

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0412 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 07/26/00

PART DATA

| | PART NAME | PART NUMBER |
|-----|---|----------------------|
| | VENDOR NAME | VENDOR NUMBER |
| LRU | : LO2 MANIFOLD RELIEF VALVE UNITED SPACE ALLIANCE - NSLD | MC284-0501-0001 |

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

VALVE, RELIEF, 1 INCH, LO2 FEEDLINE MANIFOLD RELIEF.

VALVE WAS ORIGINALLY DESIGNED AND MANUFACTURED BY PARKER-HANNIFIN. THE UNITED SPACE ALLIANCE-NSLD IS A CERTIFIED REPAIR DEPOT BUT HAS NOT YET BEEN CERTIFIED AS AN ALTERNATE PRODUCTION AGENCY.

REFERENCE DESIGNATORS: RV5

QUANTITY OF LIKE ITEMS: 1

FUNCTION:

RELIEVES PRESSURE BUILDUP FROM LO2 MANIFOLD. NOT NORMALLY REQUIRED TO OPERATE. THE MAIN POPPET OF THE VALVE IS ISOLATED FROM THE FEED SYSTEM UNTIL MECO BY THE UPSTREAM FEEDLINE RELIEF SHUTOFF VALVE (PV7). THE RELIEF VALVE INCORPORATES A SENSE PORT WHICH SENSES THE LO2 MANIFOLD PRESSURE VIA A SENSE LINE. THE CRACKING AND RESEAT PRESSURES ARE BETWEEN 190 & 220 PSIG.

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LRU: VALVE, RELIEF

ITEM NAME: LO2 MANIFOLD RELIEF VALVE (RV5)

CRITICALITY OF THIS

FAILURE MODE: 1/1

FAILURE MODE:

RUPTURE/LEAKAGE OF THE VALVE BODY DURING LOADING, ASCENT, AND DUMP/ INERT.

MISSION PHASE:

PL PRE-LAUNCH

LO LIFT-OFF

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102 COLUMBIA

103 DISCOVERY

104 ATLANTIS

105 ENDEAVOUR

CAUSE:

FATIGUE, MATERIAL DEFECTS, DAMAGED/DEFECTIVE BODY JOINT SEALS.

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:

LO2 LEAKAGE INTO THE AFT COMPARTMENT FROM MANIFOLD SENSE LINE (VALVE INLET IS NOT EXPOSED TO LO2 UNTIL RELIEF SHUTOFF VALVE (PV7) IS OPENED AT MECO).

POSSIBLE LOSS OF ADJACENT CRITICAL FUNCTIONS DUE TO CRYO EXPOSURE. POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION AND FIRE/EXPLOSION HAZARD. LEAKAGE INTO AFT COMPARTMENT DETECTABLE DURING PROPELLANT LOADING USING HAZARDOUS GAS DETECTION SYSTEM (HGDS).

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ALSO RESULTS IN POSSIBLE LOSS OF HELIUM SUPPLY DURING MANIFOLD REPRESSURIZATION CAUSING LOSS OF AFT COMPARTMENT PURGE (RTL5 AND TAL ABORT CRITICAL).

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

(C) MISSION:
ON GROUND, VIOLATION OF HGDS LCC REQUIREMENT WILL RESULT IN LAUNCH SCRUB.

(D) CREW, VEHICLE, AND ELEMENT(S):
POSSIBLE LOSS OF CREW/VEHICLE.

(E) FUNCTIONAL CRITICALITY EFFECTS:
1R/2 2 SUCCESS PATHS. TIME FRAME – LOADING/ASCENT.
1) RELIEF VALVE (RV5) RUPTURES/EXTERNAL LEAKAGE.
2) LO2 MANIFOLD RELIEF SHUTOFF VALVE (PV7) FAILS TO REMAIN CLOSED/LEAKS.

RESULTS IN LO2 LEAKAGE INTO THE AFT COMPARTMENT. POSSIBLE LOSS OF ADJACENT CRITICAL FUNCTIONS DUE TO CRYO EXPOSURE. POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION AND FIRE/EXPLOSION HAZARD. LEAKAGE INTO AFT COMPARTMENT DETECTABLE DURING PROPELLANT LOADING USING HAZARDOUS GAS DETECTION SYSTEM (HGDS).

