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PRINT DATE: 04/10/90

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE
NUMBER: 03-1-0301-X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION : 1 04/10/90

1056

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
■ LRU :	VALVE, FILL, 8 IN. FAIRCHILD CONTROL SYSTEMS	MC284-0397-0021 74328000-147

PART DATA

- EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
FILL VALVE, INBOARD LH2, 8 INCH, PNEUMATICALLY OPERATED, INCLUDES A RELIEF VALVE.
- REFERENCE DESIGNATORS: PV12
- QUANTITY OF LIKE ITEMS: 1
ONE LH2
- FUNCTION:
PROVIDES A MEANS OF LOADING AND DRAINING THE ET THROUGH THE PROPELLANT FEED SYSTEM. THE VALVE, ALONG WITH THE OUTBOARD FILL AND DRAIN VALVE (PV11), PROVIDES A REDUNDANT MEANS OF CONTAINING PROPELLANT IN THE FEED SYSTEM. THE VALVE IS MOUNTED ON THE FEED LINE MANIFOLD TO ISOLATE THE FILL LINE FROM THE FEED SYSTEM. IT IS REQUIRED TO BE CLOSED FOR PROPELLANT TOPPING/REPLENISHMENT OPERATIONS. BOTH THE INBOARD AND OUTBOARD VALVES REMAIN CLOSED DURING ENGINE OPERATION. FOLLOWING NOMINAL OR RTLS/TAL ABORT MECO, THE INBOARD & OUTBOARD FILL VALVES ARE SOFTWARE COMMANDED OPEN FOR DUMP OF RESIDUAL LH2. THE INBOARD VALVE REMAINS OPEN AFTER INERTING THROUGH REENTRY AND LANDING. VALVE INCORPORATES AN ANTI-SLAM MECHANISM TO PREVENT VALVE SLAMMING DAMAGE DURING IMPROPER VALVE OPEN/CLOSE OPERATIONS. THE VALVE ALSO INCORPORATES A RELIEF VALVE, RELIEVING FROM THE FILL LINE INTO THE MANIFOLD; AND A PORT FOR INSTALLATION OF LH2 RELIEF SHUTOFF ISOLATION VALVE (PV8).

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL FAILURE MODE
NUMBER: 03-1-0301-05**

REVISION# 3 01/10/94 R

SUBSYSTEM NAME: MAIN PROPULSION
LRU: VALVE, FILL, 8 IN.
ITEM NAME: VALVE, FILL, 8 IN.

CRITICALITY OF THIS
FAILURE MODE: 1/1

FAILURE MODE:
FAILS TO RELIEVE LH2 FILL LINE BOILOFF INTO FEED MANIFOLD.

MISSION PHASE:
LO LIFT-OFF

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

CAUSE:
BINDING.

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:
RESULTS IN POSSIBLE OVERPRESSURIZATION AND RUPTURE OF THE FILL LINE DUE TO PRESENCE OF GH2 RESIDUALS FROM DRAINBACK. POSSIBLE OVERPRESSURIZATION OF AFT COMPARTMENT AND FIRE/EXPLOSION HAZARD. BLADE LIFTOFF FROM THE VALVE SEAT MAY ALLOW RELIEF INTO THE MANIFOLD, BUT THIS FUNCTION IS NOT A DESIGN REQUIREMENT AND HAS NOT BEEN CERTIFIED.

(B) INTERFACING SUBSYSTEM(S):
SAME AS A.

(C) MISSION:
POSSIBLE LOSS OF CREW/VEHICLE.

(D) CREW, VEHICLE, AND ELEMENT(S):
SAME AS C.

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(E) FUNCTIONAL CRITICALITY EFFECTS:

- 1R/2, 2 SUCCESS PATHS. TIME FRAME OTBD F/D VALVE CLOSURE TO DUMP.
1) INBOARD FILL AND DRAIN VALVE (PV12) OR TOPPING VALVE (PV13) LEAKS EXCESSIVELY.
2) INBOARD FILL AND DRAIN VALVE (PV12) FAILS TO RELIEVE.

RESULTS IN LH2 LEAKAGE INTO FILL LINE. SUBSEQUENT FAILURE OF THE RELIEF VALVE MAY CAUSE OVERPRESSURIZATION AND RUPTURE OF THE LINE. POSSIBLE FIRE/EXPLOSION HAZARD IN AFT COMPARTMENT. POSSIBLE LOSS OF HELIUM SUPPLY DURING MANIFOLD REPRESS RESULTING IN LOSS OF AFT COMPARTMENT PURGE (RTL5 AND TAL ABORT CRITICAL). POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:

