

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE

NUMBER: 03-3-4001-X

SUBSYSTEM NAME: ORBITAL MANEUVERING SYSTEM (OMS)

REVISION : 2 03/16/90

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU :	VALVE ASSEMBLY, BI-PROP, ENG AEROJET	1186700 SAME

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
VALVE ASSEMBLY, ENGINE, BI-PROPELLANT, PNEUMATIC ACTUATED (NORMALLY CLOSED). (INCLUDES CONTROL VALVE, PNEUMATIC ACTUATOR, RACK AND PINION GEAR ASSEMBLY, RELIEF VALVE.)

QUANTITY OF LIKE ITEMS: 2
ONE PER ENGINE

FUNCTION:
VALVE IS USED TO INITIATE ENGINE FIRING THRU GPC COMMAND TO ENGINE CONTROL PNEUMATIC VALVE. OX LEAD TO THE COMBUSTION CHAMBER IS PROVIDED. VALVE IS PNEUMATICALLY OPERATED THRU ACTUATOR, RACK AND PINION ASSEMBLY WITH ENGINE ARMING VALVE IN OPEN POSITION PRIOR TO FIRING AND ENGINE CONTROL VALVE OPENING UPON FIRING COMMAND TO PRESSURIZE ACTUATOR. SERIES VALVE ELEMENTS PROVIDE REDUNDANT SEALING. EACH VALVE ASSEMBLY CONSISTS OF AN ACTUATOR ASSEMBLY, UPSTREAM BALL, DOWNSTREAM BALL AND POSITION INDICATION. THE RACK AND PINION ASSEMBLY OPERATES A SET OF FUEL AND OXIDIZER VALVE ELEMENTS SIMULTANEOUSLY. THE ACTUATOR FORCE IS PROVIDED BY AN ACTUATOR SUPPLIED WITH NITROGEN FROM THE GN2 TANK.

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LRU :VALVE ASSEMBLY, BI-PROP, ENG
ITEM NAME: VALVE ASSEMBLY, BI-PROP, ENG CRITICALITY OF THIS FAILURE MODE:1R2

FAILURE MODE:
INTERNAL LEAKAGE OF CONTROL VALVE (RESULTS IN EXTERNAL GN2 LEAK)

MISSION PHASE:
LO LIFT-OFF
DO DE-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY: 102 COLUMBIA
: 103 DISCOVERY
: 104 ATLANTIS

CAUSE:
CONTAMINATION, CORROSION, PLATING OR MATERIAL DEFECT, SPRING BREAKS,
SEAT CRACKS, VIBRATION.

■ CRITICALITY 1/1 DURING INTACT ABORT ONLY? YES

REDUNDANCY SCREEN A) PASS
B) PASS
C) PASS

PASS/FAIL RATIONALE:
A)
B)
C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
FUNCTIONAL DEGRADATION - LOSS OF PRESSURANT GAS THROUGH VENT PORT
DURING ENGINE FIRING (MAY RESULT IN LOSS OF ENGINE - INABILITY TO
ACTUATE BI-PROPELLANT VALVE).

(B) INTERFACING SUBSYSTEM(S):
LOSS OF INTERFACE REDUNDANCY.

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(C) MISSION:

POSSIBLE MISSION IMPACT - IF PRESSURANT LOSS IS EXCESSIVE REDLINE ADDITIONAL PROPELLANT FOR RCS BACKUP DEORBIT. (DECREASED PROPELLANT AVAILABLE FROM OMS TO RCS THROUGH INTERCONNECT FOR ON-ORBIT OPERATIONS).

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

NO EFFECT - ENGINE CAN BE ISOLATED AND PROPELLANT UTILIZED BY OTHER ENGINE. CRIT 1 FOR ABORT - ONE ENGINE CANNOT DEplete PROPELLANT WITHIN TIME REQUIRED. REDUCED FLOWRATE DURING DUMP COULD CAUSE LANDING WEIGHT, C.G. PROBLEMS.

(E) FUNCTIONAL CRITICALITY EFFECTS:

POSSIBLE CREW/VEHICLE LOSS - FAILURE MAY RESULT IN INABILITY TO PERFORM DEORBIT BURN. 1R EFFECT ASSUMES FAILURE OF BOTH OMS ENGINES AND INADEQUATE PROPELLANT FOR RCS DEORBIT.

- DISPOSITION RATIONALE -

(A) DESIGN:

AN 18-MICRON FILTER IS PROVIDED TO LIMIT THE POSSIBILITY OF CONTAMINANT CAUSING CONTROL VALVE LEAKAGE, JAMMING OF MOVING PARTS. THE UPSTREAM ENGINE PRESSURIZATION VALVE PROVIDES REDUNDANCY FOR THE LEAKAGE FAILURE MODE DURING STATIC PERIODS. IN EVENT THE PNEUMATIC PRESSURANT SUPPLY IS LOST REDUNDANT ENGINE SYSTEMS ARE PROVIDED, EITHER OF WHICH IS ADEQUATE FOR DE-ORBIT. DUAL COILS ARE PROVIDED FOR EACH VALVE. EACH COIL IS POWERED FROM A SEPARATE BUS.

