FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 03-1-0451 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 08/09/00

PART DATA

	PART NAME / **VENDOR NAME**	**PART NUMBER** / **VENDOR NUMBER**
LRU	: VALVE, DUAL CHECK PARKER-HANNIFIN	MC284-0515-0005

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
VALVE, DUAL CHECK, LO2 BLEED, 1 INCH DIAMETER.

REFERENCE DESIGNATORS: CV31
CV33
CV35

QUANTITY OF LIKE ITEMS: 3
ONE PER ENGINE

FUNCTION:
PARALLEL FLAPPERS CONTAINED IN ONE CHECK VALVE ASSEMBLY PROVIDE A PATH FOR LO2 RECIRCULATION/BLEED AND POGO SUPRESSION FLOW. PREVENTS REVERSE FLOW OF LO2 INTO THE SSME DURING START SEQUENCE AND IN THE EVENT OF AN ENGINE MALFUNCTION (PREMATURE SHUTDOWN). ONE CHECK VALVE ASSEMBLY IS PROVIDED FOR EACH ENGINE SYSTEM.

EACH CHECK VALVE ASSEMBLY HAS ONE 0.052 INCH ORIFICE TO PROVIDE A CONTROLLED (4 SCFM) GHE REPRESSURIZATION PURGE TO THE RESPECTIVE SSME DURING ENTRY (DUE TO THE EXCESSIVE LEAK RATE THROUGH THE ENGINE HPOT SEALS THE LO2 PREVALVES ARE MAINTAINED CLOSED TO PREVENT LOSS OF HELIUM SUPPLY).

POGO RECIRCULATION VALVES (PV20,21) ARE OPENED AT T-12.5 SECONDS TO CHILL DOWN POGO RETURN LINE UNTIL OVERBOARD BLEED VALVE (PV19) IS CLOSED AT T-9.4 SECONDS. THIS CHECKS (VALVE FLAPPERS CLOSE) BLEED FLOW FROM ENGINES UNTIL ENGINE START. ENGINE START SEQUENCE BEGINS AT T-6.6 SECONDS.

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SUBSYSTEM NAME: MAIN PROPULSION
LRU: LO2 1" BLEED CHECK VALVE (CV31, 33, 35) **CRITICALITY OF THIS**
ITEM NAME: LO2 1" BLEED CHECK VALVE (CV31, 33, 35) **FAILURE MODE:** 1R2

FAILURE MODE:
FAILS TO OPEN AT SSME START.

MISSION PHASE:
PL PRE-LAUNCH
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) PASS
B) FAIL
C) PASS

PASS/FAIL RATIONALE:
A)

B)
FAILS SCREEN B BECAUSE CHECK VALVES DO NOT HAVE POSITION INDICATION.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
LOSS OF REDUNDANCY. REDUNDANT FLAPPER IS CAPABLE OF SUPPLYING REQUIRED FLOW DURING BLEED AND ENGINE OPERATION.

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

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(C) MISSION:
NO EFFECT.

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

(E) FUNCTIONAL CRITICALITY EFFECTS:
CASE 1:
3/3. TIME FRAME - SSME START TRANSIENT.

NO EFFECT. LOSS OF POGO RETURN PATH (BOTH FLAPPERS WITHIN ONE CHECK VALVE ASSEMBLY (CV31, CV33, CV35) FAIL TO OPEN) CAUSING OVERFLOW OF HELIUM PRECHARGE FROM POGO ACCUMULATOR INTO HIGH PRESSURE OXIDIZER TURBOPUMP (HPOT) IS TOLERATED.

CASE 2:
1R/2 2 SUCCESS PATHS. TIME FRAME - ASCENT.
1,2 BOTH FLAPPERS WITHIN ONE CHECK VALVE ASSEMBLY (CV31, CV33, OR CV35) FAIL TO OPEN.

LOSS OF POGO RETURN PATH CAUSES EXCESSIVE GO2 VOLUME IN POGO ACCUMULATOR RESULTING IN BUBBLE COLLAPSE AND LOSS OF POGO DAMPING FUNCTION. MAY RESULT IN EXCESSIVE VEHICLE POGO OSCILLATION. POSSIBLE LOSS OF CREW/VEHICLE.

CASE 3:
1R/2 2 SUCCESS PATHS. TIME FRAME - POST MECO ENGINE SHUTDOWN SEQUENCE.
1,2 BOTH FLAPPERS WITHIN ONE CHECK VALVE ASSEMBLY (CV31, CV33, OR CV35) FAIL TO OPEN.

DURING ZERO-G SHUTDOWN SEQUENCE, HELIUM IS INJECTED INTO POGO ACCUMULATORS TO MAINTAIN NPSP AND PREVENT HPOT OVERSPEED. LOSS OF POGO RETURN PATH CAUSES GHE OVERFLOW FROM ACCUMULATORS AND INGESTION INTO THE HPOT RESULTING IN PUMP OVERSPEED AND POSSIBLE UNCONTAINED ENGINE DAMAGE. POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:
THE LO2 CHECK VALVE HOUSING IS MADE FROM 321/304L CRES. PARALLEL FLAPPERS (TEFLON-COATED 304 CRES) ARE USED TO PROVIDE THE REVERSE FLOW CHECK CAPABILITY. A FLAPPER WEDGE IS USED TO KEEP THE FLAPPERS OPEN 30 DEGREES AND ALLOW THE FLOW FORCES TO CLOSE THE FLAPPERS BY THE HYDRODYNAMIC FORCES OF REVERSE FLOW. THE HINGE BOXES ARE TEFLON COATED TO PREVENT

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BINDING. THE FLAPPER CRACKING PRESSURE IS 0.5 PSID, WHICH IS LESS THAN THE SYSTEM PRESSURE ACTING TO OPEN THE FLAPPERS. THE ASSEMBLY INCLUDES A 0.052 INCH ORIFICE FOR REPRESSURIZATION/PURGING OPERATIONS.