THE RELIEF VALVE WAS CYCLED 5000 TIMES (2500 EACH AT AMBIENT AND CRYOGENIC TEMPERATURES) DURING CERTIFICATION TESTING. THE MAIN VALVE BLADE (CLOSURE) LIFTS OFF FROM ITS SEAT AT 70 PSID AS WAS DETERMINED IN CERTIFICATION TESTING OF THE LO2 VALVE. THE RELIEF VALVE IS OF SIMPLE DESIGN CONSISTING OF SEVEN PARTS. A SPHERICAL POPPET IS SPRING LOADED ONTO A KEL-F SEAT AND IS CLOSELY GUIDED THROUGHOUT ITS SHORT STROKE. TO FURTHER PREVENT BINDING, ALL SURFACES WITHIN THE RELIEF VALVE THAT ARE IN CONTACT WITH THE ALUMINUM OXIDE POPPET ARE HARD ANODIZED 6061-T651. CONTAMINATION IS MORE LIKELY TO PREVENT CLOSURE RATHER THAN PREVENT OPENING.

(B) TEST:

ATP

ANTI-SLAM VALVES (BEFORE ASSEMBLY INTO THE ACTUATOR) EXAMINATION OF PRODUCT; AMBIENT PROOF (1275 PSIG); AMBIENT AND CRYO FLOW; AMBIENT AND CRYO CRACKING PRESSURE; POST TEST EXAMINATION.

ACTUATOR (BEFORE ASSEMBLY ONTO THE FILL AND DRAIN VALVE) EXAMINATION OF PRODUCT; POSITION INDICATION; AMBIENT PROOF (1275); ELECTRICAL CHARACTERISTICS; AMBIENT EXTERNAL LEAKAGE.

RELIEF VALVE ASSEMBLY (BEFORE INSTALLATION INTO THE FILL AND DRAIN VALVE) EXAMINATION OF THE PRODUCT; AMBIENT PROOF (340 PSIG); AMBIENT AND CRYO CRACK/RESEAT (15-50 PSID) AND INTERNAL LEAKAGE; POST TEST EXAMINATION.

FILL AND DRAIN VALVE ASSEMBLY -

EXAMINATION OF PRODUCT

ELECTRICAL BONDING

AMBIENT AND CRYO PROOF WITH VALVE OPEN AND CLOSED - 143 PSIG

AMBIENT AND CRYO EXTERNAL LEAKAGE OF VALVE BODY (110 PSIG)

CRYO EXTERNAL LEAKAGE OF ACTUATOR (740 PSIG)

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AMBIENT AND CRYO RESPONSE TIME (NORMAL AT 400 AND 740 PSIG ACTUATOR PRESSURE, AND SLAM AT 740 PSIG)

AMBIENT AND CRYO ACTUATOR LEAKAGE FROM PORT TO PORT

AMBIENT AND CRYO VALVE SHAFT SEAL (PRIMARY AND SECONDARY) LEAKAGE WITH 110 PSID ACROSS THE SEAL

AMBIENT AND CRYO VALVE INTERNAL LEAKAGE (INLET-TO-OUTLET WITH 15 PSID, OUTLET-TO-INLET WITH 110 PSID)

AMBIENT AND CRYO RELIEF VALVE CRACK AND RESEAT (15 TO 50 PSID)

POST TEST EXAMINATION

CERTIFICATION

STRUCTURAL LOAD AT CRYO TEMPS (-400 DEG F) (AXIAL, SHEAR, TORSION, BENDING) WITH THE VALVE IN TENSION, PERFORM VALVE RESPONSE TIME (NOMINAL AND SLAM) ACTUATOR INTERNAL LEAKAGE, PRIMARY AND SECONDARY SHAFT SEAL LEAKAGE, INTERNAL LEAKAGE (OUTLET-TO-INLET AND INLET-TO-OUTLET), CRACK AND RESEAT, AND, EXTERNAL LEAKAGE (BODY AND ACTUATOR) TESTS. REPEAT WITH THE VALVE IN COMPRESSION.

VALVE LIFE CYCLING:

2400 AMBIENT TEMPERATURE CYCLES WITH 5 PSIG INTERNAL PRESSURE (525 NORMAL CYCLES AND 1875 SLAM CYCLES)

100 AMBIENT CYCLES (50 NORMAL AND 50 SLAM CYCLES) WITH VALVE INLET VENTED TO ATMOSPHERE AND VALVE OUTLET CONNECTED TO A 4 CUBIC FOOT VOLUME PRESSURIZED TO 110 PSIG WITH GN2

2400 CRYO TEMPERATURE (-400 DEG F) CYCLES WITH 50 60 PSIG INTERNAL PRESSURE (1775 NORMAL CYCLES AND 625 SLAM CYCLES)

100 NORMAL CRYO CYCLES WITH THE VALVE INLET VENTED TO ATMOSPHERE AND THE OUTLET PRESSURIZED TO 110 PSIG.

FOR THE FOREGOING LIFE TEST, PRIOR TO AND EVERY 100 CYCLES THEREAFTER, ACTUATOR INTERNAL LEAKAGE, PRIMARY AND SECONDARY SHAFT SEAL LEAKAGE, AND VALVE INTERNAL LEAKAGE (OUTLET-TO-INLET) TESTS WERE PERFORMED.

