

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE

NUMBER: 03-3-2002-X

SUBSYSTEM NAME: ORBITAL MANEUVERING SYSTEM (OMS)

REVISION : 2 03/16/90

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU 01	TANK, PROPELLANT STORAGE, OX. MDAC/AMCO	73P550013
LRU 02	TANK, PROPELLANT STORAGE, FUEL MDAC/AMCO	73A740000

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

TANK, OMS PROPELLANT STORAGE, MMH, N2O4, MONOLITHIC TITANIUM (6AL4V).

QUANTITY OF LIKE ITEMS: 4

TWO PER POD

FUNCTION:

STORES PROPELLANT AT AN ULLAGE PRESSURE OF 250-313 PSI. REGULATED HELIUM IS SUPPLIED TO THE ULLAGE TO FORCE PROPELLANT TO THE OMS ENGINE OR RCS ENGINE AS REQUIRED. THE TANK ALSO HOUSES ZERO G PROPELLANT ACQUISITION, RETENTION & SCREEN DEVICES IN ADDITION TO PROPELLANT GAUGING DEVICES. THE TANK IS A CYLINDER WITH ELLIPTICAL DOMES AND IS 49 INCHES IN DIAMETER WITH A VOLUME OF 90 FT³. SIX DOORS ARE PROVIDED IN THE TANK FOR ACCESS AND FEEDTHROUGH.

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
NUMBER: 03-3-2002-02

SUBSYSTEM: ORBITAL MANEUVERING SYSTEM (OMS) REVISION# 2 03/16/90
LRUTANK, PROPELLANT STORAGE, FUEL
ITEM NAME: TANK, PROPELLANT STORAGE, OX. CRITICALITY OF THIS FAILURE MODE:1R2

FAILURE MODE:
EXTERNAL LEAKAGE (FLANGE SEAL 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:
DAMAGE TO ACCESS DOOR OR SEAL LANDS, MATERIAL DEFICIENCY OR INCORRECT SEAL, SHOCK, VIBRATION, PROPELLANT EXPOSURE, LONG TERM MOLECULAR TYPE LEAKAGE (SEAL PERMEATION).

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN A) PASS
B) FAIL
C) PASS

PASS/FAIL RATIONALE:

- A)
- B)
- C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
NO EFFECT UNLESS REDUNDANT SEALS LEAK.

(B) INTERFACING SUBSYSTEM(S):
NO EFFECT - POSSIBLE CORROSION/MATERIAL DAMAGE TO ADJACENT

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STRUCTURE/TPS/ELECTRICAL INSULATION/EPOXY MATERIALS IF REDUNDANT SEALS LEAK.

(C) MISSION:

NO EFFECT - LEAKAGE OF REDUNDANT SEALS WOULD RESULT IN LAUNCH DELAY.

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

NO EFFECT UNLESS REDUNDANT SEALS FAIL.

(E) FUNCTIONAL CRITICALITY EFFECTS:

POSSIBLE CREW/VEHICLE LOSS IF LEAK RESULTS IN EXCESSIVE LOSS OF PROPELLANT OR PRESSURANT. 1R EFFECT REQUIRES FAILURE OF REDUNDANT SEALS. NO INSTRUMENTATION AVAILABLE FOR DETECTION OF FIRST FAILURE IN FLIGHT.

- DISPOSITION RATIONALE -

(A) DESIGN:

THE FACTOR OF SAFETY (BURST) IS 1.5 X WORKING PRESSURE. COMPLETE STRESS ANALYSIS FOR EACH TANK SEGMENT WAS PERFORMED. PROPELLANT COMPATIBLE MATERIALS ARE UTILIZED. TANK IS CLASSIFIED AS FRACTURE CRITICAL FOR HANDLING & IS SUBJECT TO FRACTURE CONTROL REQUIREMENTS. ALL FITTINGS AND ACCESS DOORS USED ON THE TANK HAVE REDUNDANT STATIC AND SPRING LOADED SEALS. DOOR SEALS ARE VERIFIABLE.