-DISPOSITION RATIONALE-

(A) DESIGN:
THE RELIEF VALVE CONSISTS OF TWO SECTIONS: A PRESSURE ACTUATED MAIN POPPET SECTION AND A PILOT SECTION WHICH SENSES MANIFOLD PRESSURE BY MEANS OF A SENSING LINE.

THE PILOT SECTION CONTROLS THE OPENING AND CLOSING OF THE MAIN POPPET BY ALLOWING THE MANIFOLD PRESSURE TO ENTER OR EXIT A CONTROL CHAMBER. WHEN THE MANIFOLD PRESSURE REACHES A PREDETERMINED PILOT SETTING, THE PILOT VENTS THE CHAMBER PRESSURE OVERBOARD ALLOWING THE PRESSURE DIFFERENTIAL ACROSS THE MAIN POPPET TO PUSH THE MAIN POPPET OPEN. ONCE THE MANIFOLD PRESSURE DROPS BELOW THE PILOT CONTROL SETTING, THE PILOT POPPET CLOSSES, THE MANIFOLD PRESSURE ENTERS THE CONTROL CHAMBER, AND THE MAIN POPPET CLOSSES.

THE END CAP, THE PILOT HOUSING, AND THE MAIN BODY ARE CONSTRUCTED OF 6061-T651 ALUMINUM ALLOY. THE INTERMEDIATE HOUSING IS CONSTRUCTED OF 304L CRES. THE

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THERMAL ISOLATOR IS CONSTRUCTED OF VESPEL SP21. THE MAIN SEAT VALVE HOUSING IS CONSTRUCTED OF PH13-8MO CRES.

THE VALVE IS DESIGNED FOR A STRUCTURAL FACTOR OF SAFETY OF 2.0 PROOF, 4.0 BURST. IT IS DESIGNED FOR 10,000 CYCLES (100 MISSION EQUIVALENT) AND TESTED THROUGH A TOTAL OF 5000 CYCLES UNDER CRYOGENIC AND AMBIENT TEMPERATURES.

THERE ARE SIX EXTERNAL LEAK PATHS. THEY ARE SEALED USING SPRING LOADED FACE SEALS (SPRING IS INCONEL, JACKET IS TEFLON). THE VALVE BODY SEALING SURFACES HAVE 8 MICROINCH SURFACE FINISH.

(B) TEST:

ATP

VISUAL INSPECTION

STROKE VERIFICATION OF MAIN POPPET (0.225 +/- 0.002 INCH)

AMBIENT TEST

PROOF PRESS: VALVE BODY, 440 PSIG INLET & SENSE PORT, 450 PSIG OUTLET

INTERNAL LEAKAGE:

1 TO 180 PSIG GHE AT INLET AND SENSE PORT;
10 SCIM MAX AT OUTLET PORT

EXTERNAL LEAKAGE: 220 PSIG GHE; 5 SCIM MAX

CRACK/RESEAT: 190 TO 220 PSIG

REVERSE FLOW LEAKAGE:

10 PSID GHE OUTLET TO INLET
MAIN SEAT LEAKAGE 50 SCIM MAX
PILOT REVERSE LEAKAGE 1700 SCIM MAX.

CRYOGENIC TEST (GHE AT -300 DEG F):

CRACK/RESEAT: 190 TO 220 PSIG, VALVE BODY AMBIENT

EXTERNAL LEAKAGE: 220 PSIG, 10 SCIM MAX, VALVE BODY -100 DEG F

INTERNAL LEAKAGE: 180 PSIG, 10 SCIM MAX, VALVE BODY -100 DEG F

CERTIFICATION

LIFE TEST

CRYO - 4500 CYCLES OPEN AND CLOSED USING LN2, VALVE CHECKED FOR INTERNAL LEAKAGE AFTER EACH 500 CYCLES, VALVE CHECKED FOR CRYO INTERNAL LEAKAGE AFTER EACH 1500 CYCLES.

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AMBIENT - 500 CYCLES, VALVE INTERNAL LEAK CHECK EACH 50 CYCLES.