RELIEF VALVE LIFE CYCLING:

2500 CYCLES AT CRYO (-400 DEG F) TEMP, 2500 CYCLES AT AMBIENT.

FOLLOWING EACH 500 CYCLES PERFORM FILL AND DRAIN VALVE INTERNAL LEAKAGE (OUTLET-TO-INLET AND INLET-TO-OUTLET), AND CRACK/RESEAT TESTS. POST CYCLE EXAMINATION.

VIBRATION:

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PRE-VIBRATION TESTS - VALVE RESPONSE TIME (NORMAL AND SLAM), ACTUATOR INTERNAL LEAKAGE, PRIMARY AND SECONDARY SHAFT SEAL LEAKAGE, INTERNAL LEAKAGE (OUTLET-TO-INLET AND INLET-TO-OUTLET), CRACK AND RESEAT, AND EXTERNAL LEAKAGE (BODY AND ACTUATOR).

TRANSIENT SINUSOIDAL VIBRATION -
(AT 110 PSIG AND -250 DEG F) IN EACH AXIS

RANDOM VIBRATION TESTS -

13.3 HRS IN EACH OF THREE AXES WITH VALVE CLOSED AND AT -250 DEG F MAXIMUM. HALF OF THE TIME THE VALVE INTERNAL PRESSURE IS 110 PSIG; THE OTHER HALF AT 5 PSIG. ONCE EACH HOUR, CLOSING PRESSURE IS REMOVED FROM THE ACTUATOR. ALSO BOTH CLOSING AND OPENING PRESSURES ARE APPLIED CONCURRENTLY TO THE ACTUATOR. IN BOTH CASES THE VALVE REMAINS CLOSED.

DESIGN SHOCK: 18 SHOCKS OF 15G EACH THREE IN EACH DIRECTION ALONG EACH OF THREE AXES, ALL WITH VALVE OPEN AND ACTUATOR VENTED

DESIGN SHOCK POST TEST:
AMBIENT VALVE RESPONSE, INTERNAL AND EXTERNAL LEAKAGES. CRYO VALVE RESPONSE, INTERNAL AND EXTERNAL LEAKAGES. ELECTRICAL CHARACTERISTICS; POSITION INDICATION.

BURST: 165 PSIG VALVE OPEN 165 PSIG ON OUTLET OF CLOSED VALVE, 1700 PSIG ACTUATOR

GROUND TURNAROUND TEST
V41BH0.030 PV10,12 FILL VALVE FUNCTIONAL (EVERY FIFTH FLIGHT)

(C) INSPECTION:
RECEIVING INSPECTION
RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION. BODY HOUSING FORGING IS ULTRASONICALLY AND PENETRANT INSPECTED.

CONTAMINATION CONTROL
PARTS ARE VERIFIED CLEAN TO LEVEL 400. THE ACTUATOR IS CLEANED TO 400A.

ASSEMBLY/INSTALLATION
ALL PARTS ARE PROTECTED FROM DAMAGE AND CONTAMINATION. LOG OF CLEAN ROOM AND TOOL CALIBRATION ARE VERIFIED BY INSPECTION. ALL SURFACES REQUIRING CORROSION PROTECTION ARE VERIFIED. VISUAL (3X TO 7X) AND DIMENSIONAL INSPECTION OF VALVE BODY AND COMPONENTS ARE VERIFIED DURING ASSEMBLY. THREADED FASTENER TORQUES ARE VERIFIED BY INSPECTION. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE ASSEMBLY PROCEDURE.

CRITICAL PROCESSES
HEAT TREATMENT AND DRY FILM LUBE APPLICATION ARE VERIFIED BY INSPECTION.

NON DESTRUCTIVE EVALUATION
VALVE BODY, PRIOR TO FINAL MACHINING, IS SUBJECTED TO DYE PENETRANT INSPECTION. REQUIREMENTS FOR DETAIL PARTS PENETRANT INSPECTION ARE BASED UPON CONFIGURATION, MATERIAL, AND MANUFACTURING PROCESSES.

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TESTING
ACCEPTANCE TEST VERIFIED BY INSPECTION.

HANDLING/PACKAGING
PACKAGING FOR SHIPMENT VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:
THERE HAVE BEEN NO ACCEPTANCE TEST, QUALIFICATION TEST, FIELD OR FLIGHT
FAILURES ASSOCIATED WITH THIS FAILURE MODE.

(E) OPERATIONAL USE:
NO CREW ACTION CAN BE TAKEN

- APPROVALS

EDITORIALLY APPROVED : RI
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TECHNICAL APPROVAL : VIA CR

Handwritten signature and date: 1/19/94
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