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.

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NUMBER: 03-3-4001-01

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:
FAILS OPEN, FAILS TO CLOSE.

MISSION PHASE:

PL	PRELAUNCH
LO	LIFT-OFF
OO	ON-ORBIT
OO	DE-ORBIT
LS	LANDING SAFING

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

CAUSE:
CONTAMINATION, CORROSION, MATERIAL DEFECT, ELECTRICAL FAILURE ACTUATOR FAILURE (SCORED CYLINDER WALL, GALLING OF INTERFACE, BROKEN RETURN SPRING, PISTON/SPRING SEIZED, JAMMED, OR COCKED, IMPROPER CLEARANCE); CONTROL VALVE FAILS OPEN (ELECTRICAL FAILURE, SPRING BREAKS, POPPET HANGS UP, FAILS TO VENT); GEARS JAM, SHOCK, VIBRATION.

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN A) PASS
B) PASS
C) PASS

PASS/FAIL RATIONALE:
A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
LOSS OF REDUNDANCY (SERIES VALVE ELEMENT).

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(B) INTERFACING SUBSYSTEM(S):
NO EFFECT UNLESS SERIES VALVES FAIL.

(C) MISSION:
NO EFFECT. ENGINE WILL NOT BE USED UNTIL DEORBIT BURN.

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT UNLESS SERIES ELEMENTS FAIL OPEN.

(E) FUNCTIONAL CRITICALITY EFFECTS:
POSSIBLE LOSS OF CREW/VEHICLE. FAILED OPEN CONDITION OF BI-PROP VALVES IN SERIES COULD RESULT IN LOSS OF PROPELLANT REQUIRED FOR DEORBIT.

- DISPOSITION RATIONALE -

(A) DESIGN:
PROPELLANT COMPATIBLE MATERIALS ARE USED. SERIES VALVE ELEMENTS (BALLS, CONTROL VALVES, ACTUATORS) PROVIDE REDUNDANCY FOR THE LEAKAGE OR FAIL OPEN MODE. A 100-MICRON PROPELLANT INLET FILTER IS UTILIZED TO LIMIT THE POTENTIAL FOR CONTAMINATION THAT COULD CAUSE JAMMING OF MOVING PARTS. AN 18 MICRON FILTER IS PROVIDED TO LIMIT THE POSSIBILITY OF CONTAMINANT CAUSING JAMMING OF MOVING PARTS OF THE CONTROL VALVE. FRACTURE MECHANICS ANALYSIS BY THE SUPPLIER INDICATES INFINITE ACTUATOR LIFE. ANALYSIS INDICATES ALL PARTS OF THE ACTUATION SYSTEM ARE CAPABLE OF WITHSTANDING MAX ANTICIPATED LOADS. THE TANK ISOLATION VALVE CAN BE CLOSED BETWEEN FIRINGS TO LIMIT THE LEAKAGE POTENTIAL. REDUNDANT ENGINES ARE PROVIDED EITHER OF WHICH IS ADEQUATE FOR DEORBIT.

■ (B) TEST:
QUALIFICATION TESTS
THERMAL CYCLE (-23 TO +150 DEG F), LEAK AND FUNCTIONAL TESTS THROUGHOUT TEMPERATURE RANGE, ENDURANCE (220 DRY, 2200 WET CYCLES). BENCH HANDLING SHOCK TEST, POST-TEST ACCEPTANCE, BURST OF BALL VALVE HOUSING (825 PSI DESIGN), BURST OF ACTUATOR AND CONTROL VALVE (1080 PSI DESIGN). VIBRATION AT ENGINE LEVEL. ALSO QUALIFIED AS PART OF ENGINE ASSEMBLY - 138 FIRINGS DURING ENGINE QUALIFICATION, 498 FIRING TESTS AT POD LEVEL AT WSTF.