CRYO STEADY STATE FLOW TEST

SENSES PORT PRESS AT 230 PSIG GHE AT -320 DEG F FLOW RATE OF 197 GPM LN2
AT 103 PSID

CRYO RESPONSE TEST

1.5 SEC TO INDICATE STEADY FLOW AFTER CRACKING WITH LN2

CRYO FUNCTIONAL TEST USING LN2

CRACKED AT 208 PSIG; RESEAT AT 192 PSIG

RANDOM VIBRATION 13.3 HOURS IN EACH OF THE THREE AXES

FIRST 4 HOUR AND 26 MINUTE PERIOD
ENVIRONMENT: AMBIENT
SENSE PORT: 180 PSIG GHE AT -320 DEG F
MAIN INLET: AMBIENT

SECOND 4 HOUR AND 26 MINUTE PERIOD
ENVIRONMENT: AMBIENT TO +100 TO -100 TO AMBIENT
SENSE PORT: 180 PSIG GHE AT -320 DEG F
MAIN INLET: 180 PSIG GHE AT -320 DEG F

THIRD 4 HOUR AND 26 MINUTE PERIOD
ENVIRONMENT: AMBIENT
SENSE PORT: 180 PSIG GHE AT -320 DEG F
MAIN INLET: 180 PSIG LN2

CRACK/RESEAT AND INTERNAL LEAKAGE PERFORMED AT COMPLETION OF EACH
AXIS OF VIBRATION.

BENCH HANDLING AND DESIGN SHOCK PER MIL-STD-810
FOLLOWED BY AMBIENT CRACK/RESEAT AND INTERNAL LEAKAGE TESTS.

THERMAL CYCLE TEST (3 CYCLES)

VALVE AT 70 DEG F; SHOCKED WITH -300 DEG F FLUID FOR 20 MINUTES MIN; VALVE
ALLOWED TO WARM UP TO 70 DEG F; VALVE HEATED TO 275 DEG F FOR 15
MINUTES. DURING THE 15 MINUTES THE VALVE WAS TESTED FOR AMBIENT
CRACK/RESEAT PRESSURE.

ELECTRICAL BONDING

BURST TEST

880 PSIG ON SENSE AND INLET PORTS, 1200 PSIG ON OUTLET PORT

GROUND TURNAROUND TEST

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ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING INSPECTION

RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION. PART PROTECTION COATING AND PLATING REQUIREMENTS ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

CONTAMINATION CONTROL PROCESS AND CORROSION PROTECTION PROVISIONS ARE VERIFIED. CLEANLINESS TO LEVEL 400A (PROCUREMENT SPECIFICATION REQUIREMENT IS 800A) VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

ALL CRITICAL DIMENSIONS ARE VERIFIED BY INSPECTION. LOG OF CLEAN ROOM AND TOOL CALIBRATION IS VERIFIED BY INSPECTION. TORQUE PER DRAWING REQUIREMENTS AND SURFACE FINISH ARE VERIFIED BY INSPECTION. SURFACES REQUIRING CORROSION PROTECTION ARE VERIFIED BY INSPECTION. ALL SEALING SURFACES AND SEALS ARE VISUALLY EXAMINED BEFORE INSTALLATION USING 10X MAGNIFICATION. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE MANUFACTURING PROCEDURE.

CRITICAL PROCESSES

HEAT TREATMENT, WELDING, PARTS PASSIVATION, AND ANODIZING ARE VERIFIED. DRY FILM LUBRICANT APPLICATIONS ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

ALL WELDS ARE VISUALLY EXAMINED AND VERIFIED BY DYE PENETRANT. IN ADDITION, BELLOWS WELDS (EXCLUDING END FITTING WELDS) ARE X-RAYED.

TESTING

ATP VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING FOR SHIPPING 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:

FLIGHT

NO CREW ACTION CAN BE TAKEN.

GROUND

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

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- 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 | : CHARLES EBERHART | : /S/ CHARLES EBERHART |
| MPS SUBSYSTEM MGR. | : TIM REITH | : /S/ TIM REITH |
| MOD | : JEFF MUSLER | : /S/ JEFF MUSLER |
| USA SAM | : MICHAEL SNYDER | : /S/ MICHAEL SNYDER |
| USA ORBITER ELEMENT | : SUZANNE LITTLE | : /S/ SUZANNE LITTLE |
| NASA SR&QA | : ERICH BASS | : /S/ ERICH BASS |