

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 REMAIN CLOSED/CHECK DURING ASCENT.

MISSION PHASE:

PL PRE-LAUNCH
LO LIFT-OFF

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102 COLUMBIA
103 DISCOVERY
104 ATLANTIS
105 ENDEAVOUR

CAUSE:

PIECE PART STRUCTURAL FAILURE

CRITICALITY 1/1 DURING INTACT ABORT ONLY? YES

AOA ABORT ONCE AROUND
ATO ABORT TO ORBIT
PAD PAD ABORT
RTLS RETURN TO LAUNCH SITE
TAL TRANS-ATLANTIC LANDING

REDUNDANCY SCREEN

A) PASS
B) FAIL
C) PASS

PASS/FAIL RATIONALE:

A)

B)

SCREEN B FAILS DUE TO LACK OF INSTRUMENTATION.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

CASE 1: NOMINAL MISSIONS

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NO EFFECT, FAILURE PERMITS MINOR FLOW BETWEEN THE RECIRCULATION RETURN SYSTEM AND THE LH2 FEED SYSTEM.

LOSS OF REDUNDANCY TO PREVENT LH2 LEAKAGE INTO AFT COMPARTMENT. RECIRC RELIEF VALVE WILL FAIL TO ISOLATE A SHUTDOWN ENGINE WITH UNCONTAINED DAMAGE (ASSUMES ENGINE IS DAMAGED ONLY TO THE EXTENT THAT ISOLATION OF THE DAMAGE WILL SAFE THE SYSTEM). THE RECIRC RETURN DISCONNECT IS CLOSED FOLLOWING ENGINE SHUTDOWN TO ISOLATE ORBITER SYSTEM FROM ET.

CASE 2: IN FLIGHT ABORT

RECIRC RELIEF VALVE WILL FAIL TO ISOLATE A SHUTDOWN ENGINE WITH UNCONTAINED DAMAGE (ASSUMES ENGINE IS DAMAGED ONLY TO THE EXTENT THAT ISOLATION OF THE DAMAGE WILL SAFE THE SYSTEM). THE RECIRC RETURN DISCONNECT IS CLOSED FOLLOWING ENGINE SHUTDOWN TO ISOLATE ORBITER SYSTEM FROM ET.

CASE 3: PAD ABORT

RECIRC RELIEF VALVE WILL FAIL TO ISOLATE A SHUTDOWN ENGINE WITH UNCONTAINED DAMAGE (ASSUMES ENGINE IS DAMAGED ONLY TO THE EXTENT THAT ISOLATION OF THE DAMAGE WILL SAFE THE SYSTEM) OR MAIN FUEL VALVE INTERNAL LEAKAGE. THE RECIRC RETURN DISCONNECT IS CLOSED FOLLOWING ENGINE SHUTDOWN TO ISOLATE ORBITER SYSTEM FROM ET.

(B) INTERFACING SUBSYSTEM(S):

SAME AS A.

(C) MISSION:

NO EFFECT.

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

SAME AS C.

(E) FUNCTIONAL CRITICALITY EFFECTS:

1R2 2 SUCCESS PATHS. TIME FRAME - PREMATURE ENGINE SHUTDOWN (NOMINAL MISSIONS)

- 1) PREMATURE ENGINE SHUTDOWN INCLUDING LOSS OF LH2 SYSTEM INTEGRITY.
- 2) RECIRC RELIEF VALVE (RV7) FAILS TO REMAIN CLOSED/CHECK.

RESULTS IN LH2/GH2 LEAKAGE INTO THE AFT COMPARTMENT UPON BLEED VALVE OPENING. POSSIBLE LOSS OF ADJACENT CRITICAL FUNCTIONS DUE TO CRYO EXPOSURE. POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION AND FIRE/EXPLOSION HAZARD. POSSIBLE LOSS OF CREW/VEHICLE.

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-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 (32 MICROINCH SURFACE FINISH). 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.

IF ANY OF THE INTERNAL PARTS WERE TO FAIL STRUCTURALLY, THE VALVE WOULD FAIL OPEN. STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF VALVE OPERATION. THE CURRENT SEAL/POPPET CONFIGURATION HAS PASSED REVERSE FLOW SEAT LEAKAGE REQUIREMENTS AT CRYOGENIC TEMPERATURES DURING ACCEPTANCE AND CERTIFICATION TESTING. THE VALVE IS DESIGNED FOR A USEFUL LIFE OF 1400 CYCLES (100 ORBITER MISSION EQUIVALENT) AND FACTOR OF SAFETY OF 2.0 PROOF; 4.0 BURST.

(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:

LIQUID HYDROGEN AT 100 PSIA INLET, 40 PSID MAX

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

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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

PARTS PASSIVATION VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

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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:

LEAKAGE DURING QUAL TEST UNDER CRYOGENIC CONDITIONS WAS ATTRIBUTED TO THE DESIGN OF THE VALVE (REFERENCE CAR A9400). THE VALVE WAS REDESIGNED TO INCREASE SEAL COMPRESSION AND ELIMINATE METAL-TO-METAL CONTACT OF THE SEAT AND POPPET. THE REDESIGNED UNIT, WHICH IS ON ALL VEHICLES, OPERATES PROPERLY THROUGHOUT THE OPERATING TEMPERATURE RANGE.

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:

FLIGHT:

NO CREW ACTION CAN BE TAKEN.

GROUND:

GROUND OPERATIONS SAFING PROCEDURES CONTAIN SAFING SEQUENCE OF EVENTS FOR MAJOR LEAKS IN THE HYDROGEN SYSTEM.

- 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