

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE**NUMBER: 03-1-0261 -X****SUBSYSTEM NAME:** MAIN PROPULSION**REVISION:** 2 08/10/00**PART DATA**

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	:SSME GHE SUPPLY INTERCONNECT "OUT" CHECK VALVE CIRCLE SEAL	ME284-0472-0002, -0012 P69-180

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

INTERCONNECT "OUT" CHECK VALVE, 0.375 INCH DIAMETER.

REFERENCE DESIGNATORS: CV28
CV39
CV44

QUANTITY OF LIKE ITEMS: 3
ONE PER ENGINE HE SUPPLY

FUNCTION:

THE FUNCTION OF THE CHECK VALVE (CV28,39,44) IS TO PREVENT REVERSE FLOW FROM THE PNEUMATIC HELIUM SUPPLY TO THE ENGINE HELIUM SUPPLY THROUGH THE INTERCONNECT OUT SOLENOID VALVE (LV60,62,OR 64). THE PILOTED 2-WAY SOLENOID VALVES WILL HOLD PRESSURE ONLY IN THE INLET-TO-OUTLET DIRECTION AND WILL NOT PREVENT BACKFLOW (OUTLET-TO-INLET). CHECK VALVE IS LOCATED DOWNSTREAM OF THE SOLENOID VALVE WHICH ALLOWS HELIUM TRANSFER FROM A PARTICULAR ENGINE SUPPLY SYSTEM TO EITHER THE PNEUMATIC ACTUATION SUPPLY OR ANOTHER ENGINE SUPPLY SYSTEM.

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE

NUMBER: 03-1-0261-01

REVISION#: 1 06/05/01

SUBSYSTEM NAME: MAIN PROPULSION

LRU: SSME GHE SUPPLY I/C "OUT" CHECK VALVE

CRITICALITY OF THIS

ITEM NAME: SSME GHE SUPPLY I/C "OUT" CHECK VALVE

FAILURE MODE: 1R3

FAILURE MODE:

FAILS TO OPEN/REMAIN OPEN.

MISSION PHASE: LO LIFT-OFF

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

CAUSE:

PIECE PART STRUCTURAL FAILURE, BINDING, CONTAMINATION

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN

- A) PASS
- B) FAIL
- C) PASS

PASS/FAIL RATIONALE:

A)

B)

FAILS B SCREEN BECAUSE ENGINE SUPPLY PRESSURES ARE INDISTINGUISHABLE WHEN INTERCONNECT 'OUT' VALVES ARE OPENED POST-MECO.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

NO EFFECT.

(B) INTERFACING SUBSYSTEM(S):

SAME AS A.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
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(C) MISSION:
SAME AS A.

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

(E) FUNCTIONAL CRITICALITY EFFECTS:

CASE 1:

1R/3 3 SUCCESS PATHS. TIME FRAME - ASCENT.

- 1) ENGINE PNEUMATIC HELIUM LEAKAGE. LEAK DEPLETES BOTH AFFECTED ENGINE AND PNEUMATIC SYSTEM, REQUIRING INTERCONNECT IN FROM A SECOND ENGINE TO REACH A SAFE SHUTDOWN MODE.
- 2,3) BOTH REMAINING INTERCONNECT "OUT" CHECK VALVES FAIL TO OPEN/REMAIN OPEN.

RESULTS IN LOSS OF HELIUM SUPPLY TO THE AFFECTED ENGINE. INTERRUPTION OF FLOW TO HIGH PRESSURE OXIDIZER TURBOPUMP INTERMEDIATE SEAL MAY RESULT IN UNCONTAINED ENGINE FAILURE PRIOR TO SAFE REDLINE SHUTDOWN. POSSIBLE LOSS OF CREW/VEHICLE.

CASE 2:

1R/3 5 SUCCESS PATHS. TIME FRAME - ASCENT.

- 1) PNEUMATIC ACCUMULATOR SYSTEM LEAKAGE DEPLETING ACTUATION PRESSURE FOR CLOSURE OF LO2 PREVALVES AT MECO.
- 2) EITHER MPS PNEUMATIC ISOLATION VALVE (LV7 OR LV8) FAILS OPEN PREVENTING ISOLATION OF MPS PNEUMATIC SUPPLY.
- 3) EITHER E2 INTERCONNECT "IN" CHECK VALVE FAILS TO CHECK OR E2 INTERCONNECT "OUT" SOLENOID VALVE FAILS OPEN ALLOWING E2 SUPPLY PRESSURE TO DECAY WITH PNEUMATIC SUPPLY PRESSURE.
- 4,5) BOTH E1 AND E3 INTERCONNECT "OUT" CHECK VALVES (CV28 & CV 44) FAIL TO OPEN, PREVENTING USE OF SURPLUS ENGINE HELIUM SUPPLY TO REPLENISH ACCUMULATOR SUPPLY PRESSURE.

LOSS OF PNEUMATIC ACTUATION HELIUM RESULTS IN LO2 PREVALVE FAILING TO CLOSE AND INABILITY TO MAINTAIN INJECTED HELIUM AND LO2 PRESSURE TO THE HIGH PRESSURE OXYGEN TURBOPUMP TO PREVENT PUMP OVERSPEED AND CAVITATION AT MECO. RESULTS IN UNCONTAINED ENGINE DAMAGE, AFT COMPARTMENT OVERPRESSURIZATION, AND FIRE/EXPLOSION HAZARD. AT MECO, THE ENGINE 2 HELIUM SUPPLY IS SWITCHED INTO THE PNEUMATIC VALVE SYSTEM (VIA LV10) AS A BACKUP, BY SOFTWARE COMMAND, WHICH MAY ACTUATE THE LO2 PREVALVES CLOSED. POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

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(A) DESIGN:

THE CHECK VALVE IS A POPPET TYPE, SPRING LOADED AND PRESSURE ASSISTED TO THE CLOSED POSITION. THE POPPET AND SPRING ARE CONTAINED IN A THREADED HOUSING AND END CAP. THE POPPET SEAL IS A SELF-CENTERING TEFLON O-RING. THE VALVE BODY IS DESIGNED TO A FACTOR OF SAFETY OF 2.0 PROOF AND 4.0 BURST. THE VALVE BODY PROVIDES A GUIDE FOR THE POPPET TRAVEL.

