

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE**NUMBER: 03-1-0401 -X****SUBSYSTEM NAME:** MAIN PROPULSION**REVISION:** 1 07/12/00**PART DATA**

PART NAME	PART NUMBER
VENDOR NAME	VENDOR NUMBER
LRU : LO2 PREVALVE	MC284-0396-0007,-0009
UNITED SPACE ALLIANCE - NSLD	73325000-115,-119

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

VALVE, PRE, LO2 12 INCH PNEUMATICALLY OPERATED, INCORPORATES REVERSE FLOW RELIEF VALVE

VALVE WAS ORIGINALLY DESIGNED AND MANUFACTURED BY FAIRCHILD CONTROLS BUT IS NOW MANUFACTURED BY UNITED SPACE ALLIANCE-NSLD AS AN ALTERNATE PRODUCTION AGENCY.

REFERENCE DESIGNATORS: PV1
PV2
PV3

QUANTITY OF LIKE ITEMS: 3

FUNCTION:

VALVE OPEN DURING CHILLDOWN AND LOADING. REQUIRED TO REMAIN OPEN DURING ENGINE OPERATION. REVERSE FLOW RELIEF VALVE AND A VISOR LIFTOFF MECHANISM PROVIDE MEANS OF RELIEVING BOILOFF PRESSURE WITHIN FEEDLINE WITH PREVALVE IN CLOSED POSITION. ELECTRICAL CIRCUITRY LOCKOUT PREVENTS PREVALVE CLOSURE UNTIL THRUST CHAMBER PRESSURE DECAYS TO 30% LEVEL DURING A NORMAL MISSION. CLOSING OF THE PREVALVE BECOMES CRITICAL DURING MAIN ENGINE CUTOFF (MECO). DURING THIS ZERO G CONDITION, HELIUM IS INJECTED INTO SYSTEM VIA SSME POGO ACCUMULATOR TO MAINTAIN REQUIRED LO2 PRESSURE AT THE SSME HPOTP TO PREVENT OVERSPEED. USED AS AN ISOLATION VALVE FOR THE PROPELLANT FEED SYSTEM FOR A SHUTDOWN/FAILED SSME. THE VALVE IS REOPENED FOR PROPELLANT DUMP AND CLOSED FOR REENTRY. DURING MECO, THE 30% MINIMUM CHAMBER PRESSURE REQUIREMENT IS REMOVED FROM THE ENGINE OPERATION PARAMETERS. VALVE INCORPORATES AN ANTI-SLAM MECHANISM TO PREVENT VALVE SLAMMING DAMAGE DURING IMPROPER VALVE OPEN/CLOSE OPERATIONS.

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LRU: LO2 PREVALVE (PV1, PV2, PV3)

ITEM NAME: LO2 PREVALVE (PV1, PV2, PV3)

CRITICALITY OF THIS

FAILURE MODE: 1/1

FAILURE MODE:

FAILS TO REMAIN OPEN DURING ENGINE OPERATION.

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? NO

REDUNDANCY SCREEN

A) N/A

B) N/A

C) N/A

PASS/FAIL RATIONALE:

A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

RESULTS IN LOSS OF OXIDIZER FLOW TO ONE ENGINE. OPEN PRESSURE IS CONTINUOUSLY APPLIED TO VALVE DURING ASCENT.

(B) INTERFACING SUBSYSTEM(S):

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ONE ENGINE WOULD SHUTDOWN. POSSIBLE LO2 PUMP CAVITATION AND OVERSPEED, RESULTING IN UNCONTAINED ENGINE DAMAGE. POSSIBLE FEEDLINE/MANIFOLD RUPTURE DUE TO WATER HAMMER EFFECT (LINE PRESSURE IS IN EXCESS 600 PSI). RESULTS IN EARLY LO2 DEPLETION, AFT COMPARTMENT OVERPRESSURE, AND POSSIBLE LOSS OF CRITICAL COMPONENTS DUE TO CRYOGENIC EXPOSURE. POSSIBLE VALVE VISOR FRACTURE AND INGESTION INTO ENGINE (ENGINE INLET SCREENS WOULD NOT CONTAIN PARTS OF THIS SIZE).

(C) MISSION:

VALVE FAILURE TO REMAIN OPEN DURING LOADING HAS NO EFFECT - RESULTS IN LAUNCH SCRUB. FAILURE DURING NORMAL/ABORT DUMPS ALSO HAS NO EFFECT.