THE DESIGN FACTORS OF SAFETY FOR PROOF IS 2 TIMES OPERATING PRESSURE (800 PSIG), AND 4 TIMES OPERATING PRESSURE (1600 PSIG) FOR BURST. STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF VALVE OPERATIONS; FRACTURE/FATIGUE ANALYSES SHOW THAT ALL CRITICAL PARTS ARE SATISFACTORY FOR FOUR TIMES EXPECTED LIFE.

(B) TEST:

ATP (ALL TESTS RUN AT AMBIENT TEMPERATURE)

PROOF
- CLOSURE DEVICE PROOF PRESSURE (550 PSIG)
- BODY PROOF PRESSURE (800 PSIG)

LEAKAGE
- INTERNAL LEAKAGE, REVERSE DIRECTION (10 AND 275 PSIG)
- EXTERNAL LEAKAGE (400 PSIG)

FUNCTIONAL
- CRACKING (0.6 PSID MAX)
- RESEATING (0.1 PSID) PRESSURES

CERTIFICATION (LEAKAGE AND CRACK/RESEAT TESTS WERE PERFORMED BEFORE AND AFTER THE FOLLOWING TESTS.)

LEAKAGE
- INTERNAL, REVERSE DIRECTION (10 AND 275 PSIG)
- EXTERNAL, (400 PSIG)

CRACKING/RESEAT
- AMBIENT AND CRYOGENIC (0.6 PSID AND 0.1 PSID)

LIFE
- 2000 CYCLES AT AMBIENT TEMPERATURE WITH AMBIENT FUNCTIONAL TESTS AFTER 1000 AND 2000 CYCLES
- 1000 CYCLES AT -320 DEG F FOLLOWED BY CRYOGENIC FUNCTIONAL TESTS
- 2000 CYCLES AT +130 DEG F FOLLOWED BY AMBIENT FUNCTIONAL TESTS

THERMAL
- THREE THERMAL CYCLE TESTS (AMBIENT TO 275 DEG F TO AMBIENT) FOLLOWED BY AMBIENT FUNCTIONAL TESTS

SHOCK
- BENCH HANDLING AND DESIGN SHOCK PER MIL-STD-810B

VIBRATION

RANDOM - 13.3 HOURS EACH AXIS (3) AT CRYOGENIC TEMPERATURES (-300 DEG F); 3.3 HOURS CLOSED AND 10 HOURS WITH FLOWING LIQUID NITROGEN; EACH AXIS TEST FOLLOWED BY CRYOGENIC FUNCTIONAL TEST
TRANSIENT - (5 TO 35 HZ AT + OR - .25G PEAK)

PERFORMANCE - FLOW TESTS
TWO FLAPPER
AMBIENT AND CRYOGENIC (-320 DEG F)
SINGLE FLAPPER
AMBIENT AND CRYOGENIC (-320 DEG F)

BURST
FLAPPER (1100 PSIG)
VALVE BODY (1600 PSIG)

GROUND TURNAROUND TEST
ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:
RECEIVING INSPECTION
RAW MATERIALS ARE VERIFIED FOR MATERIAL PROCESS AND INSPECTION.

CONTAMINATION CONTROL
CONTAMINATION CONTROL PROCESS AND CORROSION PROTECTION PROVISIONS ARE VERIFIED. CLEANLINESS TO LEVEL 800A IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
PARTS ARE PROTECTED FROM DAMAGE AND CONTAMINATION. DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. THE INSIDE SURFACES OF THE VALVE ARE VISUALLY INSPECTED USING A BORESCOPE (10X MAGNIFICATION). ELECTROCHEM ETCH MARKING IS VERIFIED BY INSPECTION. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE ASSEMBLY PROCEDURE.

CRITICAL PROCESSES
PROCESSES OF EB WELDING, HEAT TREATMENT, PASSIVATION, AND ELECTROPOLISH ARE VERIFIED BY INSPECTION. HELIUM LEAK TEST IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
X-RAY AND PENETRANT INSPECTION OF E.B. WELDS ARE VERIFIED BY INSPECTION.

TESTING
ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING
PACKAGING, HANDLING, AND TRANSPORTATION OF PRODUCT VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

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CURRENT DATA ON TEST FAILURE, FLIGHT FAILURE, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATABASE.

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

- APPROVALS -

S&R ENGINEERING	: W.P. MUSTY	: /S/ W. P. MUSTY
S&R ENGINEERING ITM	: P. A. STENGER-NGUYEN	: /S/ P. A. STENGER-NGUYEN
DESIGN ENGINEERING	: MIKE FISCHER	: /S/ MIKE FISCHER
MPS SUBSYSTEM MGR.	: TIM REITH	: /S/ TIM REITH
MOD	: BILL LANE	: /S/ BILL LANE
USA SAM	: MIKE SNYDER	: /S/ MIKE SNYDER
USA ORBITER ELEMENT	: SUZANNE LITTLE	: /S/ SUZANNE LITTLE
NASA SR&QA	: ERICH BASS	: /S/ ERICH BASS