PRINT DATE: 03/30/90

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.

PRINT DATE: 03/30/90

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
NUMBER: 03-3-4001-05

REVISION# 2 03/16/90

SUBSYSTEM: ORBITAL MANEUVERING SYSTEM (OMS)
LRU :VALVE ASSEMBLY, BI-PROP, ENG
ITEM NAME: VALVE ASSEMBLY, BI-PROP, ENG

CRITICALITY OF THIS FAILURE MODE:1R2

■ FAILURE MODE:
STRUCTURAL FAILURE OF PNEUMATIC ACTUATOR. RUPTURE, EXTERNAL LEAKAGE

MISSION PHASE:
LO LIFT-OFF
DO DE-ORBIT

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

CAUSE:
MATERIAL DEFICIENCY, WELD CRACK/DEFECT, FAULTY FABRICATION, STRESS RISER, TEST DAMAGE, STRESS CORROSION, SHOCK, 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:
LOSS OF FUNCTION - SYSTEM PRESSURANT LOSS WOULD RESULT IN LOSS OF ONE ENGINE DUE TO INABILITY TO ACTUATE BI-PROPELLANT VALVES.

(B) INTERFACING SUBSYSTEM(S):
LOSS OF REDUNDANT ENGINE.

(C) MISSION:
POSSIBLE MISSION IMPACT - REDLINE ADDITIONAL PROPELLANT FOR RCS BACKUP

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
NUMBER: 03-3-4001-05

DEORBIT. DEORBIT NEXT PRIMARY LANDING SITE IF PROPELLANT FOR RCS BACKUP IS NOT AVAILABLE. (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 LOSS OF CREW/VEHICLE. LOSS OF REDUNDANT ELEMENTS RESULTS IN INABILITY TO FIRE OMS ENGINE FOR DEORBIT BURN. IR EFFECT ASSUMES LOSS OF BOTH OMS ENGINES AND INADEQUATE PROPELLANT FOR RCS DEORBIT.

- DISPOSITION RATIONALE -

(A) DESIGN:
THE FACTOR OF SAFETY (BURST) FOR THE ACTUATOR HOUSING IS 3.0 X WORKING PRESSURE. THE ACTUATOR IS OF LOW CAPACITY AND SEES ONLY REGULATED OUTLET PRESSURE FROM THE STORAGE VESSEL. FRACTURE MECHANICS ANALYSIS PERFORMED BY SUPPLIER INDICATES INFINITE LIFE. REDUNDANT ENGINE SYSTEMS ARE PROVIDED, EITHER OF WHICH IS ADEQUATE FOR DE-ORBIT.

(B) TEST:
QUALIFICATION TESTS
ENDURANCE (2400 PRESSURE CYCLES), THERMAL (-23 TO +150 DEG F.), VIBRATION TEST AT ENGINE LEVEL. BURST (1080 DESIGN). QUALIFIED AS PART OF ENGINE ASSEMBLY - 138 FIRINGS DURING ENGINE QUALIFICATION, 498 FIRINGS AT SYSTEM LEVEL AT WSTF.

ACCEPTANCE TESTS
EXAMINATION OF PRODUCT, WELD EVALUATION INCLUDING RADIOGRAPHIC, AND INSPECTION FOR STRESS RISER OR OTHER FLAWS. PROOF PRESSURE (900 PSI), EXTERNAL LEAKAGE.

GROUND TURNAROUND
V43CB0.170 PERFORMS BALL VALVE FUNCTIONAL TEST FOR FIRST FLIGHT AND CONTINGENCY.
V43CB0.186 PERFORMS GN2 ACTUATOR PISTON LEAK CHECK AT LOW PRESSURE EVERY FIFTH FLIGHT.
V43CB0.196 PERFORMS GN2 ACTUATOR PISTON LEAK CHECK FIRST FLIGHT AND CONTINGENCY.
V43CE0.100 PERFORMS PNEUMATIC SYSTEM ELECTRICAL CONTROL VERIFICATION EVERY FLIGHT.

GN2 PRESSURE MONITORED IN FLIGHT FOR INDICATION OF LEAKAGE. BALL VALVE PERFORMANCE (CYCLE TIME AND % OPEN) MONITORED IN FLIGHT (TO EXTENT ALLOWED BY SAMPLE RATE.

(C) INSPECTION:
RECEIVING INSPECTION
MATERIALS AND PROCESSES CERTIFICATIONS ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL
CLEANLINESS TO LEVEL 200 FOR MMH AND 200A FOR NTO. 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 DURING FABRICATION IS VERIFIED BY INSPECTION.

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 IS VERIFIED BY INSPECTION.

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

■ (D) FAILURE HISTORY:
NONE

(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

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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		