMBALLING CYCLES (90,000 CYCLES), BURST (825
PSI). BELLOWS WELDS ARE RADIOGRAPHICALLY AND DYE PENETRANT INSPECTED
FOLLOWING INSTALLATION. LINE ASSEMBLY INCLUDING BELLOWS IS SUBJECTED
TO PROOF PRESSURE & LEAK TEST. USED ON ENGINE AND POD QUAL TEST
ARTICLES. ENGINE QUAL PROGRAM - 138 FIRINGS AT ENGINE LEVEL. POD QUAL
- 517 FIRINGS AT POD LEVEL.

ACCEPTANCE TESTS

ATP TESTS INCLUDE EXAMINATION OF PRODUCT, WELD INSPECTION, PROOF
PRESSURE, LEAKAGE, PRESSURE DROP, AND FUNCTIONAL TESTS.

GROUND TURNAROUND

V42BE0.130 REQUIRES CONTINUOUS INTERNAL POD PURGE TO LIMIT CORROSION
FROM MINOR PROPELLANT LEAKAGE.

V43CBO.210 PERFORMS FIRST FLIGHT LEAK CHECKS.

V43CBO.240 TOXIC VAPOR LEAK OF PROP. FEED SYSTEM 1ST FLIGHT AND
CONTINGENCY.

V43CEO.030 PERFORMS DETAILED VISUAL INSPECTION OF FLUID SYSTEM,
EFFECTIVITY WHENEVER POD IS REMOVED, NOT TO EXCEED 5 FLIGHT
INTERVAL.

V43CEO.120 REQUIRES SAMPLING OF STATIC AIR IN VARIOUS POD INTERNAL

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
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COMPARTMENTS 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 ARE MONITORED EACH FLIGHT FOR
EVIDENCE OF LEAKAGE.

(C) INSPECTION:

RECEIVING INSPECTION
MATERIALS AND PROCESSES CERTIFICATIONS ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL
CONNECTOR IS CLEANED TO ALRC SPECIFICATION. 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. VISUAL AND DIMENSIONAL INSPECTION OF COMPLETED ASSEMBLY IS
VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
PENETRANT AND RADIOGRAPHIC INSPECTION OF WELDS ARE VERIFIED BY
INSPECTION. RADIOGRAPHIC INSPECTION OF CONCENTRIC WELDED SLEEVES 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:
NONE.

(E) OPERATIONAL USE:
USE PERIGEE ADJUST BURN TO DEplete PROPELLANT FROM LEAKING POD (OUT OF

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PLANE COMPONENT IF NECESSARY) AND REDUCE DELTA V REQUIREMENT FOR DEORBIT. AFTER LEAKED PROPELLANT HAS DISPERSED, PERFORM DEORBIT BURN WITH GOOD POO. (LEAKAGE IS ISOLATABLE BY USE OF TANK ISOLATION VALVES).

- APPROVALS -

RELIABILITY ENGINEERING:	J. N. HART	:	<u>[Signature]</u>
DESIGN ENGINEERING	: V. F. ROZDOS	:	<u>[Signature]</u>
QUALITY ENGINEERING	: O. J. BUTTNER	:	<u>[Signature]</u> 4/2/90
NASA RELIABILITY	:	:	<u>[Signature]</u>
NASA SUBSYSTEM MANAGER	:	:	<u>[Signature]</u>
NASA QUALITY ASSURANCE	:	:	<u>[Signature]</u>