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

POSSIBLE LOSS OF CREW/VEHICLE.

(E) FUNCTIONAL CRITICALITY EFFECTS:

NONE.

-DISPOSITION RATIONALE-

(A) DESIGN:

DURING THE BOOST PHASE, THE PREVALVE IS MAINTAINED IN THE OPEN POSITION BY CONTINUOUS OPEN ACTUATION PRESSURE APPLIED TO THE ACTUATOR, AND THE CLOSING PRESSURE VENTED. IN ADDITION, THE VALVE VISOR IS HELD IN THE OPEN POSITION BY TWO MECHANICAL DETENTS. IF THE PNEUMATIC SYSTEM (OPEN COMMAND) WERE TO BE COMPLETELY VENTED, THE DETENTS WOULD BE SUFFICIENT TO RESTRAIN THE VISOR IN THE OPEN POSITION. A FULL FLOW LN2 DETENT VERIFICATION TEST HAS BEEN SUCCESSFULLY PERFORMED. DURING QUAL TESTING THE VALVE WAS VIBRATED IN ALL THREE AXES, WITH THE ACTUATOR VENTED, AND THE DETENTS HELD THE VISOR IN THE OPEN POSITION. THE VALVE DESIGN IS SUCH THAT THE VISOR IS COMPLETELY OUT OF THE FLOW STREAM WHEN IN THE OPEN POSITION. THE VISOR RESTS BEHIND A FLOW LINER WHEN IT IS IN THE OPEN POSITION.

(B) TEST:

ATP

ACTUATOR - AMBIENT PROOF (1275 PSIG); CRYO PROOF OF ACTUATOR FLANGE AND SHAFT SEALS (358 PSID); POSITION INDICATION; ELECTRICAL CHARACTERISTICS; AMBIENT AND CRYO RESPONSE TIME (NORMAL AND SLAM) AT 400 AND 740 PSIG ACTUATION PRESSURE; AMBIENT AND CRYO LEAKAGE (FROM PORT TO PORT); AMBIENT AND CRYO SHAFT SEAL LEAKAGE (PRIMARY AND SECONDARY) WITH 220 PSID ACROSS SEAL; AMBIENT AND CRYO EXTERNAL LEAKAGE.

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RELIEF VALVE ASSEMBLY - AMBIENT PROOF (299 PSIG), AMBIENT AND CRYO CRACK AND RESEAT (15-50 PSID).

PREVALVE ASSEMBLY - POSITION INDICATION; ELECTRICAL CHARACTERISTICS; VALVE HOUSING AND VISOR AMBIENT PROOF (299 PSIG); VALVE HOUSING AND VISOR CRYO PROOF (358 PSID); ACTUATOR AMBIENT PROOF (1275 PSIG); AMBIENT AND CRYO EXTERNAL LEAKAGE (WITH VALVE BODY AT 220 PSIG AND ACTUATOR AT 740 PSIG); AMBIENT AND CRYO RESPONSE TIME AT 400 AND 740 PSIG ACTUATION PRESSURE; AMBIENT AND CRYO ACTUATOR LEAKAGE FROM PORT TO PORT; AMBIENT AND CRYO VALVE SHAFT SEAL (PRIMARY AND SECONDARY) LEAKAGE WITH 220 PSID ACROSS THE SEAL; AMBIENT AND CRYO VISOR LEAKAGE (INLET-TO-OUTLET WITH 200 PSID, OUTLET-TO-INLET WITH 5 PSID AMBIENT AND 15 PSID CRYO); AMBIENT RELIEF VALVE CRACK (6.7 TO 50 PSID) AND RESEAT (5 TO 50 PSID) WITH ACTUATOR CLOSE PRESSURE ON; CRYO RELIEF VALVE CRACK AND RESEAT (15 TO 50 PSID) WITH ACTUATOR CLOSE PRESSURE ON; AMBIENT VISOR LIFT-OFF (15 PSID MAX) WITH ACTUATOR VENTED.

