

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0411 -X

SUBSYSTEM NAME: MAIN PROPULSION**REVISION:** 1 08/09/00**PART DATA**

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: LH2 RECIRCULATION MANIFOLD RELIEF VALVE (RV7) CIRCLE SEAL	ME284-0474-0003

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

VALVE, RELIEF. LH2 RECIRCULATION RETURN/TOPPING SYSTEM. 3/8 INCH DIAMETER.

REFERENCE DESIGNATORS: RV7**QUANTITY OF LIKE ITEMS:** 1**FUNCTION:**

PROVIDES MEANS OF RELIEVING EXCESS PRESSURE FROM THE PORTION OF LH2 RECIRCULATION SYSTEM BETWEEN THE ENGINE BLEED VALVES, TOPPING VALVE (PV13), AND RECIRCULATION RETURN DISCONNECT (PD3). THE RECIRCULATION RETURN DISCONNECT IS CLOSED FOLLOWING SSME SHUTDOWN. THE VALVE RELIEVES LH2 FROM THE RECIRC SYSTEM INTO THE LH2 FEED MANIFOLD.

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SUBSYSTEM NAME: MAIN PROPULSION

LRU: LH2 RECIRC MANIFOLD RELIEF VALVE (RV7)

CRITICALITY OF THIS

ITEM NAME: LH2 RECIRC MANIFOLD RELIEF VALVE (RV7)

FAILURE MODE: 1R2

FAILURE MODE:

FAILS TO OPEN/RELIEVE FOLLOWING CLOSURE OF ET/ORBITER RECIRCULATION DISCONNECT VALVE (PD3).

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) N/A
C) PASS

PASS/FAIL RATIONALE:

A)

B)

RELIEF VALVE IS STANDBY REDUNDANT TO MANIFOLD OVERPRESSURIZATION. FAILURE IS NOT DETECTABLE SINCE THERE IS NO INSTRUMENTATION IN THE RECIRCULATION MANIFOLD.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

LOSS OF REDUNDANCY TO RELIEVE THE LH2 RECIRCULATION RETURN/TOPPING SYSTEM. THE RECIRCULATION RETURN DISCONNECT (PD3) IS NORMALLY OPEN; THE VALVE IS CLOSED FOLLOWING MECO OR AN ENGINE SHUTDOWN. SSME BLEED VALVE(S) ARE

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OPENED AT ENGINE SHUTDOWN PLUS 16 SECONDS. ANALYSIS INDICATES THAT PRESSURE BUILDUP IN THE RECIRCULATION SYSTEM DURING THE 16 SECOND PERIOD BETWEEN SSME SHUTDOWN AND OPENING OF THE ENGINE BLEED VALVE IS INSUFFICIENT TO BURST THE LINE.

(B) INTERFACING SUBSYSTEM(S):

SAME AS A.

(C) MISSION:

NO EFFECT ON MISSION OR CREW/VEHICLE.

(D) CREW, VEHICLE, AND ELEMENT(S):

SAME AS C.

(E) FUNCTIONAL CRITICALITY EFFECTS:

CASE 1:

1R/2 2 SUCCESS PATHS. TIME FRAME - ASCENT.

- 1) LH2 RECIRC DISCONNECT (PD3) FAILS TO REMAIN OPEN.
- 2) RECIRC RELIEF VALVE (RV7) FAILS TO RELIEVE.

PRESSURE BUILDUP FROM BOILOFF OF TRAPPED LH2 MAY RUPTURE THE RECIRCULATION SYSTEM. POSSIBLE LOSS OF ADJACENT CRITICAL COMPONENTS DUE TO CRYOGENIC EXPOSURE. POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION AND FIRE/EXPLOSION HAZARD. POSSIBLE LOSS OF CREW/VEHICLE.

CASE 2:

1R/3 3 SUCCESS PATHS. TIME FRAME - PREMATURE SHUTDOWN.

- 1) PREMATURE SSME SHUTDOWN.
- 2) BLEED VALVE FAILS TO OPEN ON SHUTDOWN ENGINE.
- 3) RECIRC RELIEF VALVE (RV7) FAILS TO RELIEVE.

UPON OCCURRENCE OF FIRST FAILURE, ORBITER SOFTWARE WILL CLOSE PD3. SAME EFFECTS AS CASE 1 ABOVE.

CASE 3:

1R/3 4 SUCCESS PATHS. TIME FRAME - BETWEEN MECO AND DUMP OR PAD ABORT AND DETANK INITIATION.

- 1,2,3) ALL THREE ENGINE BLEED VALVES FAIL TO OPEN AT MECO.
- 4) RECIRC RELIEF VALVE (RV7) FAILS TO RELIEVE.

SAME EFFECTS AS CASE 1 ABOVE.

CASE 4:

1R/2 2 SUCCESS PATH. TIME FRAME - POST LH2 DUMP, AFTER BLEED VALVES CLOSE.

- 1) INCOMPLETE LH2 DUMP DUE TO FAILURE OF TOPPING VALVE (PV13) TO OPEN/REMAIN OPEN.
- 2) RECIRC RELIEF VALVE (RV7) FAILS TO RELIEVE.

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SAME EFFECTS AS CASE 1 ABOVE.