(B) TEST:

QUALIFICATION TESTS

ENDURANCE TESTS (2200 WET, 220 DRY VALVE CYCLES). THERMAL CYCLES: VIBRATION TESTING AT ENGINE LEVEL. BURST (ACTUAL BURST 16,300 PSI). QUALIFIED AS PART OF ENGINE ASSEMBLY-138 FIRINGS DURING ENGINE QUAL, 498 FIRINGS AT SYSTEM LEVEL AT WSTF.

ACCEPTANCE TESTS

VISUAL INSPECTION, PROOF PRESSURE, ELECTRICAL CHECKS, PULL-IN AND DROP-OUT VOLTAGE (EACH COIL AND BOTH COILS), LEAKAGE, CLEANLINESS.

GROUND TURNAROUND

V43C80.185 PERFORMS GN2 CONTROL VALVE LEAK CHECK AT LOW PRESSURE EVERY FIFTH FLIGHT.

V43C80.195 CHECKS VALVE LEAKAGE AT HIGH PRESSURE (OPEN AND CLOSED POSITIONS) PRIOR TO FIRST FLIGHT AND CONTINGENCY. GN2 PRESSURE MONITORED IN FLIGHT FOR INDICATION OF LEAKAGE.

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V43CBO.210 PERFORMS EXTERNAL LEAK VERIFICATION FIRST FLIGHT.
V43CBD.280 PERFORMS PRESSURE DECAY PNEUMATIC SYSTEM EVERY FLIGHT.
V43CEO.100 VERIFIES NO PRESSURE DECAY WITH CONTROL VALVE OPEN.
S00FJO.040 PERFORMS POST ACTUATION PNEUMATIC LEAK/FUNCTIONAL TEST EVERY FLIGHT.

(C) INSPECTION:

RECEIVING INSPECTION
MATERIALS AND PROCESSES CERTIFICATIONS 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. VISUAL AND DIMENSIONAL INSPECTION OF BODY IS PERFORMED DURING FABRICATION.

NONDESTRUCTIVE EVALUATION
PENETRANT AND RADIOGRAPHIC INSPECTION OF WELDS ARE VERIFIED BY INSPECTION. PENETRANT INSPECTION OF BALL AND CONTROL VALVE BODY AFTER ETCHING AND PRIOR TO FINISH IS VERIFIED BY INSPECTION. MAGNETIC PARTICLE AND PENETRANT INSPECTION OF RACK IS VERIFIED BY INSPECTION. PENETRANT INSPECTION OF PINION IS VERIFIED BY INSPECTION.

CRITICAL PROCESSES
THE WELDING PROCESS AND VERIFICATION THAT WELDS MEET SPECIFICATION REQUIREMENTS ARE VERIFIED BY INSPECTION. SOLDER JOINTS AND PROCESSES ARE VERIFIED BY INSPECTION.

TESTING
TEST EQUIPMENT AND TOOL CALIBRATION ARE VERIFIED BY INSPECTION. ACCEPTANCE TEST IS VERIFIED BY INSPECTION. MICRO-ETCH OF ROUGH CUT BODY FOR CRYSTAL STRUCTURE.

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

■ (D) FAILURE HISTORY:

CAR ACB035 RECORDS A MINOR LEAKAGE FAILURE WHICH COULD NOT BE VERIFIED. THIS WAS ATTRIBUTED TO CONTAMINATION WHICH SUBSEQUENTLY DISLODGED. NO CORRECTIVE ACTION OTHER THAN THAT ALREADY REQUIRED FOR CLEANLINESS CONTROL.

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CAR AB6696 RECORDS A LEAKAGE FAILURE DUE TO A TEST SET-UP ERROR IN WHICH THE TEST SET-UP FILTER WAS INSTALLED IN REVERSE. THE RESULTANT CONTAMINATION CAUSED DAMAGE TO THE SEAL GROOVE. THE FILTER WAS MARKED TO INDICATE PROPER FLOW DIRECTION.

CAR AC4290 RECORDS A LEAKAGE FAILURE DUE TO TEST ERROR. THE PRESSURE WAS RELIEVED FROM THE UPSTREAM SIDE OF THE VALVE DURING PROOF PRESSURE TEST RESULTING IN O-RING EXTRUSION. PROCEDURAL CHANGES AND CAUTION NOTES WERE INCORPORATED.

(E) OPERATIONAL USE:

COMPLETE MISSION REQUIREMENTS USING CROSSFEED FOR PROPELLANT UTILIZATION. REDLINE ADDITIONAL PROPELLANT FOR RCS BACKUP DEORBIT. NEXT PLS DEORBIT IF PROPELLANT FOR RCS BACKUP NOT AVAILABLE. POSSIBLE MISSION IMPACT. DECREASED PROPELLANT AVAILABLE FROM OMS TO RCS THROUGH INTERCONNECT FOR ON-ORBIT OPERATION.

- APPROVALS -

RELIABILITY ENGINEERING: J. N. HART
DESIGN ENGINEERING : V. F. ROZNOS
QUALITY ENGINEERING : O. J. BUTTNER
NASA RELIABILITY :
NASA SUBSYSTEM MANAGER :
NASA QUALITY ASSURANCE :

: JA Ochoa
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