CERTIFICATION

STRUCTURAL LOAD AT CRYO TEMPS (-300 DEG F) (AXIAL, SHEAR, TORSION, BENDING)

LIFE CYCLING (3050 AMBIENT CYCLES, 2050 CRYO CYCLES. ACTUATOR RECEIVED ADDITIONAL 300 AMBIENT AND 200 CRYO SLAM CYCLES); RELIEF VALVE LIFE (500 CYCLES AMBIENT, 500 CYCLES CRYO); ANTI-SLAM VALVE LIFE (2700 CYCLES AMBIENT, 1800 CYCLES CRYO)

THREE THERMAL CYCLES (70 DEG F TO -300 DEG F TO +200 DEG F TO 70 DEG F)

TRANSIENT SINUSOIDAL VIBRATION (AT 200 PSIG AND -250 DEG F); RANDOM VIBRATION (13.3 HRS IN EACH OF THREE AXES WITH VALVE OPEN AND AT 200 PSIG/LESS THAN -250 DEG F. OPEN PRESSURE WAS REMOVED DURING A PORTION OF THE TEST; SUBSEQUENTLY REPEATED TO CERTIFY THE ANTI-SLAM ACTUATOR)

DESIGN SHOCK (18 SHOCKS OF 15G EACH - THREE IN EACH DIRECTION OF THREE AXES, ALL WITH VALVE OPEN AND ACTUATOR VENTED; REPEATED TO CERTIFY THE ANTI-SLAM ACTUATOR)

AMBIENT AND CRYO FUNCTIONAL, INTERNAL AND EXTERNAL LEAKAGE PERFORMANCE

BURST (413 PSIG VALVE BODY, 1700 PSIG ACTUATOR)

OMRSD

ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING INSPECTION

RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL

VALVE IS CLEANED TO LEVEL 800A AND THE ACTUATOR IS CLEANED TO 400A.

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ASSEMBLY/INSTALLATION

ALL PARTS ARE PROTECTED FROM DAMAGE AND CONTAMINATION. LOG OF CLEAN ROOM AND TOOL CALIBRATION ARE VERIFIED BY INSPECTION. MICROSCOPIC EXAMINATION OF ALL DETAIL PARTS ARE MADE PRIOR TO ASSEMBLY. TORQUE REQUIREMENTS VERIFIED BY INSPECTION. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE ASSEMBLY PROCEDURES. CRITICAL DIMENSIONS AND SURFACE FINISHES EXAMINED FROM (3X TO 7X) MAGNIFICATION FOR MATERIAL DEFECTS.

CRITICAL PROCESSES

HEAT TREATMENT AND DRY FILM LUBE APPLICATION ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

FLOW LINER WELD VISUALLY EXAMINED & VERIFIED BY X-RAY. THE VALVE BODY, PRIOR TO FINAL MACHINING, IS SUBJECTED TO DYE PENETRANT INSPECTION. REQUIREMENTS FOR DETAIL PARTS PENETRANT INSPECTION ARE BASED UPON CONFIGURATION, MATERIAL, AND MANUFACTURING PROCESSES.

TESTING

ACCEPTANCE TEST PROCEDURES VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING FOR CLEANLINESS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

HAVE EXPERIENCED VALVE DAMAGE INTERNALLY IN OLDER CONFIGURATION OF THE VALVE (CRACK IN FLOW LINER, CAR A9981, AND MAIN SEAL FRACTURE, CAR AB6078) FROM INCORRECT OPERATION OF THE VALVE (VALVE ACTUATION WITHOUT SNUBBING PRESSURE IN ACTUATOR CAUSES SLAMMING OF THE VALVE). AN ANTI-SLAM MECHANISM HAS BEEN INSTALLED TO PREVENT VALVE DAMAGE DUE TO SLAMMING.

DURING AN INSPECTION OF THE OV-103 DETENT ROLLERS ONE ROLLER WAS FOUND WITH UNEVEN WEAR. THE ROLLER WAS REPLACED WITH A SPECIAL CONTOURED ROLLER TO MATCH THE VISOR DETENT BUMP. ALL OTHER ROLLERS SHOWED ONLY MINOR WEAR. OMRSD SPECIFIES PERIODIC SCREEN INSPECTION (V41BUO.160) WHICH WILL DETECT CONTAMINANTS GENERATED BY THE ROLLERS (REF CAR AD3220).

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 -

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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	: STUART KOBATA	: /S/ STUART KOBATA
MPS SUBSYSTEM MGR.	: TIM REITH	: /S/ TIM REITH
MOD	: JEFFREY L. MUSLER	: /S/ JEFFREY L. MUSLER
USA SAM	: MICHAEL SNYDER	: /S/ MICHAEL SNYDER
USA ORBITER ELEMENT	: SUZANNE LITTLE	: /S/ SUZANNE LITTLE
NASA SR&QA	: WILLIAM PRINCE	: /S/ WILLIAM PRINCE