-DISPOSITION RATIONALE-

(A) DESIGN:

THIS RELIEF VALVE IS AN OFF THE SHELF ITEM SIMILAR IN CONSTRUCTION TO AN IN-LINE CHECK VALVE. THE DESIGN CONSISTS OF A POPPET, A SPRING SEAT, AND A NUT, ALL OF 316 CRES; A ONE PIECE BODY OF INCONEL 718; A SPRING OF 302 CRES; AND A RESILIENT SEAL RING OF TEFLON. THE POPPET IS SPRING LOADED IN THE CLOSED POSITION. THE RESILIENT TEFLON SEALING RING, RETAINED IN A GROOVE IN THE POPPET, SEALS AGAINST A SPHERICAL SURFACE MACHINED IN THE BODY. UPSTREAM PRESSURE OVERCOMES THE SPRING FORCE TO UNSEAT THE POPPET. IF THE DOWNSTREAM PRESSURE IS GREATER THAN THE UPSTREAM PRESSURE THE DIFFERENTIAL WILL AID IN SEALING.

THE ONLY PART THAT COULD BIND WOULD BE THE POPPET ASSEMBLY SPRING SEAT AT THE HOUSING INTERFACE. THIS IS MORE LIKELY TO OCCUR AFTER THE VALVE HAS OPENED (WHEN THE POPPET COULD POSSIBLY COCK). HOWEVER, IN QUAL TESTING, NO SUCH PROBLEM WAS DETECTED AFTER 1400 CYCLES (1000 AT CRYO TEMPS).

(B) TEST:

ATP

EXAMINATION OF PRODUCT

AMBIENT PROOF PRESSURE:

260 PSIG ON INLET AND OUTLET, 260 PSID OUTLET TO INLET

CRYO CRACK AND RESEAT PRESSURE:

-300 DEG F; 5 TO 40 PSIG

AMBIENT EXTERNAL LEAKAGE: 130 PSIG HELIUM

CRYO REVERSE FLOW SEAT LEAKAGE:

-300 DEG F, UP TO 130 PSIG HELIUM ON OUTLET

CERTIFICATION

CRACK AND RESEAT PRESSURE:

-413 DEG F, 5 TO 40 PSIG HELIUM

REVERSE FLOW SEAT LEAKAGE:

-413 DEG F, UP TO 130 PSIG HELIUM, 10 SCIM

PRESSURE DROP:

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LIQUID HYDROGEN AT 100 PSIA INLET, 40 PSID MAX

VIBRATION TEST: VALVE BODY AT -300 DEG F FOR DURATION OF TEST

TRANSIENT SHOCK - SINUSOIDAL SWEEP OF 5 TO 35 HZ.

RANDOM VIBRATION - 48 MINUTES/AXIS TOTAL EXPOSURE TIME

VISUAL INSPECTION, CRACK AND RESEAT PRESSURE AT -300 DEG F AND ROOM AMBIENT, REVERSE FLOW LEAKAGE AT ROOM AMBIENT.

LIFE CYCLE:

AMBIENT: 400 CYCLES, DRY AIR AT ROOM AMBIENT

CRYO (-300 DEG F): 1000 CYCLES, LN2

CRACK PRESSURE, RESEAT PRESSURE, AND REVERSE FLOW LEAKAGE AT -300 DEG F AFTER 400 ROOM AMBIENT CYCLES AND AFTER 1000 CRYO CYCLES.

AT CONCLUSION OF LIFE CYCLE TEST: CRACK PRESSURE, RESEAT PRESSURE, AND REVERSE FLOW LEAKAGE AT STABILIZED ROOM AMBIENT. DISASSEMBLY OF UNIT AND VISUAL INSPECTION OF ALL PARTS (REASSEMBLED FOR BURST TEST)

BURST TEST:

520 PSIG ON INLET AND OUTLET, 520 PSID OUTLET TO INLET

GROUND TURNAROUND TEST

ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING INSPECTION

RAW MATERIALS ARE SUBJECTED TO VERIFICATION OF MATERIAL CERTIFICATION. MATERIAL INSPECTION INCLUDES BOTH VISUAL AND DIMENSIONAL EXAMINATIONS. CERTIFYING DOCUMENTATION SUCH AS TEST REPORTS AND RECORDS ARE MAINTAINED IN ACCORDANCE WITH MATERIALS RECEIVED. RECEIVING INSPECTION VERIFIES CERTIFICATION OF SPRING HEAT TREATMENT AND PERFORMS LOAD TEST OF SPRINGS.

CONTAMINATION CONTROL

CONTAMINATION CONTROL PROCESSES ARE VERIFIED. PARTS ARE ASSEMBLED IN A CLEANROOM (CLASS 10,000). CLEANLINESS TO LEVEL 400 IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

DRAWING TORQUE REQUIREMENTS, DIMENSIONS, AND SURFACE FINISHES ARE VERIFIED. ALL PARTS VISUALLY INSPECTED. SEALS ARE VISUALLY EXAMINED FOR BURRS AND CONTAMINATION. ELECTROCHEM ETCH MARKING IS VERIFIED BY INSPECTION. INSTALLATION AND ASSEMBLY OPERATIONS VERIFIED AT MANDATORY INSPECTION POINTS.

CRITICAL PROCESS

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PARTS PASSIVATION VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
LEAK TEST IS VERIFIED BY INSPECTION.

TESTING
ATP, INCLUDING PROOF PRESSURE TEST, IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING
IN PROCESS OPERATIONS ARE VERIFIED BY INSPECTION TO PROTECT PARTS AND
PRECLUDE MISHANDLING. PARTS PACKAGING 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