

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
NUMBER: M4-186-CV010-01

SUBSYSTEM: ELECTRICAL POWER GENERATION - CRYO, GENERIC REVISION# 1 11/12/91 R

ITEM NAME: CHECK VALVE 02

CRITICALITY OF THIS FAILURE MODE: 1R3

FM

- FAILURE MODE:
FAILS OPEN OR INTERNAL LEAKAGE

MISSION PHASE:

LO LIFT-OFF
 CO ON-ORBIT
 DO DE-ORBIT
 LS LANDING SAFING

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

- CAUSE:
CONTAMINATION, CORROSION

- CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

- REDUNDANCY SCREEN A) PASS
 B) FAIL
 C) PASS

PASS/FAIL RATIONALE:

- A)
- B)
FAILURE MODE IS NOT DETECTABLE DURING FLIGHT SINCE CHECK VALVE IS NORMALLY OPEN DURING SYSTEM OPERATION.
- C)

- FAILURE EFFECTS -

- (A) SUBSYSTEM:
NO EFFECT AFTER FIRST FAILURE. FAILED CONDITION WOULD NOT BE DETECTED DURING NORMAL SYSTEM OPERATION.

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- (B) INTERFACING SUBSYSTEM(S):
SAME AS (A)
- (C) MISSION:
SAME AS (A)
- (D) CREW, VEHICLE, AND ELEMENT(S):
SAME AS (A)
- (E) FUNCTIONAL CRITICALITY EFFECTS:
FUNCTIONAL CRITICALITY EFFECTS - AN ADDITIONAL FAILURE OF THE ASSOCIATED TANK RELIEF VALVE, FAILING OPEN, MAY RESULT IN LOSS OF SYSTEM PRESSURE IF BOTH MANIFOLD ISOLATION VALVES FAIL TO CLOSE. LOSS OF SYSTEM PRESSURE RESULTS IN LOSS OF ALL THREE FUEL CELL POWERPLANTS (LOSS OF CREW/VEHICLE).

- DISPOSITION RATIONALE -

- (A) DESIGN:
VALVE PROTECTED AGAINST CONTAMINATION BY A 12 MICRON ABSOLUTE FILTER UPSTREAM OF VALVE AND A 45 MICRON ABSOLUTE FILTER SCREEN IN VALVE. VALVE IS CONSTRUCTED OF CORROSION RESISTANT MATERIALS (304L, 304 COND. 3, RC 55 ELGILOY).
- (B) TEST:
QUALIFICATION TEST INCLUDED THERMAL/OPERATING LIFE CYCLE TESTING (300K CYCLES) WITH NO EVIDENCE OF CHATTER, EXCESSIVE WEAR, CONTAMINATION, OR OPERATIONAL DEGRADATION.

ACCEPTANCE TEST VERIFIES CRACKING PRESSURES ARE WITHIN LIMITS (3 +2/-0 PSI) TOLERANCE AND PRESSURE DROP DOES NOT EXCEED 7.5 PSI AT MAXIMUM SYSTEM FLOW RATES. VALVE VERIFIED CLEANED TO LEVEL 200A BY PARTICLE COUNT AND NON-VOLATILE RESIDUE (NVR). VALVE OPERATION IS FURTHER VERIFIED DURING PANEL MODULAR ASSEMBLY AND SUBSYSTEM CHECKOUT.

CMRSD: CHECK VALVE OPERATION VERIFIED IN-FLIGHT.
- (C) INSPECTION:
RECEIVING INSPECTION
MATERIAL CERTIFICATIONS AND TEST REPORTS ARE REVIEWED TO VERIFY THAT MATERIAL COMPOSITION, DIMENSIONS, AND SURFACE CONDITIONS COMPLY WITH DESIGN REQUIREMENTS.

CONTAMINATION CONTROL
ACCOMPLISHMENT OF PREASSEMBLY CLEANING, VAPOR DEGREASING, AND

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ULTRASONIC CLEANING IS VERIFIED. PIECE PART CLEANLINESS IS CERTIFIED TO LEVEL 200A (MAQ110-301) BY A MVR AND PARTICLE COUNT (50 ML FLUSH THROUGH A MILLIPORE FILTER). COMPONENT ASSEMBLY, PACKAGING, AND SUBSEQUENT SUBASSEMBLY INSTALLATION ARE ACCOMPLISHED IN 100,000 CLASS CLEANROOM ENVIRONMENTS. COMPLETED ASSEMBLY IS VERIFIED TO LEVEL 200A.

CRITICAL PROCESSES

ELECTRON BEAM WELDS ARE INSPECTED FOR DEFECTS UNDER 10X VISUAL EXAMINATION DURING COMPONENT ASSEMBLY. INDUCTION BRAZING IS RADIOGRAPHICALLY INSPECTED DURING MODULAR ASSEMBLY.