ACCEPTANCE TEST
EXAMINATION OF PRODUCT, WELD INSPECTION, PROOF PRESSURE, INTERNAL AND EXTERNAL LEAKAGE AND FUNCTIONAL TESTS. RADIOGRAPHIC INSPECTION AND FLUORESCENT INSPECTION.

GROUND TURNAROUND
V43CA0.050 PERFORMS ENGINE PNEUMATIC VERIFICATION (POD) FOR FIRST

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FLIGHT AND CONTINGENCY BASIS.
V43CA0.075 PERFORMS ELECTRICAL INTERFACE VERIFICATION (ORBITER/POD), CONTINGENCY ONLY.
V43CA0.080 PERFORMS INSTRUMENTATION VERIFICATION EVERY FLIGHT.
V43CB0.170 PERFORMS BALL VALVE FUNCTIONAL TESTS BEFORE FIRST FLIGHT & AND ON CONTINGENCY.
V43CB0.180 PERFORMS BALL VALVE FUNCTIONAL TEST EVERY 5TH FLIGHT.
V43CE0.050 PERFORMS DRAIN AND PURGE OF BI-PROP VALVE EVERY FLIGHT.
V43CE0.090 REQUIRES PROPELLANT SAMPLE 2ND FLIGHT.
V43CF0.010 PERFORMS PROPELLANT SERVICING TO FLIGHT LOAD EVERY FLIGHT.
S00FJ0.040 PERFORMS POST ACTIVATION PNEUMATIC LEAK/FUNCTIONAL TEST EVERY FLIGHT.

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 200 A FOR NTO AND CORROSION PROTECTION PROVISION ARE VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
MANUFACTURING, ASSEMBLY AND INSTALLATION PROCEDURES ARE VERIFIED BY INSPECTION. CRITICAL DIMENSION AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. VISUAL AND DIMENSIONAL INSPECTION OF BODY AND BALL IS PERFORMED DURING FABRICATION AND VERIFIED BY INSPECTION. THE SURFACE FINISH OF THE BALL IS VERIFIED BY INSPECTION. VISUAL, DIMENSIONAL AND LUBRICANT INSPECTION OF RACK IS VERIFIED BY INSPECTION. VISUAL, DIMENSIONAL, PITCH RUN-OUT AND SURFACE FINISH INSPECTION OF PINION IS VERIFIED BY INSPECTION. VISUAL, DIMENSIONAL AND SOLDERING AT 10X MAGNIFICATION FOR LINEAR POSITIONING TRANSDUCER IS VERIFIED BY INSPECTION.

CRITICAL PROCESSES
THE WELDING PROCESS AND VERIFICATION THAT WELDS MEET SPECIFICATION REQUIREMENTS ARE 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.

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TESTING
TEST EQUIPMENT AND TOOL CALIBRATION ARE VERIFIED BY INSPECTION. ACCEPTANCE TEST IS VERIFIED BY INSPECTION. INSULATION RESISTANCE OF LINEAR POSITIONING TRANSDUCER 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:
NO FAILURE HISTORY OF THE BI-PROP VALVE FOR THE FAIL OPEN MODE.

(E) OPERATIONAL USE:
DO NOT USE ENGINE FOR OMS-1, OMS-2 AND ON ORBIT BURNS. IF REDUNDANT ELEMENT FAILS OPEN CLOSE TANK ISOLATION VALVE BETWEEN FIRINGS. DO NOT CROSSFEED OR INTERCONNECT FROM AFFECTED POD. ONLY USE ENGINE FOR DEORBIT BURN (FOR FAILED FULL OPEN); IF FAILED PARTIALLY OPEN, ONLY USE IF OTHER ENGINE IS FAILED.

- APPROVALS -

RELIABILITY ENGINEERING	J. N. HART	
DESIGN ENGINEERING	D. W. CARLSON	
QUALITY ENGINEERING	O. J. BUTTNER	4/4/90
NASA RELIABILITY		
NASA SUBSYSTEM MANAGER		5-25-90
NASA QUALITY ASSURANCE		