FAILURE OF THE CHECK VALVE TO REMAIN OPEN WOULD REQUIRE BINDING OF THE POPPET SKIRT AND BORE. INLET PRESSURES OF APPROXIMATELY 750 PSIA, HOWEVER, WILL ACT AGAINST ANY TENDENCY FOR THE POPPET TO STICK.

THE POPPET IS MADE OF 316 CRES AND HAS A DESIGN FACTOR OF SAFETY OF 2.0 PROOF AND 4.0 BURST. THE MOVING PARTS HAVE LITTLE TENDENCY TO GALL DUE TO THE LIGHT SIDE LOADS RESULTING FROM THE SYMMETRICAL GEOMETRY. THE USE OF 316 CRES AGAINST INCONEL 718 FOR THE END PIECE ALSO REDUCES THE GALLING TENDENCY.

GALLING OR STICTION MAY BE CAUSED BY CONTAMINATION ON HOUSING BORE AND GUIDED SECTION OF THE POPPET.

FAILURE TO OPEN DUE TO CONTAMINATION IS AVOIDED BY THE FILTRATION OF THE FACILITY SUPPLIED GASSES TO 25 MICRONS ABSOLUTE IN THE GROUND SYSTEM.

(B) TEST:

ATP

EXAMINATION OF PRODUCT
AMBIENT TEMPERATURE TESTS
BODY PROOF PRESSURE (9090 PSIG)
CLOSURE DEVICE PROOF PRESSURE (9090 PSIG)
EXTERNAL LEAKAGE (4500 PSIG)
INTERNAL LEAKAGE (5, 50, 300, 4500 PSIG)

LOW TEMPERATURE TESTS (-160 DEG F)
CRACKING AND RESEAT PRESSURE: 3 CYCLES
CRACKING PRESSURE 5 PSID MAX
RESEAT PRESSURE 2 PSID MIN
INTERNAL LEAKAGE (5, 50, 300, 4500 PSIG)

CERTIFICATION

FLOW TEST (0.05 LB/SEC HE)
MAX INLET PRESSURE 4200 PSIG
PRESSURE DROP (10 PSID MAX)

CHATTER TEST (4200 TO 0 PSIG)
RECORD FLOW RATE WHEN CHATTER OCCURS

CRACKING AND RESEAT PRESSURE
AMBIENT AND LOW TEMPERATURE (-160 DEG F): 3 CYCLES EACH
CRACKING PRESSURE 5 PSID MAX

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RESEAT PRESSURE 2 PSID MIN

INTERNAL LEAKAGE
AMBIENT (0 TO 4500 PSIG)
LOW TEMPERATURE (-160 DEG F, 0 TO 4500 PSIG)

LIFE CYCLE TEST

ONE CYCLE CONSISTS OF INLET PRESSURE OF 4200 PSIG FOLLOWED BY CHECKING PRESSURE OF 4500 PSIG

AMBIENT
4000 CYCLES FOLLOWED BY CRACKING, RESEATING, AND LEAKAGE TESTS

LOW TEMPERATURE (-160 DEG F)
1000 CYCLES FOLLOWED BY CRACKING, RESEATING, INTERNAL LEAKAGE, FLOW, PRESSURE DROP, AND EXTERNAL LEAK TESTS

EXTERNAL LEAKAGE TEST (1 SCCH MAXIMUM AT 4500 PSIG)

VIBRATION AND SHOCK (AMBIENT TEMPERATURE AND PRESSURE)
BY SIMILARITY TO VALVE TYPES III, IVR, AND V (RI DASH NUMBERS -0003, - 0005, AND -0014 RESPECTIVELY). THESE UNITS WERE TESTED IN EACH OF TWO AXIS 48 MINUTES FOR RANDOM VIBRATIONS AND SUBJECTED TO A SWEEP CYCLE TO COVER SHOCK REQUIREMENTS.

BURST PRESSURE (18,000 PSIG)

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

(C) INSPECTION:

RECEIVING INSPECTION
ALL RAW MATERIALS ARE VERIFIED FOR MATERIAL AND PROCESS CERTIFICATION. RECEIVING INSPECTION VERIFIES CERTIFICATION OF SPRING HEAT TREATMENT AND PERFORMS LOAD TEST OF SPRINGS.

CONTAMINATION CONTROL
ALL PARTS AND ASSEMBLIES ARE MAINTAINED TO CLEANLINESS LEVEL OF 100A.

ASSEMBLY/INSTALLATION
DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. REQUIRED TORQUES ARE VERIFIED PRIOR TO WELDING. INSPECTION POINTS ARE ESTABLISHED TO VERIFY ASSEMBLY PROCESS. WELDS ARE VISUALLY VERIFIED BY 10X MAGNIFICATION.

CRITICAL PROCESSES
ALL WELDING, ELECTROPOLISHING AND PARTS PASSIVATION ARE VERIFIED BY INSPECTION. DRY FILM LUBRICANT COATED THREADS ARE VERIFIED PER DRAWING REQUIREMENT.

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NONDESTRUCTIVE EVALUATION
HELIUM LEAKAGE DETECTION IS PERFORMED.

TESTING
ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING
PACKAGING FOR SHIPMENT IS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

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