■ (D) FAILURE HISTORY:

CAR NO. A4365-010 SUPPLIER, QUALIFICATION
DURING A CHECK VALVE POST VIBRATION LEAK CHECK, OUT OF SPECIFICATION LEAKAGE WAS DETECTED IN THE CHECKED DIRECTION. LEAKAGE WAS CAUSED BY SEVERE WEAR AT THE POPPET/VALVE HOUSING INTERFACE DUE TO THE INTRODUCTION OF SECONDARY OSCILLATING VIBRATIONS. THE WEAR WAS AGGRAVATED BY THE PRESENCE OF EXCESS PARTICULATE CONTAMINATION WITHIN THE TEST SET-UP. THE SECONDARY OSCILLATIONS WERE DETERMINED TO BE CAUSED BY AN INADEQUATE TEST SET-UP.
CORRECTIVE ACTION INCLUDED REDUCING THE VIBRATION TEST LEVEL SPECIFICATION FROM 0.4 G SQ/HZ TO 0.1 G SQ/HZ (THE APPROPRIATE LEVEL AS SPECIFIED IN MF0004-014 FOR ZONE VIBRATION REQUIREMENTS) AND REVISING THE QUALIFICATION TEST PROCEDURE TO INCLUDE: ADDING A REVERSE FLOW CHECK AFTER EACH AXIS OF RANDOM VIBRATION, REVISING THE TEST SET-UP AND FIXTURES TO PRECLUDE INTRODUCTION OF SECONDARY OSCILLATING VIBRATIONS AND TO PROVIDE POSITIVE FILTER PROTECTION OF TEST SPECIMEN.

CAR NO. AC0124-010 KSC, OV-102, GROUND CHECK
OUT OF SPECIFICATION LOSS OF MANIFOLD PRESSURE WAS DETECTED DURING OV-102 SUBSYSTEM CHECKOUT. LEAKAGE WAS ISOLATED TO THE MANIFOLD RELIEF VALVE AND/OR CHECK VALVE. LEAKAGE COULD NOT BE ISOLATED TO EITHER THE RELIEF VALVE OR CHECK VALVE SINCE THE COMPONENTS ARE INSTALLED IN PARALLEL. THIS LEAKAGE FELL WITHIN SPECIFICATION WITH FURTHER OPERATION WHICH PROMPTED MONITORING OF SYSTEM PERFORMANCE WITH FURTHER USE. THE LEAKAGE WAS SUSPECTED TO BE CAUSED BY A CONTAMINANT WHICH CLEARED ITSELF WITH SUBSEQUENT USE.

CAR NO. AC1281-010 KSC, OV-102, GROUND CHECK
DURING OV-102 SUBSYSTEM CHECKOUT, THE H2 CHECK VALVE ASSOCIATED WITH TANK SET #3, EXHIBITED OUT OF SPECIFICATION LEAKAGE IN THE CHECKED DIRECTION. DISASSEMBLY REVEALED CORROSION ON THE POPPET, SEAT, AND GALLING BETWEEN THE POPPET AND GUIDE. THE CAUSE OF LEAKAGE WAS ATTRIBUTED TO CONTAMINATION, AS A RESULT OF FLUSHING OPERATIONS AFTER REPEATED BRAZING (9 TOTAL, MAXIMUM ALLOWABLE BRAZES IS 8) AND FLUSHING OPERATIONS.
CORRECTIVE ACTION INCLUDED REVISING EO V544-454009, B01.

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AND EQ 4525-454010, A03 TO ELIMINATE FREON FLUSHING. TUBING IS INDIVIDUALLY CLEANED AND BRAZING IS DONE WITHIN CLEAN ROOM (FREON FLUSHING NOT REQUIRED AFTER BRAZING).

- (E) OPERATIONAL USE:
NO CREW ACTION AFTER FAILURE. CREW WOULD ATTEMPT TO ISOLATE SUBSEQUENT TANK LEAK BY CLOSING MANIFOLD VALVE.

- APPROVALS -

RELIABILITY ENGINEERING:	M. C. WEST	:	<u>M. C. West</u>
DESIGN ENGINEERING	: M. M. SCHEIERN	:	<u>M. M. Scheiern</u>
QUALITY MANAGER	: O. J. BUTTNER	:	<u>O. J. Buttner</u>
NASA RELIABILITY	:	:	<u>[Signature]</u>
NASA SUBSYSTEM MANAGER	:	:	<u>[Signature]</u>
NASA QUALITY ASSURANCE	:	:	<u>[Signature]</u> 4/19/92
		:	<u>[Signature]</u> 4/9/92 HTF