■ (B) TEST:

QUALIFICATION TESTS

600 PRESSURE CYCLES, 90-DAY CREEP AND PROPELLANT EXPOSURE TEST, RANDOM VIBRATION. ALSO QUALIFIED AS PART OF POD ASSEMBLY. VIBRO ACOUSTIC TESTING AT JSC - 100 EQUIVALENT MISSIONS. HOT FIRE TEST PROGRAM AT WSTF-517 TESTS. APPROX 7 YEARS PROPELLANT EXPOSURE.

ACCEPTANCE TEST

PROOF PRESSURE AND LEAKAGE, RADIOGRAPHIC AND X-RAY TESTS TO VERIFY NO PERMANENT DEFORMATION OR FLAW GROWTH, WELD INSPECTION FOR EVIDENCE OF STRESS RISER OR OTHER FLAWS.

GROUND TURNAROUND

V43C80.210 PERFORMS FIRST FLIGHT EXTERNAL LEAK CHECKS.

V43C80.215 REQUIRES PERIODIC LEAK CHECK OF FLANGE SEALS EVERY 5th FLIGHT.

V43C80.230 TOXIC VAPOR LEAK CHECK ON PROPELLANT TANK FOR FIRST FLIGHT AND ON A CONTINGENCY BASIS.

V43CE0.030 PERFORMS SUBSYSTEM INSPECTION EVERY 5TH FLIGHT. V43CE0.130 REQUIRES POD PURGE WHEN POD IS OFF ORBITER.

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V43CEO.120 REQUIRES SAMPLING OF STATIC AIR IN VARIOUS POD INTERNAL 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 MONITORED EACH FLIGHT FOR EVIDENCE OF LEAKAGE.

(C) INSPECTION:

RECEIVING INSPECTION

MATERIALS AND PROCESSES CERTIFICATION 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 INSPECTION OF COMPONENTS DURING FABRICATION ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

PENETRANT AND RADIOGRAPHIC INSPECTION OF WELDS ARE VERIFIED BY INSPECTION.

CRITICAL PROCESSES

FORGING MATERIAL GRAIN STRUCTURE IS VERIFIED BY INSPECTION. 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:

CAR'S AD1528 AND AD1622 RECORD EVIDENCE OF FLANGE SEAL LEAKAGE. THE LEAKAGE IS EVIDENCED BY CORROSION ON SURROUNDING COMPONENTS AND

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SHIELDED ELECTRICAL WIRES. THE LEAKAGE IS MINOR AND MAY NOT BE DETECTED BY THE HELIUM LEAK TESTS, POSSIBLY DUE TO SWELLING OF THE SEALS. THE LEAKAGE IS DUE TO TEFLON SEAL PERMEATION. EXAMINATION HAS REVEALED NO DAMAGE TO THE FLANGE. ADDITIONAL LEAK CHECKS (STATIC PERIOD FOLLOWED BY PURGE AND VAPOR DETECTION TEST) ARE PERFORMED FIRST FLIGHT AND EVERY 5th FLIGHT. PERIODIC INSPECTION AND CONSTANT PURGE OF THE POD ARE CONDUCTED DURING PRELAUNCH AND TEST PERIODS.

(E) OPERATIONAL USE:

FLANGE SEAL LEAKAGE IS UNLIKELY TO CAUSE MAJOR PROPELLANT LOSS. THE PRIMARY CONCERN IS CORROSION WITHIN POD DUE TO PROPELLANT EXPOSURE. NO CREW ACTION IS REQUIRED FOR THESE CASES. THE FOLLOWING ACTIONS ARE TAKEN IF LEAKAGE IS SIGNIFICANT. USE PERIGEE ADJUST BURN TO DEplete PROPELLANT FROM LEAKING POD AND REDUCE DELTA V REQUIREMENTS FOR DEORBIT. AFTER LEAKED PROPELLANT HAS DISPERSED, PERFORM DEORBIT BURN WITH GOOD POD.

- APPROVALS -

RELIABILITY ENGINEERING: J. N. HART
DESIGN ENGINEERING : D. W. CARLSON
QUALITY ENGINEERING : W. J. SMITH
NASA RELIABILITY :
NASA SUBSYSTEM MANAGER :
NASA QUALITY ASSURANCE :

: *J. N. Hart*
: *D. W. Carlson*
: *W. J. Smith*
: *4/24/90*
: *5/25-90*
: *Albert L. Smith*